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ABSTRACT

The training manual is designed to train naval personnel in the professional aspects of their rating as Data Processing (DP) Technician and is a direct help to meeting the occupational qualifications for advancement to Data Processing Technician Third Class and Data Processing Technician Second Class. Personnel of the Data Processing Technician rating operate many types of automatic data processing (ADP) equipment to provide accounting and statistical services for the Navy. The DP rating is a general rating and does not include service ratings. Areas of specialization within the rating are identified by Navy Enlisted Classification Codes. The introductory chapter of the manual gives information on the enlisted rating structure and procedures for advancement; the remaining 12 chapters deal with the technical subject matter of the DP rating: automatic data processing, card punches and verifiers, card sorters, functional wiring principles, interpreters, automatic punches, collaters, accounting machines, electronic data processing, operation and control of EDP equipment, storage concepts, and programing and languages. (Author/AJ)

DATA PROCESSING TECH 3 & 2

NAVAL TRAINING COMMAND

RATE TRAINING MANUAL NAVTRA 10264-C

PREFACE

This book is intended as an aid for men who are seeking to acquire the theoretical knowledge and the operational skills required of Data Processing Technician Third Class and Data Processing Technician Second Class. As one of the Navy Training Manuals, this book was prepared by the Naval Training Publications Detachment, Washington, D.C., for the Chief of Naval Education and Training. Review and technical assistance were provided by Commander, Training Command, U.S. Pacific Fleet, San Diego, Calif.; Commander, Training Command, U.S. Atlantic Fleet, Norfolk, Va.; Chief of Naval Technical Training, Naval Air Station, Memphis, Millington, Tenn.; Commander, Naval Ships Systems Command, Washington, D.C.; Commander, Naval Ship Engineering Center, Washington, D. C.; Commanding Officer, Service School Command, Naval Training Center, San Diego, Calif.; Commanding Officer, Naval Examining Center, Great Lakes, Ill.; Officer in Charge, Naval Ship Engineering Center, Naval Base, Norfolk, Va. and by the Director, Information Systems, Washington, D. C.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

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CREDITS

Preparation of this manual was aided by the cooperation and courtesy of International Business Machines Corporation; UNIVAC, Division of Sperry Rand Company; Honeywell, Incorporated; Radio Corporation of America; and General Kinetics Incorporated. These companies have supplied technical information, machine reference manuals, photographs of machines, and machine features which aided considerably in the preparation of this text. Permission to use these materials is gratefully acknowledged.

Illustrations not listed below are from Navy sources.

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CHAPTER 1

ADVANCEMENT AND SECURITY

This training manual is designed to train you in the professional aspects of your rating and to assist you in achieving the fundamental purpose of all naval training, victory at sea. This manual is also a direct help to you in meeting the occupational qualifications for advancement to Data Processing Technician Third Class and Data Processing Technician Second Class.

The Data Processing Technician qualifications used as a guide in the preparation of this training manual are those contained in the *Manual of Qualifications for Advancement*, NAVPERS 18068-C.

Chapters 2 through 13 of this training manual deal with the technical subject matter of the Data Processing Technician rating.

The remainder of this chapter gives information on the enlisted rating structure, the Data Processing Technician rating, requirements and procedures for advancement in rating, and references that will help you both in working for advancement and in performing your duties as a DP. This chapter includes information on how to make the best use of rate training manuals. Therefore, it is strongly recommended that you study this chapter carefully before beginning intensive study of the remainder of this manual.

THE ENLISTED RATING STRUCTURE

The two main types of ratings in the present enlisted rating structure are general ratings and service ratings.

GENERAL RATINGS identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

SERVICE RATINGS identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

THE DATA PROCESSING TECHNICIAN RATING

Personnel of the Data Processing Technician (DP) rating operate many types of automatic data processing (ADP) equipment to provide accounting and statistical services for the Navy. They wire control panels for electric accounting machines (EAM) and write programs for electronic data processing machines (EDPM). They process incoming information and make routine and special reports as required. They are thoroughly familiar with data processing applications and in the higher pay-grades are thoroughly familiar with administrative and management functions peculiar to data processing offices and installations.

The DP rating is a general rating, and does not include service ratings. Areas of specialization within the rating are identified by Navy Enlisted Classification Codes. These codes identify such specialists as an Electronic Data Processing Systems Operator, who operates large-scale electronic data processing machines and a Tabulating Machine Serviceman, who adjusts and repairs electric tabulating equipment.

The use of naval personnel to operate electric accounting machines goes back to the early days of World War II. The enormous expansion of the naval forces to meet the threat of enemy aggression resulted in a greatly increased workload for clerical personnel. Concerned with this problem, the Chief of Naval Personnel explored possibilities of handling the mountains of paperwork more efficiently. As a result of this research, the Bureau of Naval Personnel installed

and began using punched card data processing equipment, resulting in the establishment of the Specialist (I) rating. This rating remained a specialist rating until 1948. At that time it was designated Machine Accountant (MA) and incorporated into the Regular Navy rating structure. On July 1, 1967, it was redesignated Data Processing Technician, a more descriptive and appropriate title for the rating. Also in 1967, new Warrant Officer (783X) and Limited Duty Officer (623X) categories were established for Data Processing Technicians. This afforded DPs the first opportunity to apply for commissioned status and remain in their field, rather than branch into Supply or General Administration.

DP ASSIGNMENTS

Data Processing Technicians may be ordered to many different types of activities which perform data processing by both electrical and electronic methods. These include ship and shore installations of the Operating Force, Shore Support activities, Bureaus, Systems Commands, and Offices of the Navy Department. Generally speaking, the mission of a data processing installation is prescribed by the Bureau, Office, or Systems Command exercising command. The data processing systems employed may be broadly grouped as personnel, supply, maintenance and material management (3-M), fiscal, research, security, communications, and operations control. An installation may perform data processing services under one or more of these systems, and various other miscellaneous services, depending upon the type of installation and its assigned mission.

A few Data Processing Technicians who are qualified instructors may be assigned instructor duty in the DP "A" or "C" schools. Other duty assignments include the U.S. Naval Examining Center, Great Lakes, where the servicewide advancement in rating examinations are prepared and scored; Naval Training Publications Datachment, Washington, D. C., and various other highly specialized billets. (This training manual that you are now studying was revised by a Chief Data Processing Technician while he was assigned to an instructor billet at Training Publications Detachment.) Regardless of location, all Data Processing Technicians are assigned by the Bureau of Naval Personnel, Washington, D. C.

THE DP AS A LEADER

Data processing installations often accomplish their work on an assembly-line basis. They are divided into sections, with each section responsible for accomplishing certain phases of data processing applications. For example, one section receives, codes, and files source documents. Another converts the source documents into punched card data. Other sections apply the incoming data to existing files and produce reports and services as required. Each section must complete its work accurately and on time so that the work can be kept flowing in an orderly fashion. The efforts of all sections working together are required to accomplish the mission of the installation.

Obviously, someone in each section has to be responsible for seeing that the work is accomplished. This is the job of the section leader, who could be YOU. The term LEADER usually implies responsibilities in supervising and directing a group of people. As a leader, you must be able to make job assignments, supervise the work, and see that all jobs are performed correctly and on time. If you are thoroughly familiar with the work for which you are responsible, are willing to accept responsibility (both assigned and assumed), and practice the habit of setting a good example, then you are on the right road to effective leadership.

Leadership is not restricted to those in positions of supervision or authority. It concerns each and every one of us, from the Seaman on up. You exercise leadership in the way you perform your job; whether it is keypunching, operating a console, or any other task. The manner in which you follow instructions, the care you exercise when handling data, your observance of safety precautions, and your adeptness at operating machines, are only a few of the ways that leadership characteristics are displayed. You must remember that there are always others around who learn their habits (sometimes unconsciously) from what they see YOU do. Remember also that your supervisor evaluates you from personal observance of your performance. His evaluation counts in the final decision to

recommend or not recommend you for advancement in rating.

The rewards for practicing good leadership traits are many. For example, you get a certain feeling of pride when your supervisor compliments you on a job well done or when he tells someone he doesn't see how he can get along without you. There is satisfaction also in knowing that you are setting a good example for less experienced personnel to follow. Most important of all, you have an inner satisfaction in knowing that you have performed your work to the best of your ability. No one could ask more of you.

It may be well for you to stop and read that portion of *Military Requirements for Petty Officers 3 & 2* that deals with leadership. You will find points on how to exercise good leadership that can be easily applied to the Data Processing Technician rating. In addition, you will find quotations from Navy Department General Order 21, which all personnel should be familiar with.

ADVANCEMENT IN RATE

Some of the rewards of advancement are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

But the advantages of advancement are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By each advancement, you increase your value to the Navy in two ways. First, you become more valuable as a specialist in your own rating. And second, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy.

HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and occupational training manuals.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NAVPERS 1414/1. In some cases the Record of Practical Factors may contain the old form number, NAVPERS 760.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher grade.
5. Demonstrate your KNOWLEDGE by passing written examinations on the occupational and military qualification standards for advancement.

Some of these general requirements may be modified in certain ways. Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the qualifications for advancement can change. Check with your division officer or training officer to be sure that you know the most recent qualifications.

Advancement is not automatic. Even though you have met all the requirements, including passing the written examinations, you may not be able to "sew on the crow" or "add a stripe." The number of men in each rate and rating is controlled on a Navywide basis. Therefore, the number of men that may be advanced is limited by the number of vacancies that exist. When the number of men passing the examination exceeds the number of vacancies, some system must be used to determine which men may be advanced and which may not. The system used is the "final multiple" and is a combination of three types of advancement systems.

Merit rating system
Personnel testing system
Longevity, or seniority system

The Navy's system provides credit for performance, knowledge, and seniority, and, while it cannot guarantee that any one person will be

REQUIREMENTS *	E1 to E2	E2 to E3	# E3 to E4	#† E4 to E5	† E5 to E6	† E6 to E7	† E7 to E8	† E8 to E9
SERVICE	4 mos. service-or completion of Recruit Training.	8 mos. as E-2.	6 mos. as E-3.	12 mos. as E-4.	24 mos. as E-5.	36 mos. as E6. 8 years total enlisted service.	36 mos. as E-7. 8 of 11 years total service must be enlisted.	24 mos. as E-8. 10 of 13 years total service must be enlisted.
SCHOOL	Recruit Training. (C.O. may advance up to 10% of graduating class.)		Class A for PR3, DT3, PT3, AME 3, HM 3, PN 3, FTB 3, MT 3,			Class B for AGC, MUC, MNC.††		
PRACTICAL FACTORS	Locally prepared check-offs.	Record of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.						
PERFORMANCE TEST			Specified ratings must complete applicable performance tests before taking examinations.					
ENLISTED PERFORMANCE EVALUATION	As used by CO when approving advancement.		Counts toward performance factor credit in advancement multiple.					
EXAMINATIONS **	Locally prepared tests.	See below.	Navy-wide examinations required for all PO advancements.				Navy-wide, selection board.	
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)		Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavTra 10052 (current edition).					Correspondence courses and recommended reading. See NavTra 10052 (current edition).	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

* All advancements require commanding officer's recommendation.
† 1 year obligated service required for E-5, and E-6; 2 years for E-7, E-8, and E-9.
\# Military leadership exam required for E-4 and E-5.
** For E-2 to E-3, NAVEXAMCEN exams or locally prepared tests may be used.
†† Waived for qualified EOD personnel.

5.1

Figure 1-1.—Active duty advancement requirements.

REQUIREMENTS *	E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7	E8	E9
TOTAL TIME IN GRADE	4 mos.	8 mos.	6 mos.	12 mos.	24 mos.	36 mos. with total 8 yrs service	36 mos. with total 11 yrs service	24 mos. with total 13 yrs service
TOTAL TRAINING DUTY IN GRADE †	14 days	14 days	14 days	14 days	28 days	42 days	42 days	28 days
PERFORMANCE TESTS			Specified ratings must complete applicable performance tests before taking examination.					
DRILL PARTICIPATION	Satisfactory participation as a member of a drill unit in accordance with BUPERSINST 5400.42 series.							
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)	Record of Practical Factors, NavPers 1414/1, must be completed for all advancements.							
RATE TRAINING MANUAL (INCLUDING MILITARY REQUIREMENTS)	Completion of applicable course or courses must be entered in service record.							
EXAMINATION	Standard Exam		Standard Exam required for all PO advancements. Also pass Military Leadership Exam for E-4 and E-5.				Standard Exam, Selection Board.	
AUTHORIZATION	Commanding Officer		Naval Examining Center					

*Recommendation by commanding officer required for all advancements.
† Active duty periods may be substituted for training duty.

5.2

Figure 1-2.—Inactive duty advancement requirements.

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advanced, it does guarantee that all men within a particular rating will have equal advancement opportunity.

The following factors are considered in computing the final multiple:

POINTS	FACTOR	WEIGHT
80 (MAX)	Examination Score	40%
50 (MAX)	Performance (Average of marks received)	25%
20 (MAX)	Total Active Service (1 per yr)	10%
20 (MAX)	Time in Present Grade (2 per yr)	10%
15 (MAX)	Awards (pts per award)	7.5%
15 (MAX)	PNA (Maximum 3 per exam cycle)	7.5%
200 (MAX POSSIBLE)		100%

PNA (passed, not advanced) points are awarded as follows: A maximum of three points can be accrued each examination. Over five examination cycles, a maximum of 15 points can be obtained. The Naval Examining Center maintains historical tapes on candidate PNA point awards. These are awarded to passing candidates not advanced as follows:

EXAMINATION FACTOR
STANDARD SCORE

RELATIVE STANDING	POINTS
Exceeding above average (Score in 70s)	1.5
Above average (Score in 60s)	1.0
Average (remainder of passing candidates)	0.5

PERFORMANCE EVALUATION FACTOR

RELATIVE STANDING	POINTS
Upper 25% by peer group standing	1.5
Peer group standing of 26% – 50%	1.0
Peer group standing of 51% – 75%	0.5
Lower 25% by peer group standing	0.0

NOTE: Maximum of 3 multiple points per cycle.

All of the preceding information (except the examination score) is submitted to the Naval Examining Center with your examination answer sheet. After grading, the examination scores, for those passing, are added to the other factors to arrive at the final multiple. A precedence list, which is based on final multiples, is then prepared for each pay grade within each rating. Advancement authorizations are then issued, beginning at the top of the list, for the number of men needed to fill the existing vacancies.

HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement? You must study the qualifications for advancement, work on the practical factors, study the required rate training manuals, and study other material that is required for advancement in your rating. To prepare for advancement, you will need to be familiar with (1) the *Quals Manual*, (2) the Record of Practical Factors, (3) the *Bibliography for Advancement Study*, NAVTRA 10052, and (4) applicable rate training manuals. The following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

Quals Manual

The *Manual of Qualifications for Advancement*, NAVPERS 10688-C (with changes), gives the minimum occupational and military qualification standards for advancement to each pay grade within each rating. This manual is usually called the "Quals Manual," and the qualifications themselves are often called "quals." The qualifications standards are of two general types: (1) military qualification standards and (2) occupational qualification standards.

MILITARY STANDARDS are requirements that apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval

organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

OCCUPATIONAL STANDARDS are requirements that are directly related to the work of each rating.

Both the military requirements and the occupational qualification standards are divided into subject matter groups. Within each subject matter group, they are further divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

In most subject matter areas, you will find both practical factor and knowledge factor qualifications. In some subject matter areas, you may find only one or the other. It is important to remember that there are some knowledge aspects to all practical factors, and some practical aspects to most knowledge factors. Therefore, even if the *Quals Manual* indicates that there are no knowledge factors for a given subject matter area, you may still expect to find examination questions dealing with the knowledge aspects of the practical factors listed in that subject matter area.

You are required to pass a Navywide military/leadership examination for E-4 or E-5, as appropriate, before you take the occupational examinations. The military/leadership examinations are administered on a schedule determined by your commanding officer. Candidates are required to pass the applicable military/leadership examination only once. Each of these examinations consists of 100 questions based on information contained in *Military Requirements for Petty Officers 3 & 2*, NAVPERS 10056 (current edition) and in other publications listed in *Bibliography for Advancement Study*, NAVPERS 10052 (current edition).

The Navywide occupational examinations for pay grades E-4 and E-5 will contain 150 questions related to occupational areas of your rating.

If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

The *Quals Manual* is kept current by means of changes. The occupational qualifications for your rating which are covered in this training manual were current at the time the manual was printed. By the time you are studying this manual the quals for your rating may have been changed. Never trust any set of quals until you have checked it against an UP-TO-DATE copy in the *Quals Manual*.

Record of Practical Factors

Before you can take the servicewide examination for advancement, there must be an entry in your service record to show that you have qualified in the practical factors of both the military qualifications and the occupational qualifications. The RECORD OF PRACTICAL FACTORS, mentioned earlier, is used to keep a record of your practical factor qualifications. This form is available for each rating. The forms list all practical factors, both military and occupational. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns by supervising or senior PO's.

Changes are made periodically to the *Manual of Qualifications for Advancement*, and revised forms of NAVPERS 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional factors as they are published in changes to the *Quals Manual*. The Record of Practical Factors provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

Until completed, the NAVPERS 1414/1 is usually held by your division officer for insertion in your service record. If you are transferred before qualifying in all practical factors, the incomplete form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

NAVTRA 10052

Bibliography for Advancement Study, NAVTRA 10052 (revised), is a very important publication for any enlisted person preparing for advancement. This bibliography lists required and recommended rate training manuals and other reference material to be used by personnel working for advancement.

NAVTRA 10052 is revised and issued once each year by the Naval Training Support Command. Each revised edition is identified by a letter following the NAVTRA number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NAVTRA 10052, a supplementary list of study material may be issued in the form of a NAVTRA Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a Notice has been issued to supplement NAVTRA 10052 for your rating.

The required and recommended references are listed by pay grade in NAVTRA 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the reference listed at the third class level.

In using NAVTRA 10052, you will notice that some rate training manuals are marked with as asterisk (*). Any manual marked in this way is mandatory—that is, it must be completed at the indicated rate level before you can be eligible to take the servicewide examination for advancement. Each mandatory manual may be completed by (1) passing the appropriate enlisted correspondence course that is based on the mandatory training manual; (2) passing locally prepared tests based on the information given in the training manual; or (3) in some cases, successfully completing an appropriate Class A school.

Do not overlook the section of NAVTRA 10052 which lists the required and recommended references relating to the military qualification standards for advancement. Personnel of ALL ratings must complete the mandatory military requirements training manual for the appropriate rate level before they can be eligible to advance.

The references in NAVTRA 10052 which are recommended but not mandatory should also be studied carefully. ALL references listed in NAVTRA 10052 may be used as a source material for the written examinations, at the appropriate rate levels.

Rate Training Manuals

As a result of the establishment of the Naval Training Support Command under the Chief of Naval Training, new editions of rate training manuals, correspondence courses, curricula, and other training publications formerly designated with the abbreviation NAVPERS are being designated NAVTRA. This training manual, for example, is NAVTRA 10264-C, which means that it is a publication of the Naval Training Support Command and succeeds a manual designated NAVPERS 10264-B.

In this chapter, and elsewhere in this manual, training publications which already carry the new abbreviations are so listed; those not yet changed are listed as NAVPERS numbers.

There are two general types of rate training manuals. RATING manuals (such as this one) are prepared for most enlisted ratings. A rating manual gives information that is directly related to the occupational qualifications of ONE rating. SUBJECT MATTER manuals or BASIC manuals give information that applies to more than one rating.

Rate training manuals are revised from time to time to keep them up to date technically. The revision of a rate training manual is identified by a letter following the NAVTRA number. You can tell whether any particular copy of a training manual is the latest edition by checking the NAVTRA number and the letter following this number in the most recent edition of *List of Training Manuals and Correspondence Courses*, NAVTRA 10061. (NAVTRA 10061 is actually a catalog that lists all current training manuals and correspondence courses; you will find this catalog useful in planning your study program.)

Each time a rate training manual is revised, it is brought into conformance with the official publications and directives on which it is based; but during the life of any edition, discrepancies

between the manual and the official sources are almost certain to arise because of changes to the latter which are issued in the interim. In the performance of your duties, you should always refer to the appropriate official publication or directive. If the official source is listed in NAVTRA 10052, the Naval Examining Center uses it as a source of questions in preparing the Fleetwide examinations for advancement. In case of discrepancy between any publications listed in NAVTRA 10052 for a given rate, the Examining Center will use the most recent material.

Rate training manuals are designed to help you prepare for advancement. The following suggestions will help you to make the best use of this manual and other Navy training publications when you are preparing for advancement.

1. Study the military qualifications and the occupational qualifications for your rating before you study the training manual, and refer to the quals frequently as you study. Remember, you are studying the manual primarily in order to meet these quals.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for the time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the manual intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book without any particular plan, looking at the illustrations and reading bits here and there as you see the things that interest you.

4. Look at the training manual in more detail to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions:

What do I need to learn about this?

What do I already know about this?

How is this information related to information given in other chapters?

How is this information related to the qualifications for advancement?

5. When you have a general idea of what is in the training manual and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit–it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit–chapter, section, or subsection–write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training manual to the knowledge you already have. When you read about a process, a skill, or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying the unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training manual, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, chances are that you have not really mastered the material.

9. Use enlisted correspondence courses whenever you can. The correspondence courses are based on rate training manuals or on other appropriate texts. As mentioned before, completion of a mandatory rate training manual can be accomplished by passing an enlisted correspondence course based on the rate training manual. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory manuals. Taking a correspondence course helps you to master the information given in the training manual and also helps you to see how much you have learned.

10. Think of your future as you study rate training manuals. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

SOURCES OF INFORMATION

Besides training manuals, NAVTRA 10052 lists other publications on which you may be examined. You should not only study the sections required, but should become as familiar as possible with all publications you use.

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the occupational qualifications of your rating.

PUBLICATIONS YOU SHOULD KNOW ABOUT

This training manual covers only the basic principles of machine operation and control panel wiring for EAM data processing machines, and basic languages, components, and functions for programming and operation of an electronic data processing system (EDPS). While the information contained herein will give you a working knowledge of the equipment and procedures discussed, it does not cover every aspect and feature of any particular type of component or system.

Each different type of data processing installation where Data Processing Technicians are assigned has a different set of manuals and instructions for operating procedures and guidelines. It is important that you obtain and study the appropriate publications pertaining to the type of work your installation performs.

Technical Manuals

Manufacturers' technical manuals are usually furnished to the activity upon request. These manuals contain detailed information concerning machine operation, including information on optional and special devices with which machines may be equipped.

It is recommended that, in order to broaden your knowledge of the particular device or devices with which you are working, you obtain and study the appropriate manufacturers' technical manuals, as these manuals cover in detail the areas covered broadly in the rate training manuals.

SECURITY

The security of the United States in general, and of Naval operations in particular, depends to a large extent upon the success attained in safe-guarding classified materials. The Navy man will be exposed to classified material almost on a daily basis. Because of this frequency of exposure, it is necessary that the regulations pertraining to access and handling not only be known but also followed.

SECURITY CLASSIFICATIONS

Official information that requires protection in the interest of national defense is limited to three categories of classification. In descending order of importance, these categories are Top Secret, Secret, and Confidential.

TOP SECRET.—Top Secret material or information is that of which the defense aspect is paramount, and the unauthorized disclosure of which would result in EXCEPTIONALLY GRAVE DAMAGE to the Nation. Such grave damage might consist of, but is not limited to—

1. Leading to a definite break in diplomatic relations affecting the defense of the United States, an armed attack against the United States or her allies, or a war.
2. The compromise of military or defense plans, or intelligence operations, or scientific or technological developments vital to the national defense.

SECRET.—The classification Secret is limited to defense information or material, the unauthorized disclosure of which could result in SERIOUS DAMAGE to the Nation, such as

jeopardizing the international relations of the U.S., endangering the effectiveness of a program or policy of vital importance to national defense, compromising important military or defense plans or technological developments, or revealing important intelligence operations.

CONFIDENTIAL.–The use of the classification Confidential is limited to defense information or material, the unauthorized disclosure of which could be PREJUDICIAL TO THE DEFENSE INTERESTS of the Nation, such as:

1. Operational and battle reports that contain information of value to the enemy
2. Intelligence reports
3. Military radiofrequency and call sign allocations that are especially important, or are changed frequently for security reasons
4. Devices and material relating to communication security
5. Information that reveals strength of land, air, or naval forces in the United States and overseas areas, identity and composition of units, or detailed information relating to their equipment
6. Documents and manuals containing technical information used for training, maintenance, and inspection of classified munitions of war
7. Operational and tactical doctrine
8. Research, development, production, and procurement of munitions of war
9. Mobilization plans
10. Personnel security investigation and other investigations, such as courts of inquiry, which require protection against unauthorized disclosure
11. Matters and documents of a personal or disciplinary nature, which, if disclosed, could be prejudicial to the discipline and morale of the armed forces
12. Documents used in connection with procurement, selection, or promotion of military personnel, the disclosure of which could violate the integrity of the competitive system.

NOTE: Official information of the type described in items 10, 11, and 12 is classified Confidential only if its unauthorized disclosure could in fact be prejudicial to the defense interests of the Nation.

SECURITY AREAS

The shipboard and shore station spaces that contain classified matter are known as security areas. These security areas (sometimes called sensitive areas) have varying degrees of security interest, depending upon their purpose and the nature of the work and information or materials concerned. Consequently, the restrictions, controls, and protective measures required vary according to the degree of security importance. To meet different levels of security sensitivity, three types of security areas have been established: EXCLUSION, LIMITED, and CONTROLLED areas.

EXCLUSION AREA.–The cryptocenter, registered publications issuing office (RPIO) vault, classified conference room, and other spaces requiring the highest degree of control of access are designated exclusion areas. They contain classified matter of such nature that admittance to the area permits, for all practical purposes, access to such matter.

Exclusion areas are fully enclosed by walls or bulkheads of solid construction. All entrances and exits are guarded, and only persons whose duties require access and who possess appropriate security clearances are authorized to enter, after being positively identified. Normally, a list of personnel authorized entry, signed by the CO, is posted in the area.

LIMITED AREA.–Radio central, message center, relay station, transmitter rooms, and other communication spaces usually are designated limited areas.

Operating and maintenance personnel whose duties require freedom of movement within limited areas must have proper security clearances. The commanding officer may, however, authorize entrance of persons who do not have clearances. In such instances, escorts or attendants and other security precautions must be used to prevent access to classified information located within the area.

Entrances and exits of limited areas are either guarded or controlled by attendants to check personnel identification, or they may be protected by automatic alarm systems.

CONTROLLED AREA.--Passageways or spaces surrounding or adjacent to limited or exclusion areas are often designated controlled areas. Although a controlled area does not contain classified information, it serves as a buffer zone of security restriction. Moreover, it provides greater control, safety, and protection for limited and exclusion areas.

Controlled areas require personnel identification and control systems adequate to limit admittance to those having bona fide need for access to the area.

SECURITY INVESTIGATIONS AND CLEARANCES

Before a person can have access to classified material, his character and his past must be checked to the extent appropriate to the sensitivity of the material he will be handling. Following are the two basic qualifications.

1. He must be of unquestionable integrity, trustworthiness, and loyalty to the United States.
2. He must be of excellent character and of such habits and associations as to cast no doubt upon his discretion and good judgment in handling classified information.

Types of Investigations

To determine whether an individual meets the criteria for a security clearance, two types of personnel security investigations are made. They are the national agency check (NAC) and the background investigation (BI).

A national agency check consists of the review of the records and files of several Government agencies to determine if any derogatory information exists on the individual or on an organization to which he may have belonged.

The background investigation is much more extensive than a national agency check. It is designed to develop information on whether the access to classified information by the person being investigated is clearly consistent with the interests of national security. It inquires into the loyalty, integrity, and reputation of the individual.

Types of Clearances

A personnel security clearance is an administrative determination that an individual is eligible, from a security standpoint, for access to classified information of the same or lower category as the clearance being granted.

Of the two types of clearances (INTERIM and FINAL), an interim clearance is granted as the result of a lesser investigative process, and is a method for establishing temporary eligibility for access to certain levels of classified information.

An interim clearance is granted only when the delay in waiting for completion of the necessary steps for final clearance would be harmful to the national interest. Procedures to effect a final clearance are initiated simultaneously with initiation of the procedures for an interim clearance. The only type of clearance not granted to military personnel is the interim CONFIDENTIAL.

A final clearance is granted when it is determined that an individual is eligible, from a security standpoint, for access to classified information of specific levels.

Each clearance, final and interim, is evidenced by a certificate of clearance. Certificates of clearance are made a matter of record and become a permanent part of an individual's service record.

SECURITY VIOLATION AND COMPROMISES

No one in the Navy is authorized to handle any classified material except that required in the performance of duty. All other persons are unauthorized, regardless of grade, duties, or clearance.

If it is known—or even suspected—that classified material is lost, or is passed into the hands of some unauthorized person, the material is said to be compromised. The seriousness of the compromise depends on the nature of the material and the extent to which the unauthorized person may divulge or make use of what he learns.

Individuals found responsible for the loss, unauthorized disclosure, or possible subjection to compromise of classified information, and individuals who violate security regulations, are

promptly disciplined regardless of rank or position. Disciplinary action for military personnel may include trial by court-martial.

ACCOUNTING FOR AND CONTROL OF DISSEMINATION OF CLASSIFIED MATERIAL

The control of classified material is necessary for several purposes. It must be controlled to limit dissemination and to prevent excessive production or reproduction; it must be controlled so that, when regraded or declassified, the holders or recipients can be ascertained and notified; it must be controlled so that the office or person normally responsible for its security can be ascertained; and Top Secret material must be controlled so that its location can be determined promptly and so that those who have access to its contents can be ascertained. These requirements can generally be fulfilled by effective supervision, conscientious and informed execution of personal responsibilities, and efficient administration. In addition, the importance of Top Secret material requires a formal record for hand to hand transfer of custody from one accountable office or command to another. Secret material also requires a record of transfer of custody from one accountable command to another; and for Top Secret material, there is a special system for recording those who have access to Top Secret material.

The accounting system for an activity must provide readily available information on: what classified material it has received, what classified material it has produced, who has custody of a particular Top Secret document, and what disposition has been made of Top Secret and Secret material.

When military or civilian personnel resign or are to be separated from the Naval Establishment or released from active duty, all classified material held by them shall be turned in to the source from which received, to their commanding officer, or to the nearest naval command, as appropriate, prior to delivery of final orders or separation papers. In addition, any person in the Naval Establishment about to be relieved must deliver to his successor all classified material in his custody. Appropriate receipts must be completed covering as a minimum all Top Secret material.

Persons in command are responsible for controlling the dissemination of classified information emanating from or distributed within their commands. They are also responsible for the promulgation of additional directives that may be required to prevent unauthorized dissemination of information under their control. Classified material must not be removed from a command without the specific permission of the commanding officer or his authorized representative.

The dissemination of classified material is limited to those persons whose official duties require them to have knowledge or possession of such material. Responsibility for determining whether a person's official military or other governmental duties require that he possess or have access to any classified information and whether he is authorized to receive it rests upon each individual who has possession, knowledge, or command control of the information involved, and not upon the prospective recipient. These principles are equally applicable whether the prospective recipient is an individual, a U. S. military command, a defense contractor or another federal agency. In the case of a foreign government there is the additional requirement for written authorization from the Chief of Naval Operations.

Classified information must not be disclosed over telephones because of the insecurity due to executive cut-in, phantom voice interception, microwave transmission intercept, and wiretapping. Telephones located in sensitive areas must be provided with a means of complete disconnection such as a plug or jack arrangement if they are to be considered safe. Intercom systems located in sensitive areas must be confined to the sensitive area.

From a security viewpoint, the printing, duplicating or reproduction of classified material poses many problems; it contributes to the increasing volume of classified material; it permits quick and easy production of uncontrolled material containing classified information; the equipment or processes require care or special procedures to prevent or eliminate latent impressions or offset versions of the classified information; and a quantity of excess and waste

material is produced which can also contribute to compromise of the classified information.

Classified material may be produced or reproduced, however, when authorized by appropriate authority. Classified material produced or reproduced by any means must be recorded, and samples, waste or overruns resulting from the reproduction process must be safeguarded as specified in the Department of the *Navy Security Manual for Classified Information*, OPNAV Instruction 5510.1 series.

Transmission of Classified Material

Classified material must be safeguarded during transmission from one place to another as well as when held within a command. Due to the very nature of the problem, compromise or loss is more probable during transmission that at any other time. For this reason, specific rules ensure maximum security consistent with the need for rapid communication of the information.

Top Secret material may not be sent through any postal system, United States or foreign. It may be transmitted only by one of the following means:

1. Direct personal contact of military personnel (E-7 or above) and U. S. civilian employees (GS-7 or above) who have been cleared for access to Top Secret information. Military personnel (E-5 and E-6) and U. S. civilian employees (GS-5 and GS-6) who have been cleared for access to Top Secret information may transmit between Department of Defense elements located in relative close proximity to one another, provided the transmission is accomplished (begun and completed) during normal daytime duty hours on the same day.
2. Armed Forces Courier Service.
3. Electric means in encrypted form.

Secret and Confidential material may be sent by any of the methods authorized for transmitting Top Secret material, or by U. S. registered mail.

The foregoing rules apply only within the continental United States. When the national borders must be crossed, the rules are modified slightly. Secret and Confidential matter can be transmitted by U. S. registered mail provided it stays within U. S. military postal channels. Within the continental U. S., Canada, and Alaska, Secret and Confidential may be sent by registered mail with registered mail receipt.

Commanding officers are authorized to establish systems for transmitting classified material within the confines of their commands. Such systems must ensure that:

1. Top Secret material always is controlled by Top Secret control officers.
2. Personnel transmitting the classified material have security clearances for the highest category they are allowed to handle.
3. Personnel whose primary duties entail transmission of classified material are authorized in writing for such duties.
4. All personnel entrusted with transmitting classified material are instructed properly concerning their duties.

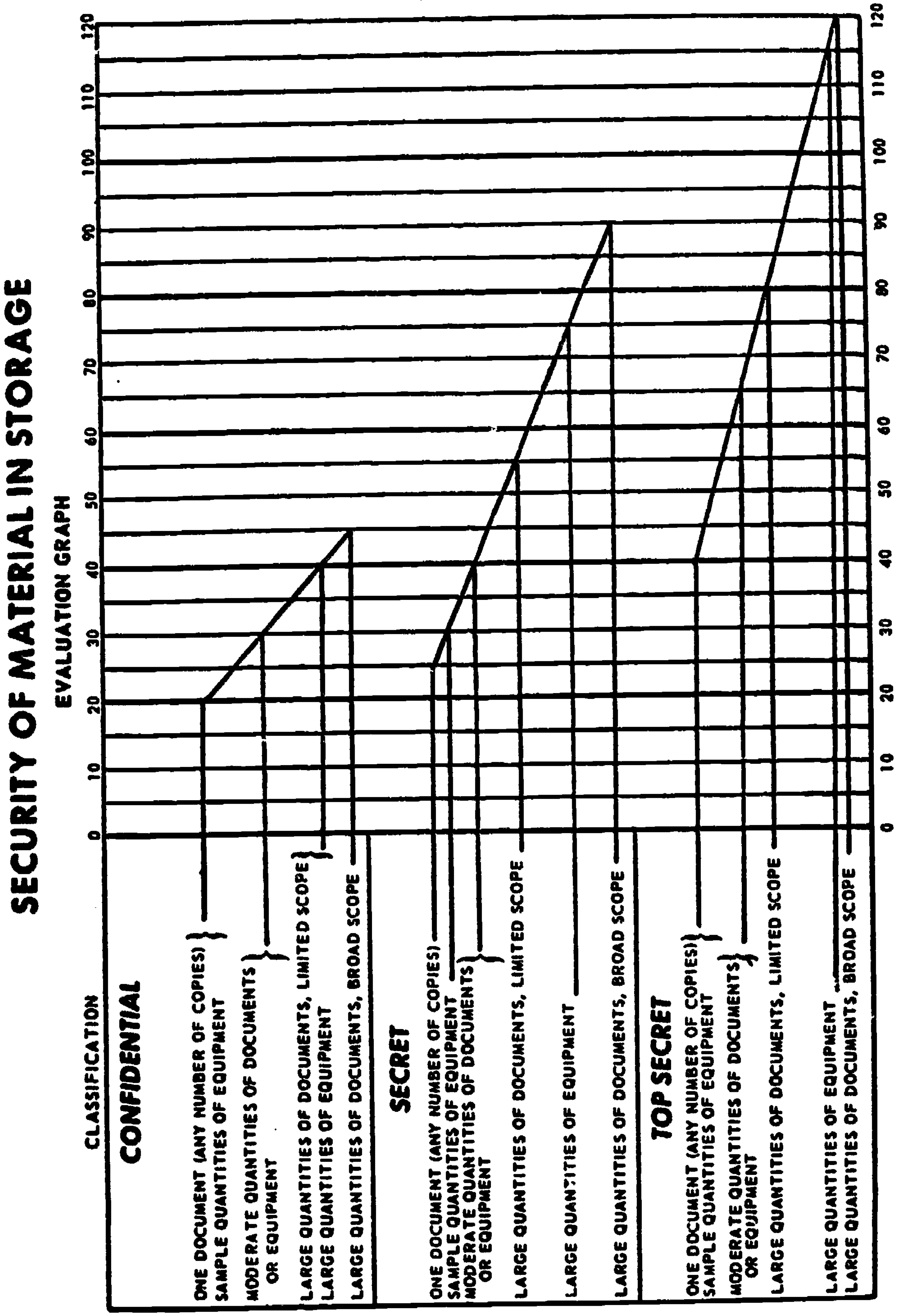
Transmission of classified material to Department of Defense contractors must meet the following conditions:

1. The contractor must have an appropriate clearance.
2. The releasing activity having cognizance over the contract or program under which the classified material is being released must determine that the contractor has a "need to know."
3. The recipient of the classified material must have the ability to physically safeguard the material.

Stowage of Classified Material

All classified matter not in actual use must be stowed in a manner that will guarantee its protection. The degree of protection necessary depends on the classification, quantity, and scope of the material.

A numerical evaluation system has been developed for determining the relationship between the security interest and the level of protection required. The more secure the stowage facilities, the higher are the numerical values assigned. Figure 1-3 shows the numerical values required for quantity and type of documents of each classification. Figure 1-4 is a guide for evaluating



31.2

Figure 1-3.—Table of numerical values required for classified material.

Element of Security	Value
1. Stowage Areas:	
a. Security Fences:	
(1) Classified area surrounded by a security fence with all gates secured or controlled	5
b. Protective Lighting:	
(1) Security areas lighted by protective lighting	5
c. Building or Ship:*	
(1) Conventional frame or good quality temporary structure	5
(a) Controlled areas within	15
(b) Limited areas within	25
(c) Exclusion areas within	35
(2) Masonry or steel structure with substantial partitions, floors and ceilings (including magazines)	10
(a) Controlled areas within	20
(b) Limited areas within	30
(c) Exclusion areas within	40
(3) Aboard a Commissioned Ship	25
(a) Controlled area	35
(b) Limited area	40
(c) Exclusion area	50
(4) "In Service" or MSC chartered vessel	10
(a) Controlled areas within	20
(b) Limited areas within	30
(c) Exclusion areas within	40
2. Stowage Containers:**	
a. Metal, keylock (built-in)	0
b. Metal, key padlock (attached)	0
c. Metal, high security key padlock (attached)	5
d. Metal, combination padlock (attached)	5
e. Metal, high security combination padlock (attached)	10
f. Metal, combination lock (built-in)	15
g. Strongroom or weapons magazine	15
h. Class C Vault	50
i. Class B Vault	60
j. Class A Vault	70
k. Class 2, approved GSA security container	60
l. Class 3, approved GSA security container	50
m. Class 4, approved GSA security container	60
n. Class 5, approved GSA security container	70
o. Class 6, approved GSA security container	55
p. Class 5 map and plan, approved GSA security container	70
2. Stowage Containers—Continued	
q. Class 6 map and plan, approved GSA security container	55
3. Guarding:	
a. Supporting Guard Force:	
(1) Civilian Supporting Guard Force	10
(2) Military Supporting Guard Force	15
b. Guards:	
(1) Civilian Guards:	
(a) Civilian guard in general area	10
(b) Civilian guard check of container each hour	15
(c) Civilian guard check of container each ½ hour	20
(d) Civilian guard in attendance at container	30
(2) Military Guards:	
(a) Military guard in general area	15
(b) Military guard check of container each hour	20
(c) Military guard check of container each ½ hour	25
(d) Military guard in attendance at container	60
c. Sentry dog accompanying military or civilian guard	10
4. Protective Alarm Systems:	
a. Area Alarm System:	
(1) Make or break (electro-mechanical) alarm to detect entry into immediate area	5
(2) Other alarm system to detect entry into immediate area	10
(3) Alarm system to detect entry or attempted entry into immediate area	15
(4) Alarm system to detect entry or attempted entry and approach to immediate area	25
b. Container Alarm Systems:	
(1) Make or break (electro-mechanical) alarm to detect opening of container	10
(2) Other alarm system to detect opening of container	15
(3) Alarm system to detect opening or tampering with container	20
(4) Alarm system to detect opening or tampering with and approach to container	25

* Buildings must be under U.S. Government control or if not under U.S. Government control the space occupied within the building must be at least a controlled area.

** Evaluate as indicated provided other elements in the security program are available to minimize the possibility of unauthorized access to the container.

31.3

Figure 1-4.—Table of numerical equivalents.

stowage facilities. Both of the figures must be used together.

Assume that a ship stows plain language translations of encrypted messages in a metal container with attached keylock in the cryptocenter. Visitors are not allowed in any of the communication spaces. Only cryptographers may enter the cryptocenter itself or remove anything from its safe. The cryptographer on watch acts as a guard in attendance at the container. From Figure 1-4 a numerical value may be assigned to these facilities as follows:

	VALUE
Sheltered aboard a commissioned ship	25
Stowed in metal container with attached high security key padlock	5
Military guard in attendance at counter	60
Total	90

From the graph in figure 1-3 it can be seen that stowage facilities with a numerical value of 90 are secure enough for everything but large quantities of Top Secret equipment and large quantities of Top Secret documents covering a broad scope.

Keys or combinations to safes and lockers containing classified material are made available only to persons whose duties require access to them. At least every 12 months keys or combinations must be changed. They also must be changed whenever any person having knowledge of them is transferred from the organization, and at any time the keys or combinations are suspected of being compromised. A key padlock should also be changed whenever a key is lost.

Any time discovery is made of an unlocked and unattended safe or cabinet that contains classified material, report the condition immediately to the senior duty officer. Do not touch the container or contents, but guard them until the duty officer arrives. The duty officer then assumes responsibility for such further actions as locking the safe, recalling the responsible persons, and reporting the security violation to the commanding officer. The custodian must hold an immediate inventory of the contents of the safe and report any loss to the commanding officer.

Destruction of Classified Material

Classified material that is not required must not be allowed to accumulate. It must either be sent to stowage at a naval records management center, or it must be destroyed. Classified documents are destroyed by burning, pulping, pulverizing, or shredding. Burning is the method most commonly used in the fleet. When destruction is accomplished by means other than burning, the residue must be inspected to ensure complete mutilation.

When classified papers are burned, the destruction must be witnessed by two commissioned officers. If sufficient officers are unavailable, warrant officers, enlisted men (E-7 or above), or U.S. civilian employees in grade GS-7 or above may witness the burning, provided they are cleared for at least the highest classification of material being destroyed. If none of these personnel categories are available, a mature and reliable enlisted man in pay grade E-5 or E-6, or a U.S. civilian employee in grade GS-5 or GS-6, may be designated as a witnessing official.

Destruction of classified matter falls into two categories, routine and emergency. Destruction, when authorized or ordered, must be complete. Destruction of superseded and obsolete classified materials that have served their purpose is termed routine destruction. Emergency destruction of classified material is authorized when there is danger of the material falling into enemy hands.

The most efficient method of destroying combustible material is by burning. It is likely that as a DP 3 or 2 you may be called upon to assist in burning classified material. Every member of the burn detail should know exactly what is to be burned and should doublecheck each item before it is burned. To facilitate complete destruction of bound publications, tear them apart, crumple the pages, and feed the pages to the fire a few at a time. If burn material is carried in a bag that is not to be burned, turn the bag inside

out to make certain every piece of paper is removed and burned. All material must be watched until it is completely consumed. The ashes must be broken up and scattered so that no scraps escape destruction.

When no incinerator is available, which often is true aboard ship, classified material may be burned in a perforated metal drum or container with a cover of wire netting. Care must be taken to prevent the classified material from being carried away by the wind. As destruction is accomplished, a list is made of the material that has been destroyed. Informing higher authority of exactly what material has been destroyed is second in importance only to the actual destruction.

Emergency destruction of classified material is authorized any time it is necessary to prevent its capture by an enemy. On board ship, classified material is not subjected to the same risks as on land. If a ship is in danger of sinking or is severely disabled, however, action is taken in accordance with the ship's emergency destruction bill, the execution of which is an all-hands evolution. This bill details the method and the order of destruction of classified matter.

Cryptographic (crypto) material has the highest priority for emergency destruction. Insofar as humanly possible, it must not be permitted to fall into enemy hands. After crypto material is destroyed, noncrypto communications material by order of classification beginning with the highest classification is destroyed, then other classified material in the following order:

1. Classified material pertaining to future plans and operations.
2. Classified material pertaining to standing, operating, or tactical procedures.
3. Equipment of a classified nature, together with pertinent technical, descriptive, and operating instructions.
4. Remaining classified material, the order of destruction to follow classification; the highest classified material being destroyed first.

When it is necessary to dispose of equipment that must remain classified, destruction shall be accomplished by any means that will prevent recognition and reconstruction or by jettisoning in random water areas of at least 1000 fathoms depth. This does not apply to crypto equipment. Special instructions are issued for this equipment.

COMMAND SECURITY PROGRAMS

Security is a means—not an end. Regulations that govern the security of classified material are comparable to electronic safety regulations. They do not guarantee protection, and they do not attempt to meet every conceivable situation. If strictly adhered to, however, they will provide a satisfactory degree of security.

To ensure that the required security measures are implemented, each command formulates written security procedures to reflect the command's particular requirements. These security procedures specify what is to be done, how it is to be done, who is to do it, and who is to supervise it.

In order that classified information may be controlled with maximum efficiency, the commanding officer or officer in charge of each command designates an officer to act as the CLASSIFIED MATERIAL CONTROL OFFICER. In commands that initiate, receive, or process Top Secret documents, he appoints a TOP SECRET CONTROL OFFICER. When an activity possesses crypto material, the CO names a CRYPTO SECURITY OFFICER. In addition, certain commands may designate a SPECIAL SECURITY OFFICER.

In performing his duties, the classified material control officer—

1. Serves as the commanding officer's advisor and direct representative in cases pertaining to security of classified material.
2. Assures that all persons who are to handle classified information are properly cleared and instructed. The clearance status should be recorded and be accessible for verification.
3. Formulates and coordinates security control measures within the command.
4. Maintains a program of declassification and downgrading of information.
5. Prepares classification guides to aid in the proper classification of material originated within the command. Preparation of such guides usually is limited to shore activities.
6. Exercises security control over visits to and from the command.

7. Reviews proposed press releases, and indicates classified information that must be deleted thereform.

8. Performs the duties of Top Secret control officer if another officer is not so designated.

The Top Secret control officer, subordinate to the classified material control officer, is responsible within the command for the receipt, custody, accountability, and distribution of Top Secret information and for its transmission outside the command. In performing his duties, the TOP SECRET control officer is governed by certain basic rules. He must, for instance–

1. Avoid unnecessary dissemination of Top Secret information

2. Release to a subordinate echelon only the absolute minimum of Top Secret information necessary for proper planning or action

3. Transmit Top Secret information within the command by direct personal contact

4. Maintain a continuous chain of receipts for Top Secret material

5. Maintain a current roster of persons within the command who are cleared for access to Top Secret information

Certain commands within the Naval Establishment are designated to maintain a Special Security Officer (SSO). The Special Security Officer and all persons detailed to assist him are granted a special clearance by the designator.

Material intended for the Special Security Officer is wrapped in a double sealed opaque envelope. The outer container bears the command address. The inner container bears the command address, the classification of the material, and the notation "To be Opened Only by the Special Security Officer." Packages so marked are immediately delivered, with the inner container unopened, to the Special Security Officer. If the receiving command does not have a Special Security Officer, the inner container is not opened and will be marked "No Special Security Officer at this Command." The inner envelope is placed in an outer opaque envelope and returned to the sender via Armed Forced Courier Service.

Additional information concerning security is included in the Department of the Navy Security Manual for Classified Information, OPNAV Instruction 5510.1 series.

CHAPTER 2

AUTOMATIC DATA PROCESSING

For one person to know all there is to know about existing automatic data processing equipment and systems is virtually impossible and certainly beyond the scope of this manual. Automatic data processing encompasses all operations from the collection of raw data to the final preparation of a meaningful report. Data processing systems, regardless of size, type, or basic use, share certain common fundamental concepts and principles. To present a logical association of these concepts and principles, the subject matter in this chapter has been generalized.

Automatic data processing, as we think of it today, normally conveys an image of flashing lights on a computer control panel and the spinning of reels of tape as they convert mountains of facts and figures into understandable terms and language. Facts needed to make decisions, solve formulas and equations, make analyses and diagnoses are all part of the expected by-product and end results of data processing.

Development of the modern electronic computer cannot be clearly traced to one individual, or even a few. Its origins stem from the efforts of literally hundreds of men, including engineers, economists, and mathematicians. From human appendages to knotted strings; from symbols and numbers to the birth of mathematics and record keeping; from the ancient abacus to the slide rule and thence to mechanical calculators and comptometers; from punched cards and electrically powered business machines to the electronic computer; all these developments have phenomenally accelerated men's computational ability. Today, hundreds of business firms, governmental agencies, and the military services are automatically processing data more effectively and more economically than ever before possible.

THE REVOLUTION IN RECORD KEEPING

No one can be certain when counting began, for even ancient man used his fingers and toes to indicate numbers. Down through the centuries, as the science of mathematics was developed, symbols and numbers dispensed with the job of counting things over and over each time, one by one. At the same time, the development of record keeping relieved man's burden of keeping everything in his head.

PENCIL AND PAPER ACCOUNTING

As long as businesses were small and communications slow, the bookkeeper (fig. 2-1) took every accounting entry and laboriously updated it, manually entering figures and reaching true balances of business standings. After about 1900, as businesses grew, the books became more complex and the lone bookkeeper could not cope with accounting problems on a manual basis. Since manual data processing was slow and vulnerable to human error, the trend from the earliest stages has been toward the replacement of human efforts even when supplemented by mechanized tools (fig. 2-2).

KEY-DRIVEN ACCOUNTING

The ancestor of today's calculator was a set of numbered rods invented by John Napier in

R49.178X

Figure 2-1.—Pencil and paper accounting.

R49.179X

Figure 2-2.–Key driven accounting.

the 17th century. They were called "Napier's Bones," (fig. 2-3) and simplified multiplication. In 1642, Blaise Pascal's "toothed-wheel" adding device, the first calculating machine, had the additional ability to subtract. Refinements to this have resulted in the open market stylus calculators of today. Gottfried Wilhelm and Baron von Leibnitz invented the first mechanical calculator (fig. 2-3) which could accurately perform the four arithmetic operations by simply turning its handle in a clockwise or reverse direction. In due time, these rudimentary devices were improved upon and with the advent of the Burroughs simple adding and listing machine in 1890, the age of key-driven accounting rapidly advanced. However, all key-driven devices are

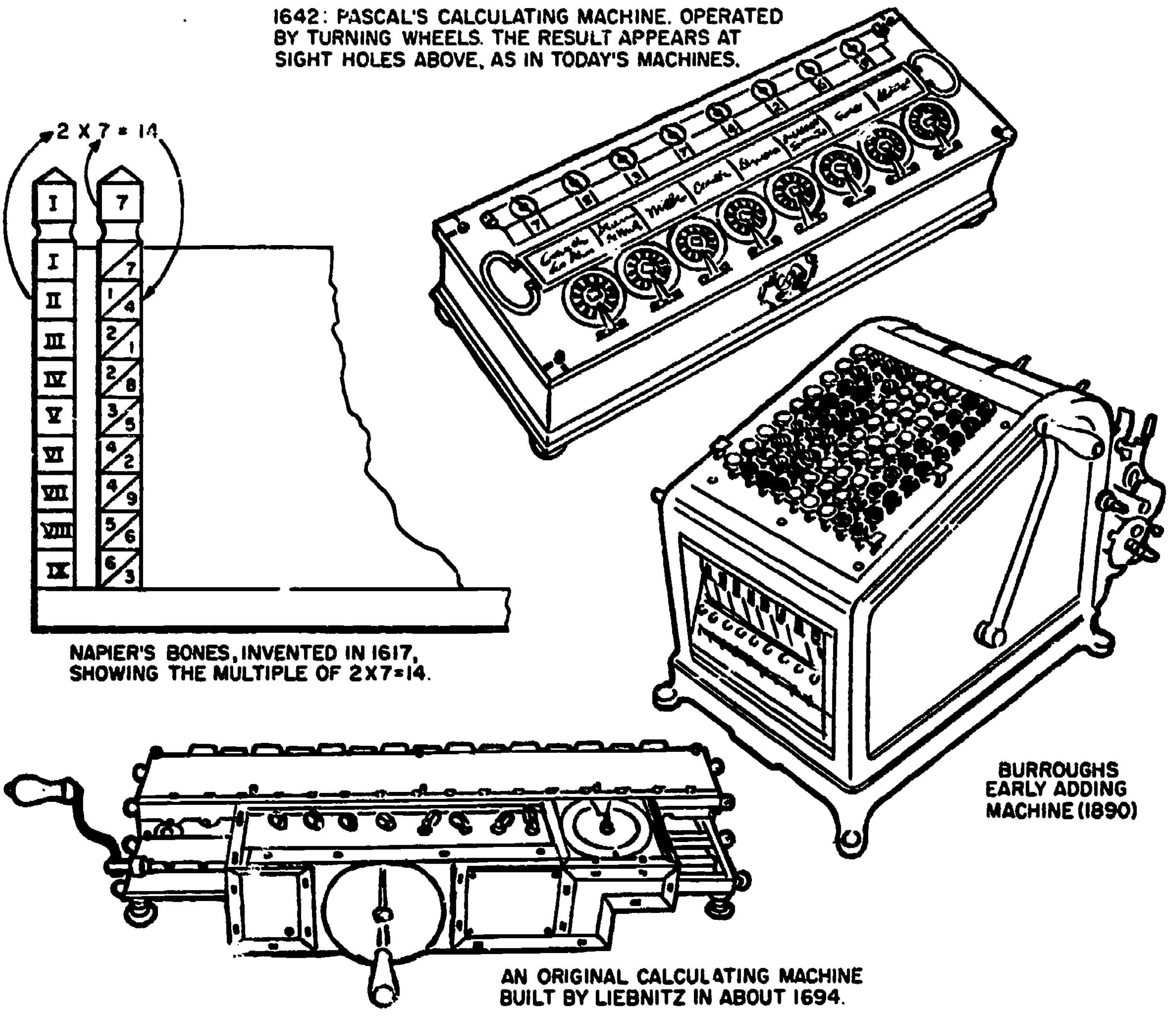


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Figure 2-3.–Advancement of calculating devices.

operated manually, not automatically. As a result, both their speed and accuracy are limited by the operator's manual proficiency at manipulating the keyboard.

PUNCHED CARD ACCOUNTING

To meet the need for more efficient equipment, the makers of business machines revised an old tool for handling paperwork–the punched card. Joseph Jacquard, a French engineer, used it over 200 years ago to operate a loom for weaving cloth in a textile mill. A chain of stiff punched cards, held together by strings, was rotated past needles of the loom. As the cards advanced, the needles which matched the holes in the cards were able to pierce the cards to form a pattern in the woven cloth. This came to be known as the Jacquard Loom.

The punched card idea disappeared until the later 1800s when Dr. Herman Hollerith adapted the theory to a smaller, more convenient card in which information could be punched (fig. 2-4). This was probably the most profound advance in data processing, for it introduced a system which employed for the first time the concept of mechanically stored information.

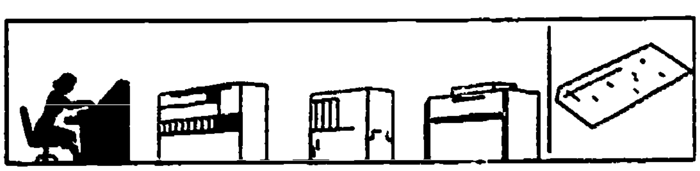

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Figure 2-4.—Punched card accounting.

During the latter part of the 1880 census, Dr. Herman Hollerith was engaged by the United States Government to devise a faster method for processing the 1890 census. He worked out a mechanical system of recording, compiling, and tabulating census facts. The operating basis of this system was long strips of paper into which were punched census data in a planned pattern, so that each hole in a specific location meant a specific thing. This new system increased the accuracy of results and reduced the cost and time in preparing the census. Data were available in 2½ years.

For the ease of handling and durability, these paper strips eventually were replaced by cards of a standard size and shape.

By 1900, Hollerith had developed an automatic electric sorting machine (fig. 2-5), a semiautomatic tabulator, and a keypunch machine. These were forerunners of our present electric punched card data processing equipment which can automatically code, sort, store input, perform calculations, and print output. The only required manual control is classifying data preparatory to punching, starting and stopping machines, and moving cards from one machine in a system to another.

ELECTRONIC DATA PROCESSING

Electronic data processing (EDP) (fig. 2-6) is accomplished through principles of electronics rather than those of a mechanical or electromechanical nature. The first attempt to build a computer largely independent of operator action was in England in 1830 by Charles Babbage. Though the machine was a failure as a practical accounting device, due to the limited technology of that era, the underlying ideas are similar to those employed in today's computers.

In 1944, an electromechanical digital computer, the Mark I, was completed at Harvard University for the U. S. Navy and was controlled by electromagnetic relays. Between 1942 and 1946, the first truly electronic computer ENIAC (Electrical Numerical Integrator and Calculator, shown in fig. 2-7), was constructed at the University of Pennsylvania and substituted electronic tubes for the electromagnetic relays. During the past decade, the memory sections and processing circuitry of computers have been replaced with magnetic cores, transistor and integrated circuits. With all the data processing functions of today virtually self-contained within the computer, little, if any, human intervention is required once the machine is given instructions.

DATA PROCESSING BY EAM

Despite the vast recent increase in the use of electronics, certain areas remain in which the employment of electronic data processing systems is not practicable. In these areas, electric

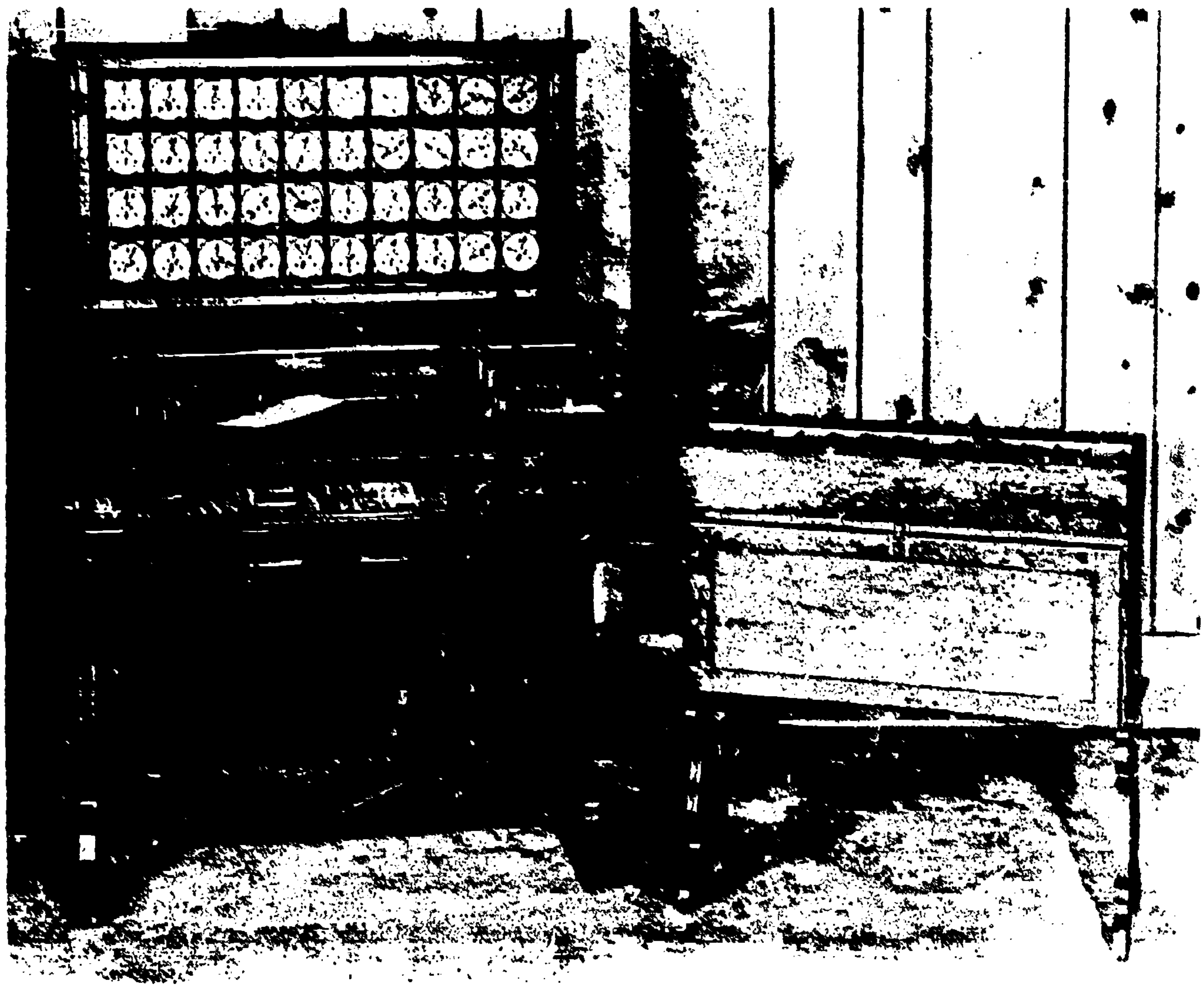

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Figure 2-5.—Hollerith's early model tabulating machine and sorting box.

R49.183X

Figure 2-6.—Electronic data processing.

accounting machine (EAM) systems function effectively and provide the answer to mechanized data handling processes. Systems which process data entirely from punched cards are normally referred to as PUNCHED CARD or EAM DATA PROCESSING SYSTEMS. Electrically powered machines so designed that each performs certain processing functions as directed by externally wired control panels (except key-driven and most sorting machines) are classified as ELECTRIC ACCOUNTING MACHINES (EAM) or Unit Record Equipment. The optimum use of this equipment under precise rules of procedure can minimize clerical operations, standardize methods, and speed up output of records and reports.

THE UNIT RECORD

In a study of punched-card data processing it is essential to have a working knowledge of the system's input medium, the punched card. The card is used as a storage medium for information which is in code. This code is characterized by a hole or combination of holes punched in a predetermined pattern into a card. These

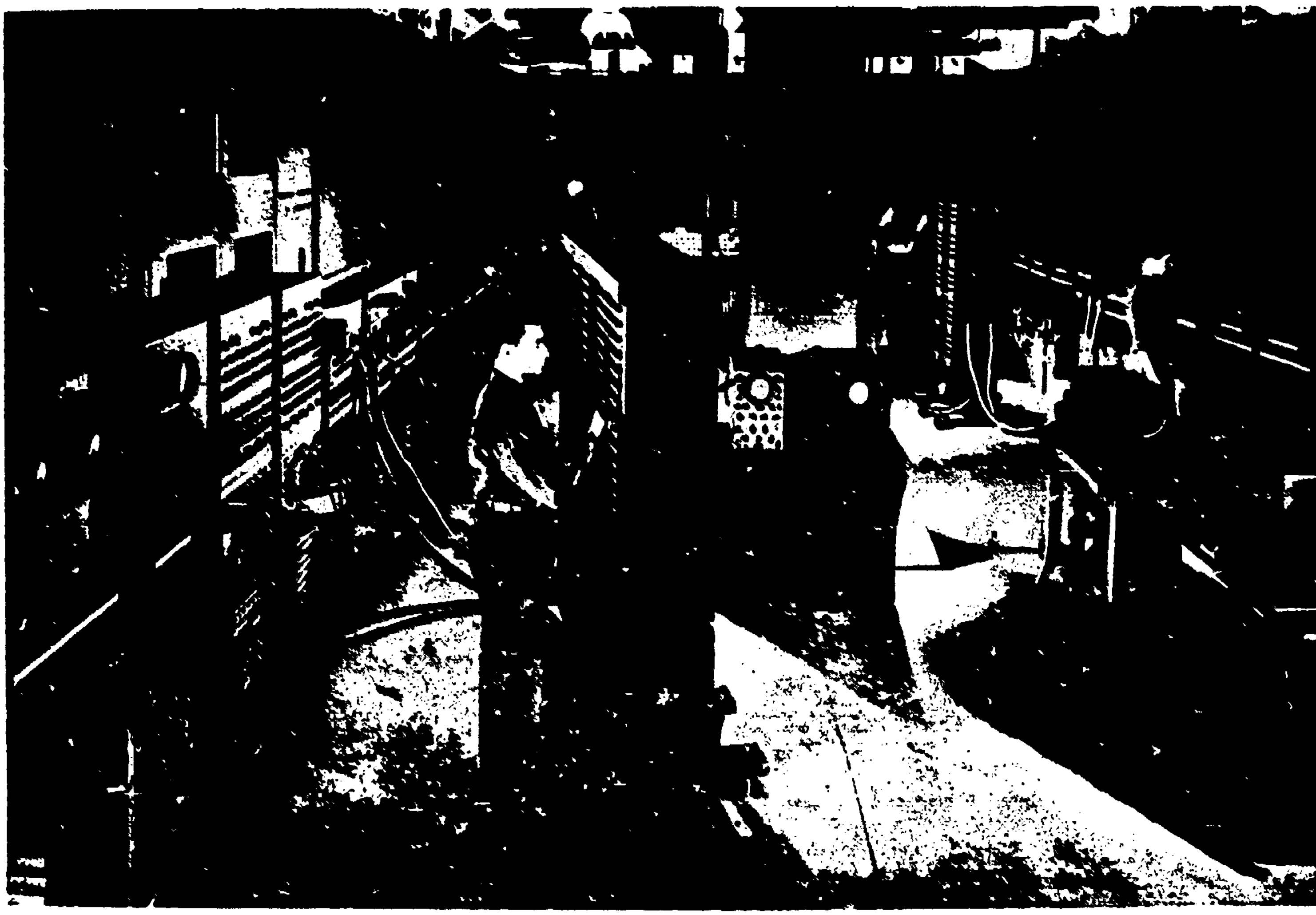

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Figure 2-7.—ENIAC, the first all-electronic digital computer.

holes serve as the machine equivalent of our language.

Transferring information from a source document, such as Personnel Diary or supply requisition into cards, produces individual records of hundreds and thousands of transactions. Once holes have been correctly punched into a card, that card becomes a permanent UNIT RECORD which may be processed by different data processing machines without losing any of its original information. The punched card is the basic unit of punched card accounting and the basis from which all mechanical data processing applications evolve.

The Punched Card

The standard punched card is 7-3/8 inches in length, 3-1/4 inches in width, and .007 inches thick. Cards (fig. 2-8) often contain a corner cut, usually at the top left or right corner of the card. These corner cuts are normally used to identify a type of card visually, or to ensure that all cards in a group are facing the same direction and are right side up.

The card is divided into 80 vertical columns, called CARD COLUMNS. These are numbered 1 to 80 from left to right. Each column is then divided into 12 punching positions which form 12 horizontal ROWS across the card. The punching positions are designated from the top to the bottom of the card by 12, 11 (often referred to as X), 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. (See col. 8 of fig. 2-8.) The 0 through 9 punching positions correspond to the numbers printed on the standard stock card. The 12 and 11 punching positions normally are not printed on the card, as this area is generally reserved for

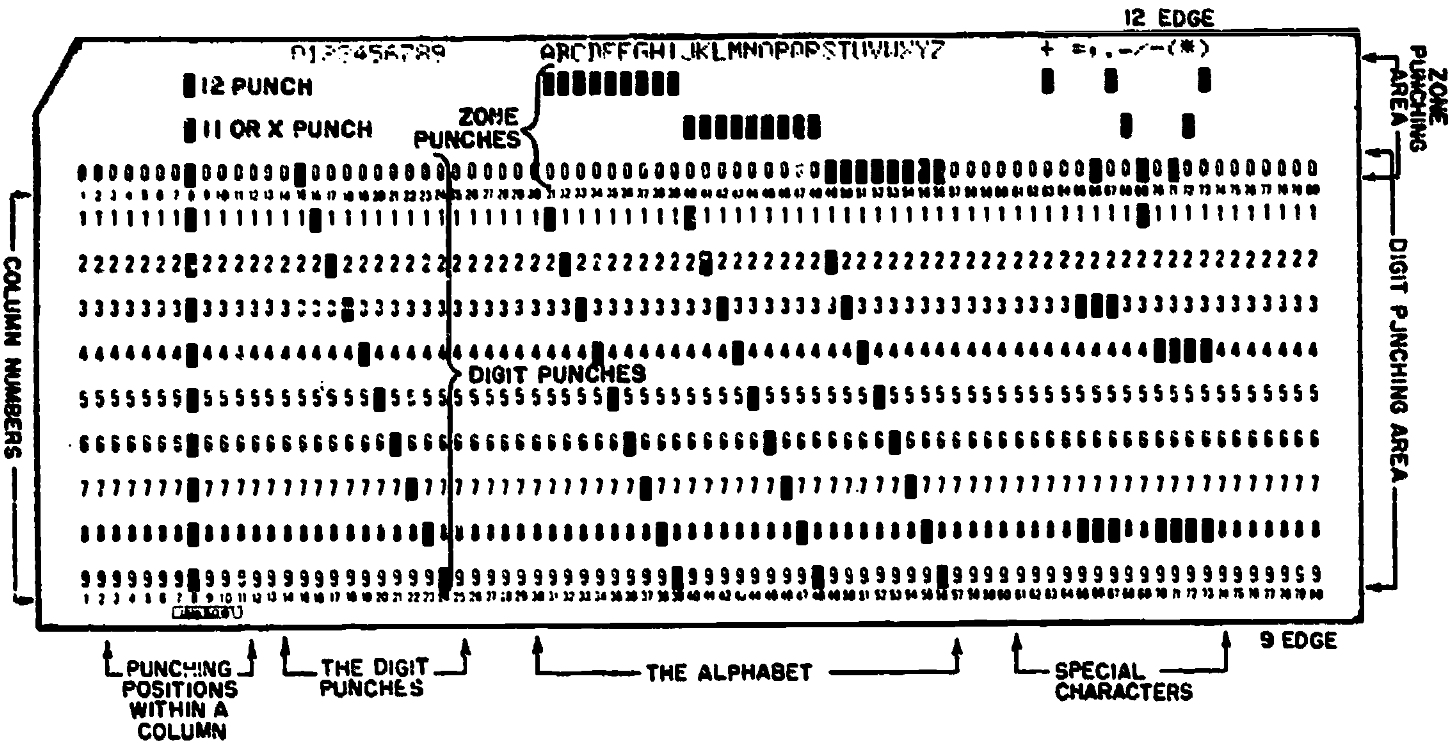

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Figure 2-8.—Hollerith code and standard card.

printed headings or for interpreting punched information.

Since one or more punches in a column represent a character, the number of columns used depends on the amount of data to be punched. If a record requires more than 80 columns to hold its data, two or more cards may be used. However, continuity between cards of one record must be established by punching identifying information in a particular column of each card.

The top edge of the card is known as the "12" EDGE, and the bottom edge as the "9" EDGE. The manner in which cards are placed in machines is governed by their respective feeding requirements. Therefore, cards are fed either 12 edge first or 9 edge first, and either FACE UP (which means the printed side of the card is facing up) or FACE DOWN, meaning the opposite. Cards are read and punched by machines either row by row (digit by digit), or column by column. Figure 2-9 illustrates how cards pass the punching mechanism of card punches column by column. First, column 1 is punched, followed by column 2, and so forth. Since only one column at a time is covered by the punching mechanism, which is capable of punching any of the 12 positions or combinations thereof, it is referred to as SERIAL punching. Figure 2-9B shows how cards fed either 12 or 9 edge first are actually fed on a row by row basis, resulting in all like digits required being punched at the same time. This is due to the fact that this type of punching mechanism (e.g., IBM 514 reproducing punch) is equipped with 80 punch dies or magnets, one for each card column. Thus, if fed 12 edge first, all 12's then 11's, and so on are punched as the card moves forward, or all 9's, 8's, and so on through 12's are punched if fed 9 edge first. This is PARALLEL punching.

Card Language

Regardless of the method of punching cards they are always read from left to right by the operator.

The standard card language, commonly referred to as the Hollerith code, uses the 12 punching positions of a vertical column to represent numeric, alphabetic, or special character punching. These 12 positions are divided into two areas known as numeric and zone. The first nine punching positions from the bottom edge of the card are the NUMERIC or DIGIT positions of 9 through 1. The remaining 0, 11, and

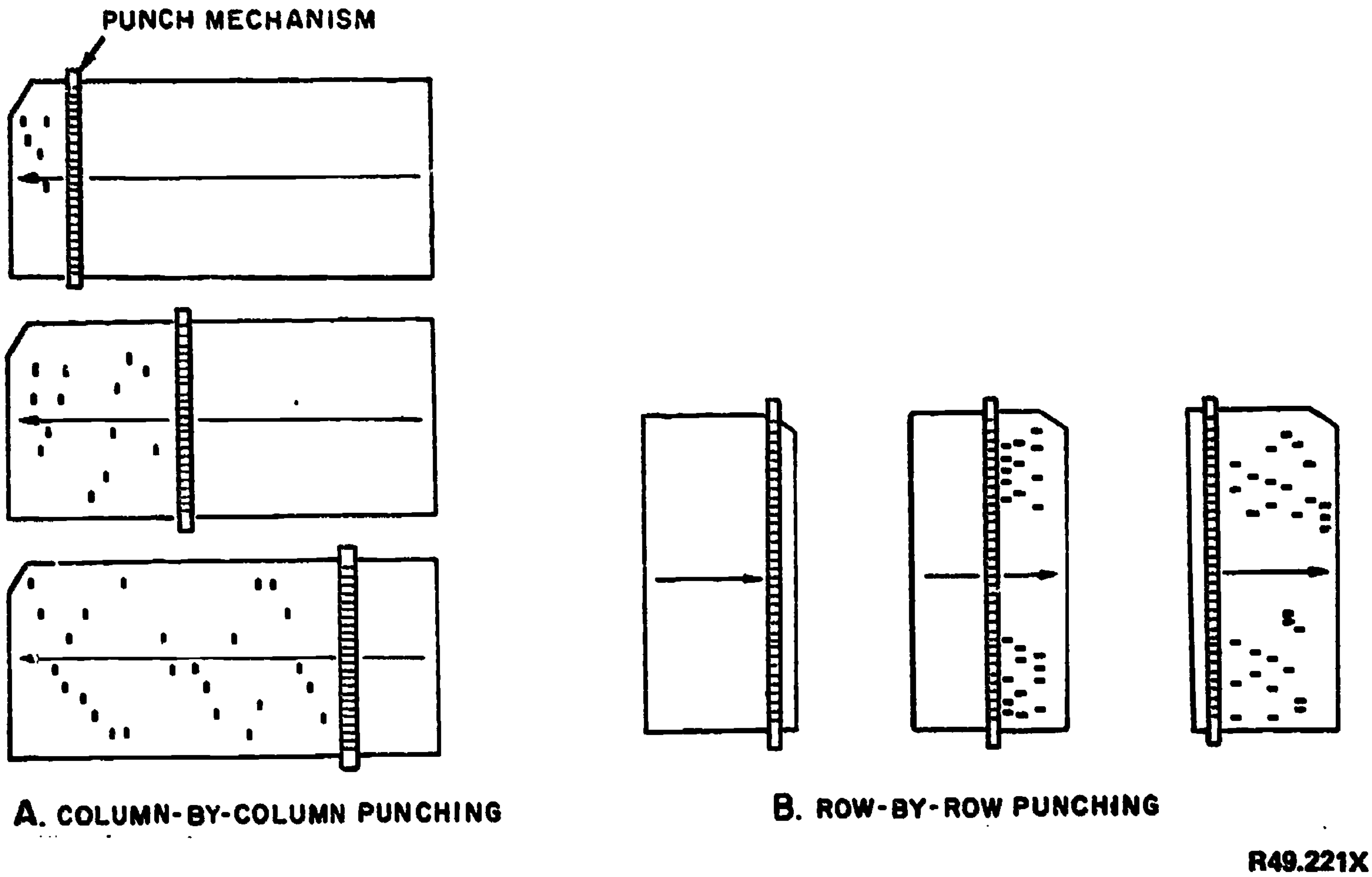

Figure 2-9.—Punching the card.

12 are the ZONE positions. (The 0 is used interchangeably to represent a zone punch or numeric punch.)

NUMERIC.—Rows 0 through 9 are used to store the 10 decimal digits and are represented by a single punch in a particular column. For example, a single punch in the 0 zone position would represent an assigned numeric value of zero.

ALPHABETIC.—To accommodate any of the 26 letters in one column, a combination of a zone and digit punch is used. The alphabet is divided into three groups and each group is identified with one of the three uppermost rows, or zones. The first nine letters of the alphabet, A through I, use a 12 zone punch AND a numeric punch of 1 through 9, respectively. The 12 punch indicates that the character in that column lies in the first group of nine letters of the alphabet. A punch in any of the 1 through 9 rows of the same column specifies which letter of the nine is represented. (Thus, 12 and 1 represent A, 12 and 2 represent B, etc.) The second group of nine letters, J through R, uses the 11 zone punch and a numeric punch 1 through 9, respectively. (Thus, 11 and 1 represent J, 11 and 2 represent K, etc.) Since only eight letters are left for the 0 zone, letters S through Z are represented by the 0 zone punch and a numeric punch 2 through 9, respectively. Examining figure 2-8, you will see that the 0-1 combination represents a special character.

It should be noted that when the 0 punch is combined with a digit, it is designating the last group of the alphabet and is being used as a zone punch.

SPECIAL CHARACTERS.—These characters provide printed symbols, may cause certain machine operations to occur, and may identify various cards. Standard special characters consist of one, two, or three punches in a card column but differ from the configurations used to represent numeric or alphabetic characters.

The following list depicts one accepted combination of punches for special characters. (The special character sets may differ from system to system, but the numeric and alphabetic characters remain the same.)

12, 3, 8 = . (Period)
12, 4, 8 =) (Close parenthesis)
11, 3, 8 = $ (Dollar sign)
11, 4, 8 = * (Asterisk)
0, 3, 8 = , (Comma)
0, 4, 8 = ((Open parenthesis)
3, 8 = = (Equality sign)
4, 8 = @ (At sign)
12 = & (Ampersand)
11 = – (Dash)
0, 1 = / (Slash)

CARD FIELDS.–Specific columns on the card, are grouped and reserved for facts relative to each transaction. These groups of columns are called FIELDS. For example, a card would have one field assigned for punching name, another for punching social security number, another for punching service abbreviation, and so on. The number of adjacent columns reserved for a field is dependent upon the MAXIMUM number of characters, or numbers, of each item appearing on the source document that is to be punched. Thus, a field could consist of from 1 to 80 card columns. Without this grouping of information into fields, classifying, comparing, and other machine processing functions would be severely hampered and, in most cases, impossible. (See fig. 2-10.)

FIELD POSITIONS.–From right to left, the positions in each field are known as the units position, tens position, hundreds position, and so on. The extreme right position of a field is called the LOW ORDER position, and the extreme left position is the HIGH ORDER position. When punching numerical fields, the punching is from left to right, with the units position of the number punched in the low order position of the field. If the number to be punched is shorter than the columns allowed in the field, zeros may be added to the LEFT of the number to complete (ZERO FILL) the field. If the punching is done as described but without zero fill it is called RIGHT JUSTIFICATION.

Punching of alphabetic fields starts in the high order position and continues until the last letter is punched. Unused columns of the field are left blank.

Types of Cards

Generally speaking, cards are categorized by their manner of preparation. They are as follows:

1. TRANSCRIPT cards are punched from data previously recorded on another document. As a general rule, they consist of detail and master cards keypunched from a source document, such as a Personnel Diary.
2. DUAL cards are punched from data recorded on the card itself. Thus, they serve the dual purpose of both source document and processing medium.
3. OUTPUT cards are machine created as a result of processing and could include new detail cards, or updated files. These cards undergo additional processing or replace outdated cards in a file.
4. SPECIAL cards are those that enable on-the-spot punching of data, such as the IBM port-a-punch card, which is a card punched from a portable device at a place remote from the data processing installation.

Patterns of Card Design

Variously designed cards reflect the wide variety of applications of punched card accounting. Seldom do different installations use identical card formats.

Figure 2-11 depicts a standard multiple card layout form used in designing one or more cards. This is especially helpful in aligning information common to more than one card.

The top card layout shown in figure 2-11 depicts a DETAIL card. A detail card is one which eventually contains all the data pertinent for one record. It is the card that will be punched most frequently by the key punchers. It will also have fields filled by other than key punching such as:

1. the results from calculations performed by other EAM gear
2. gangpunched information from master cards in reproducer operations

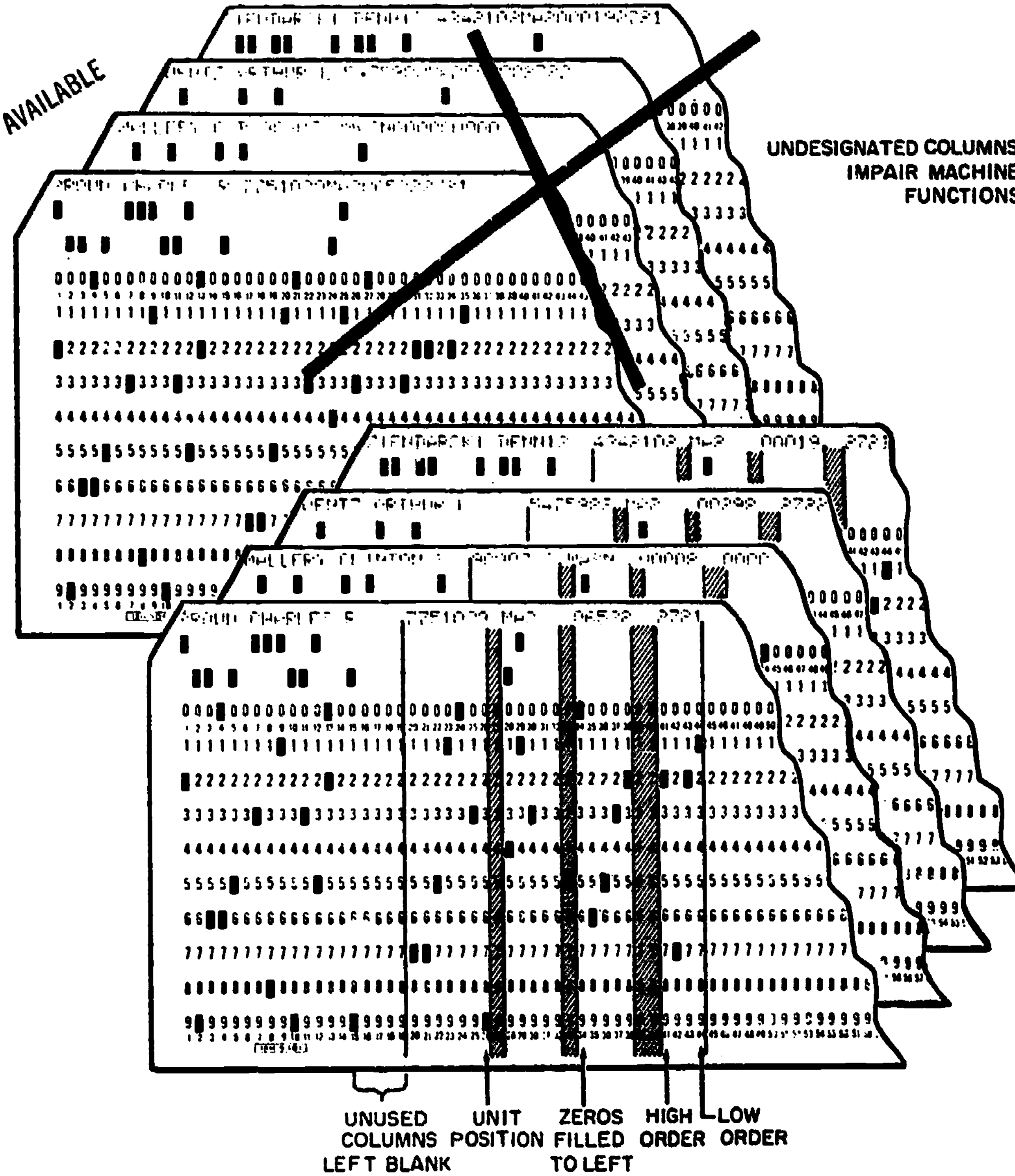

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Figure 2-10.—Card fields facilitate machine processing.

Even though these fields are not keypunched, they must still be included in the card layout.

The second card depicted in figure 2-11 is a MASTER card. A master card is a card which contains information common to all detail cards of one major group such as Project Code. The common information (Project Code) may then be mechanically reproduced into all the detail cards for the same Project Code. This saves an enormous amount of keypunch time. Master cards can be identified by a control punch (or lack of one if the details have one) such as the "X" (11 punch) shown in column 80.

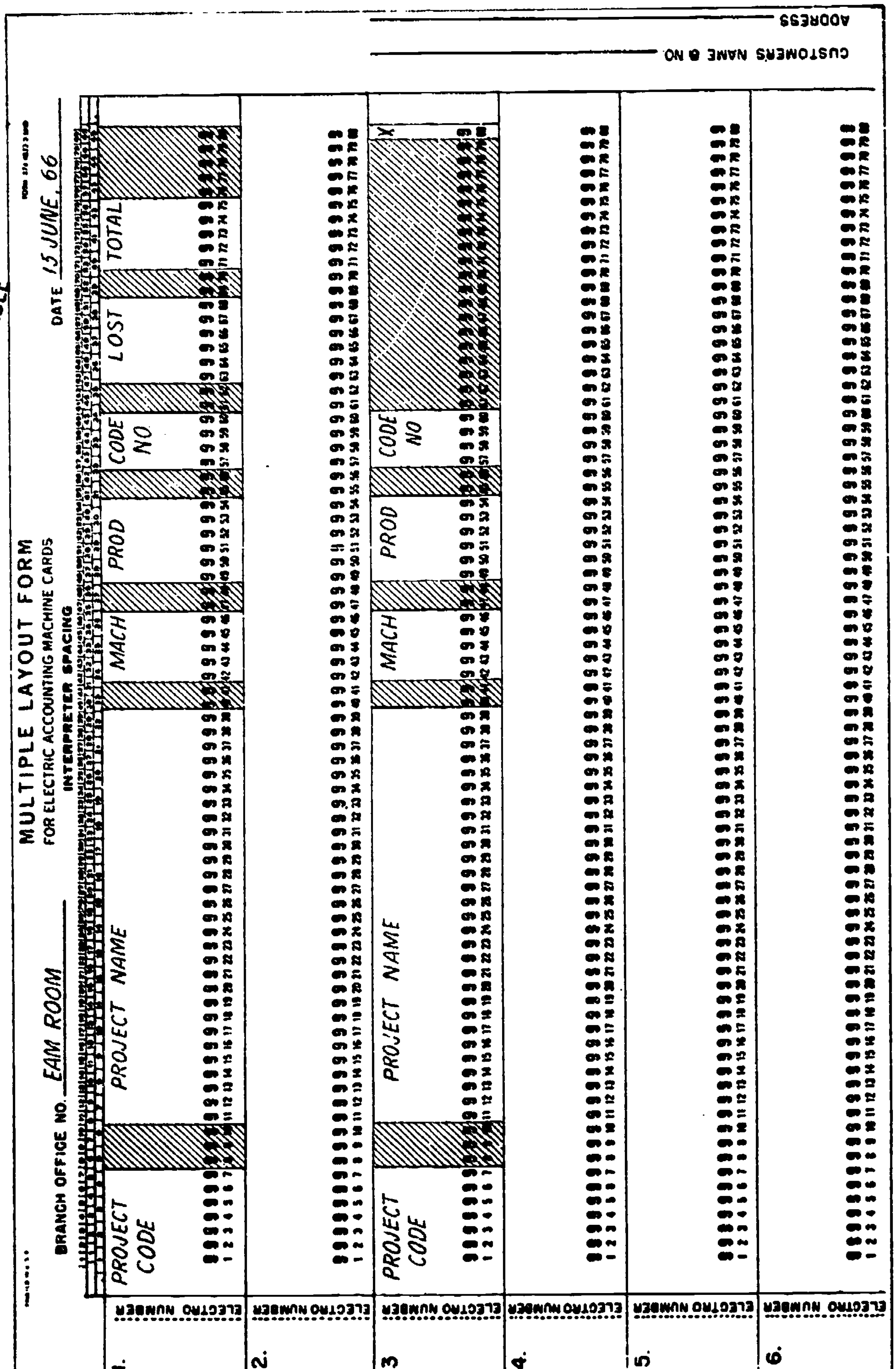

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Figure 2-11.—Multiple card layout form.

DETERMINATION OF DATA.—Following are some of the factors considered when deciding what data should be recorded in the card, and where it should be placed to meet contemplated procedures:

1. Requirements for the final preparation of finished reports are of utmost importance. All information to be listed must be included in the card, unless it is to be calculated, emitted, or summarized.

2. The sources of original information are examined for desired data. Sometimes, other data must be substituted, a different type of card used, or certain available data (though not presently needed) included in the card for future planning.

3. Once data requirements have been decided, the principle of alignment is considered. Machine processing requires a consistent arrangement of data in cards. Common types of information, therefore, are placed in corresponding columns of all cards. For instance, if social security number is punched in columns 20-28 of all current personnel cards, then social security number is placed in the same columns of any new card. This facilitates control panel wiring and eases sorting and controlling operations when various cards are used together.

4. Information is punched in the card in the sequence that it appears on the source document. Keypunching is speeded when card fields are aligned to permit punching in unison with the left to right or top to bottom reading of a document.

5. Each field of a card is assigned a method of punching (keypunched, duplicated, gangpunched, or calculated) so that all like punching operations can be grouped together. This simplified format, enables operators to take advantage of various machine characteristics, and eases other processing techniques.

TYPES OF INFORMATION.—All items of information placed in the card can be classified by any of the following three types:

1. REFERENCE information identifies the original source document from which it was created, such as name, date, batch number, or activity processing code. The size of a reference field is determined by the largest single number item to be recorded. For example, names can usually be recorded in 20 columns or less.

2. CLASSIFICATION information cross indexes, classifies, or identifies a particular item on the source document such as activity code, part, or stock number, and social security number. Field size is readily established, as a set number of columns are always required.

3. QUANTITATIVE information consists of totals punched in the card that are to be added, subtracted, multiplied, or divided, such as quantity on hand or unit price. A realistic assignment of columns for totals can be made only if the maximum size of expected totals is known. Total fields are set up to take care of all but the unusual cases, and these are handled by punching extra cards for the overflow total. Assigning too many columns to a total field results in a waste of card columns, while a field that is too small requires punching of too many extra cards for overflow totals.

Information Arrangement

When determining the position of information on cards by the type of information, consideration is usually given to the following arrangement: reference information is placed to the left of the card; classification information in the center; quantitative information to the right of the card.

To take further advantage of punched card accounting methods and equipment, other factors affecting information arrangement are borne in mind, such as:

1. grouping fields to be duplicated together
2. keeping manually punched fields from being interspersed among duplicated, gangpunched, reproduced, or summary punched fields
3. aligning fields to be skipped (not punched) in a uniform pattern on all card forms
4. placing numerical fields together to speed keypunching and lessen operator fatigue
5. locating fields to be visually checked near the right or left margin

6. restricting the size of fields to the number of columns absolutely essential for efficient handling of transactions
7. placing control fields adjacent to one another to simplify wiring and sorting operations

Priority Arrangement

Though we have discussed various patterns of card design in a somewhat logical order of importance, conflicts sometimes arise due to varying installation requirements. When this happens, good judgment must be exercised to resolve matters on a priority basis. The four major considerations used to decide card data sequence, in the order of their priority, are as follows:

1. the location of information identical or common to all cards
2. the sequence of data on source documents from which it will be punched
3. the methods of punching and machines to be used during processing
4. types of information and manual card operations

Coding systems have been devised using letters, numbers, or both (although numeric codes predominate), to identify information appearing in a raw form on source documents. The proper application of these codes to the source document eases the subsequent punching and handling of card data during machine processing.

An example of coding is to assign a two digit numeric code to replace state names (i.e., 01 for Alabama through 50 for Wyoming). This reduces the amount of key punching and allows for faster machine manipulations; e.g., two columns are used vice four (for Ohio) to thirteen (for New Hampshire).

MACHINE CONVERSION OF DATA

Since the card introduces information to the machines, it may also be considered a conveyor of data. The holes are READ by the machines in a fashion similar to the weaving pattern of the Jacquard Loom; that is, electrical contact can only be made exactly where punched holes are located, just as the needles of the Jacquard Loom pierced the holes of its card only at given spots. The passage of the cards between brushes and electric contact rollers at specific times in the cycle of a machine converts the punched holes into timed electrical impulses which are machine processable.

Machine Processing of Data

The reading and conversion of data into electrical impulses by a machine, together with a properly wired external control panel, enables the punched card data to be processed. The machine receives its instruction from the control panel, which affords processing flexibility and diversity in jobs. The type of machine used and the desired end results determine the type of processing the data undergoes. For instance, the control panel of an electric accounting machine could tell the machine what data is to be accumulated and when to print totals. (See fig. 2-12.)

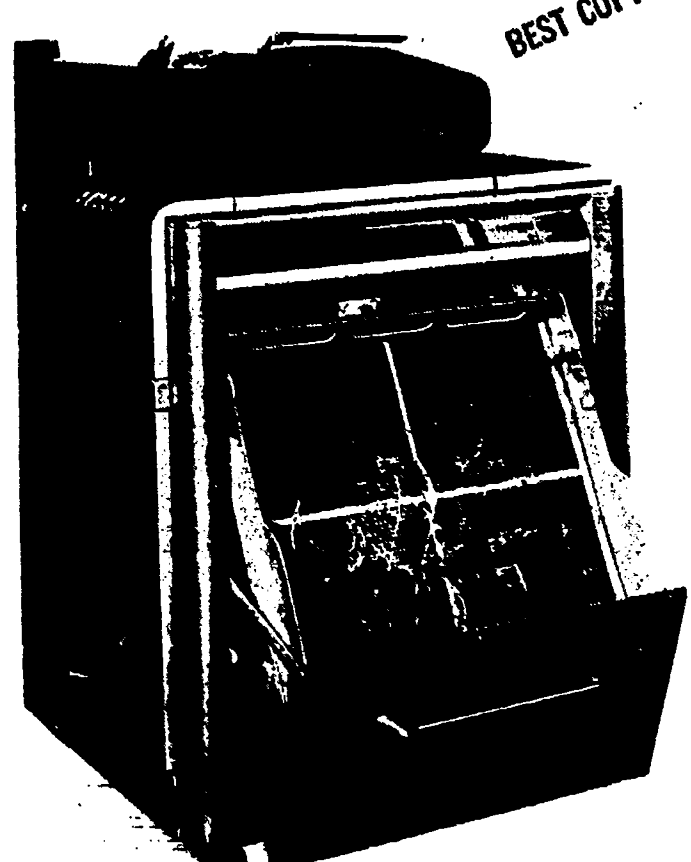

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Figure 2-12.–Control panel.

Machine Output of Data

The results of processing are also in the form of electrical impulses, and these too are converted into output form. Once again, dependent upon the type of machine used, the output form may be a machine function, holes punched into the same or other cards, printed lines of information, or any combination of these. It must be remembered, however, that output capabilities are limited, for most EAM equipment will accept but one file of cards as input and will produce only one result. There are a few exceptions, of course, such as a collator, which will accept two files of cards at the same time and manipulate these cards into one or several groups.

BASIC UNIT RECORD EQUIPMENT

Of all the types of data processing tasks performed by punched card accounting systems, three are basic: recording data, classifying or arranging data, and summarizing data. Commensurate with these tasks are several types of basic unit record equipment. They are categorized as such because they are a MUST in all EAM systems to carry out the aforementioned basic tasks. Figures 2-13 through 2-19, depicting punched card equipment, illustrate Sperry Rand UNIVAC and IBM models that are comparable to one another in design, purpose, and function.

Card Punches

The basic method of RECORDING data or converting source data into punched cards (fig. 2-13) is through keypunching, a method whereby the operator reads a coded source document and presses the keys of a keyboard to punch the data into cards. This is similar to typing and is done on a keypunch, often called a card punch. Since various other machines will act on information supplied by these punched cards, the transcription of data into the cards must be accurate.

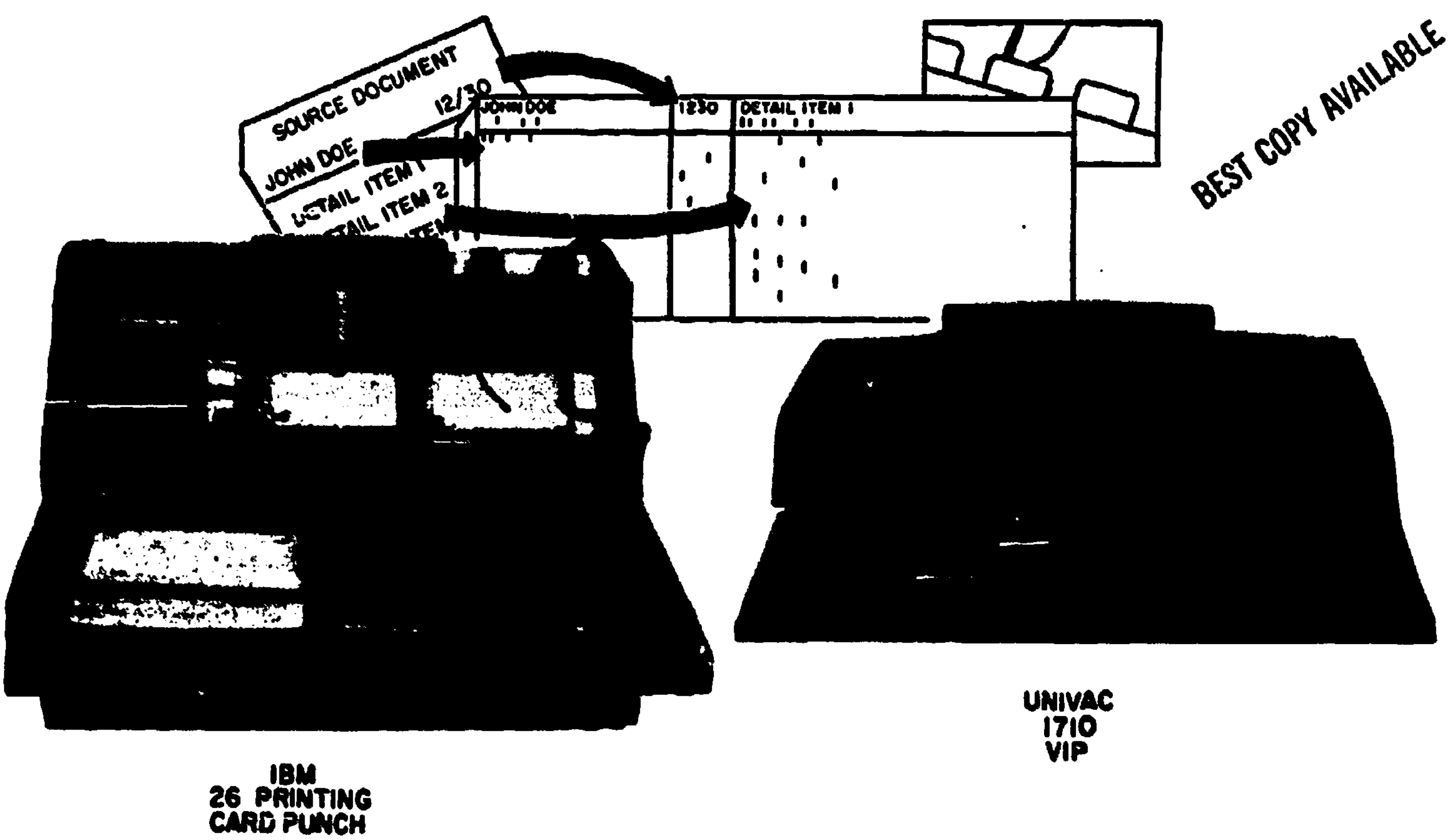

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Figure 2-13.—Converting source data to punched cards.

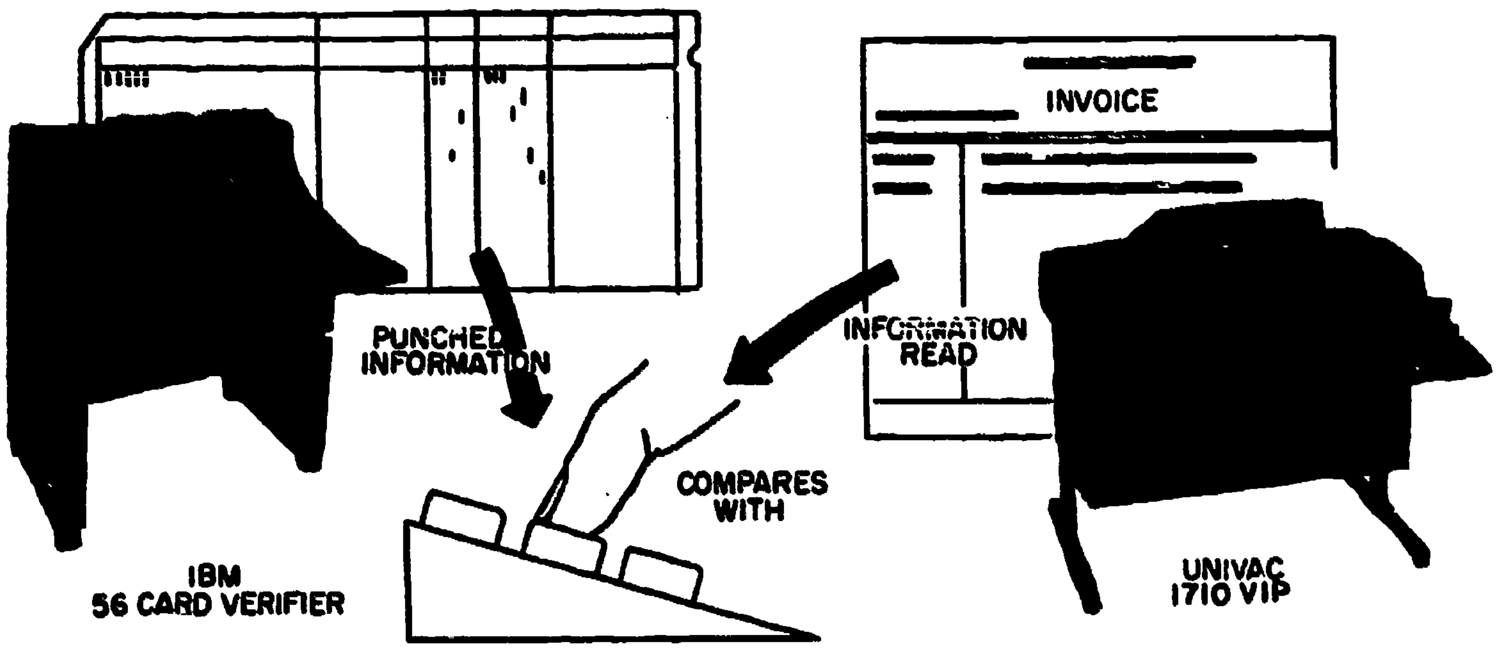

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Figure 2-14.—Verifying the accuracy of the original keypunching.

The CARD VERIFIER (fig. 2-14) is used to check the accuracy of the original keypunching. While reading from the source document from which the data was initially punched, a second operator verifies the punched data by depressing the keys of a verifier. Each key pressed is automatically compared with the hole already punched in the card and any difference causes the machine to stop.

Sorters

The end of punched card accounting is usually a printed report. Information in these reports is invariably grouped according to some definite sequence or arrangement of unit records. Since cards produced by card punch operators are seldom in any particular order, this SEQUENCING or arranging of cards is performed on a card sorter (fig. 2-15). Although sorting cards to a particular sequence is the major function of a card sorter, certain types of selection of individual cards that require special attention can also be automatically accomplished.

Accounting Machines

The basic function of the accounting machine (fig. 2-16) is the conversion of punched card data into printed statements and reports. The ability to print and total or SUMMARIZE information by classifications of punched card data, is made possible by its comparing and selecting techniques and by its mathematical capability of adding and subtracting. Through the function of DETAIL PRINTING or LISTING, complete details of individual transactions can be shown. Of equal importance is the function of GROUP PRINTING, which permits the summarization, identification, and printing of totals for groups of cards.

Because all equipment in an EAM card system processes cards for end-of-the-line processing in the accounting machine, the latter is considered the heart of a punched card data processing system. The name tabulator, which is sometimes shortened to tab, is synonymous with accounting machine.

AUXILIARY UNIT RECORD EQUIPMENT

In addition to the three basic types of machines used in an EAM system, machines in other categories have been developed to perform data processing needs of an auxiliary nature. These machines speed processing functions and lessen human effort but are NOT always essential for a system's output.

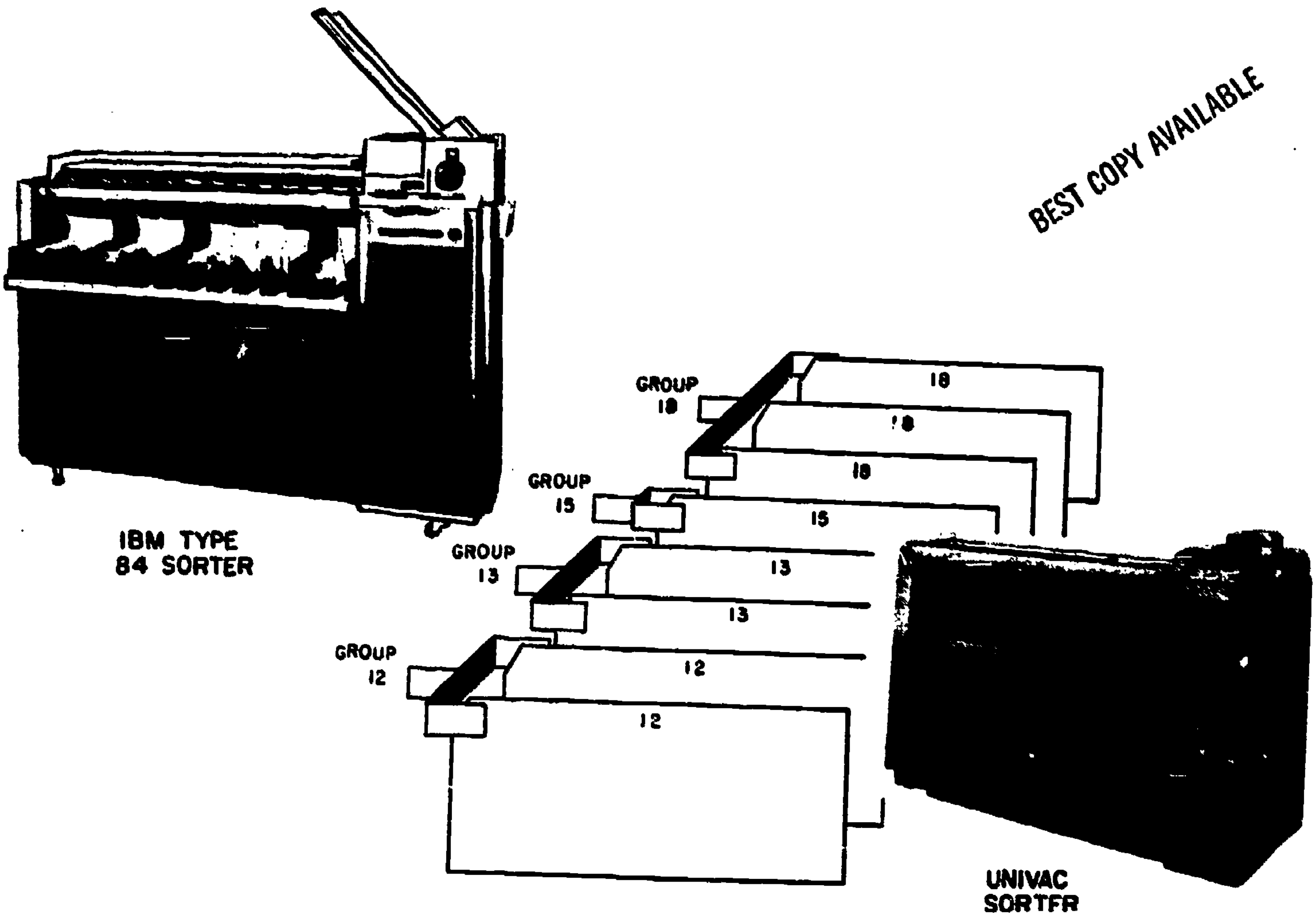

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Figure 2-15.—Grouped cards in a definite sequence.

Interpreters

The interpreter (fig. 2-17) translates the punched holes into printed information on the face of the card, thereby increasing the use of the card as a documentary recording medium. Normally, interpretation appears at the top of the card, but some interpreters can print information on any of 25 designated lines. Although skilled operators can translate punched information into correct digits and characters, interpretation is required when visual reference must be made to punched card data files.

Reproducers

When information is recorded in the form of holes in a card, all or part of the information is sometimes desired in another set of like cards (fig. 2-18). In preference to manually rekeying information into new cards on the keypunch, maximum efficiency can be achieved in the copying of one unit record to another card through the use of the reproducer or document originating machine. This process of punching any or all of the information from one set of cards into another is known as REPRODUCING. Another primary function of automatic reproducers is GANGPUNCHING (fig. 2-18), the operation of punching information from a single master card into detail cards.

Collators

Development of the basic unit record equipment for EAM systems (fig. 2-19) was brought about by the pressing need for speed and accuracy. However, jobs performed by these

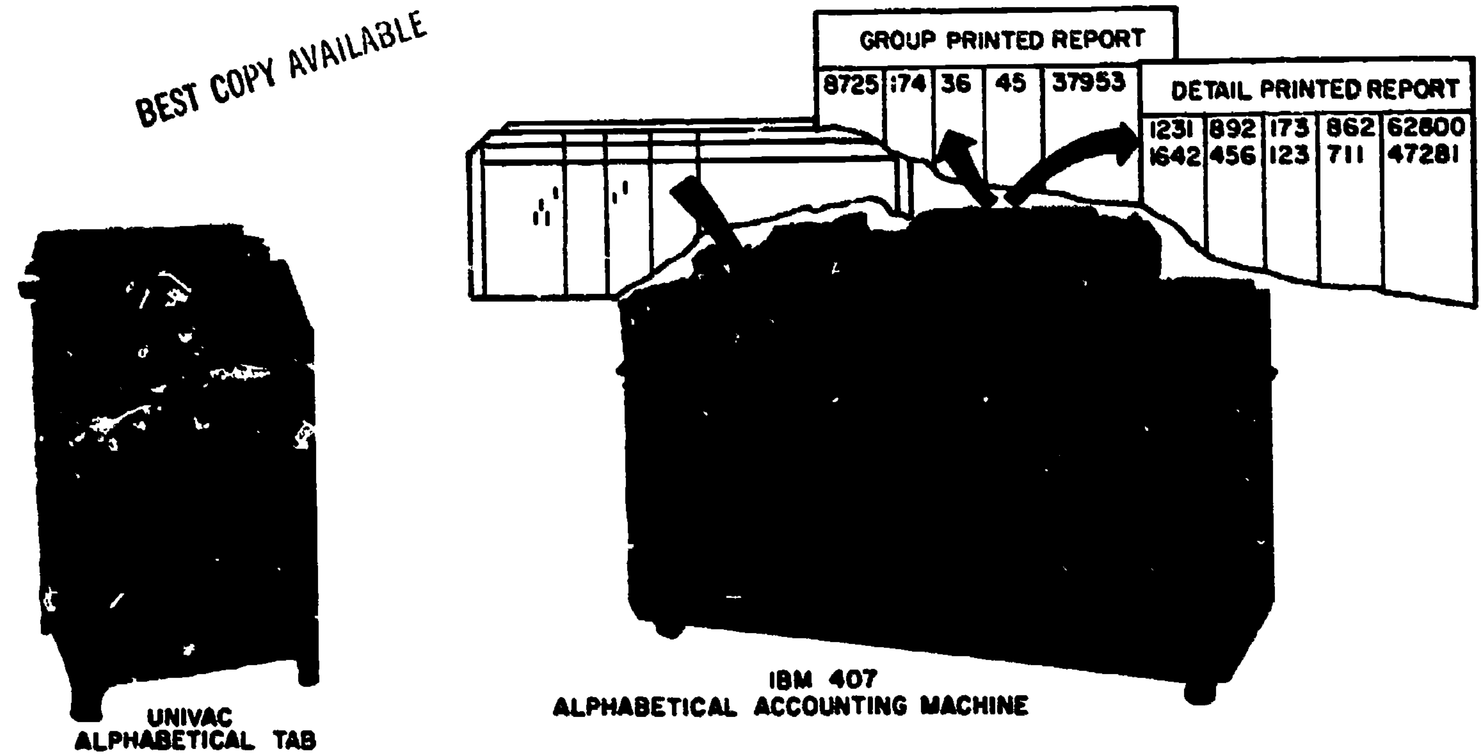

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Figure 2-16.—End of the line processing.

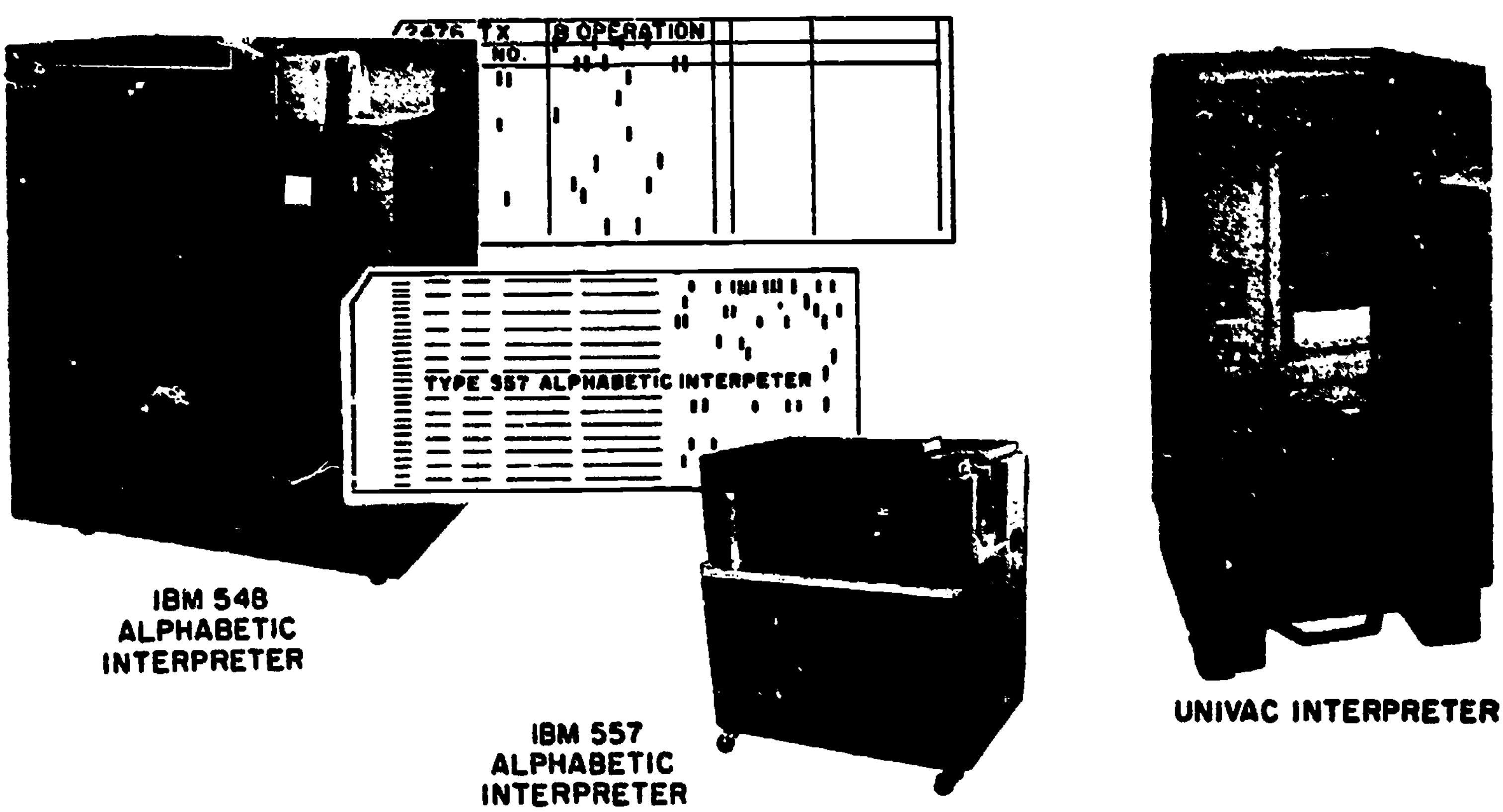

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Figure 2-17.—Translating punched holes into printed information.

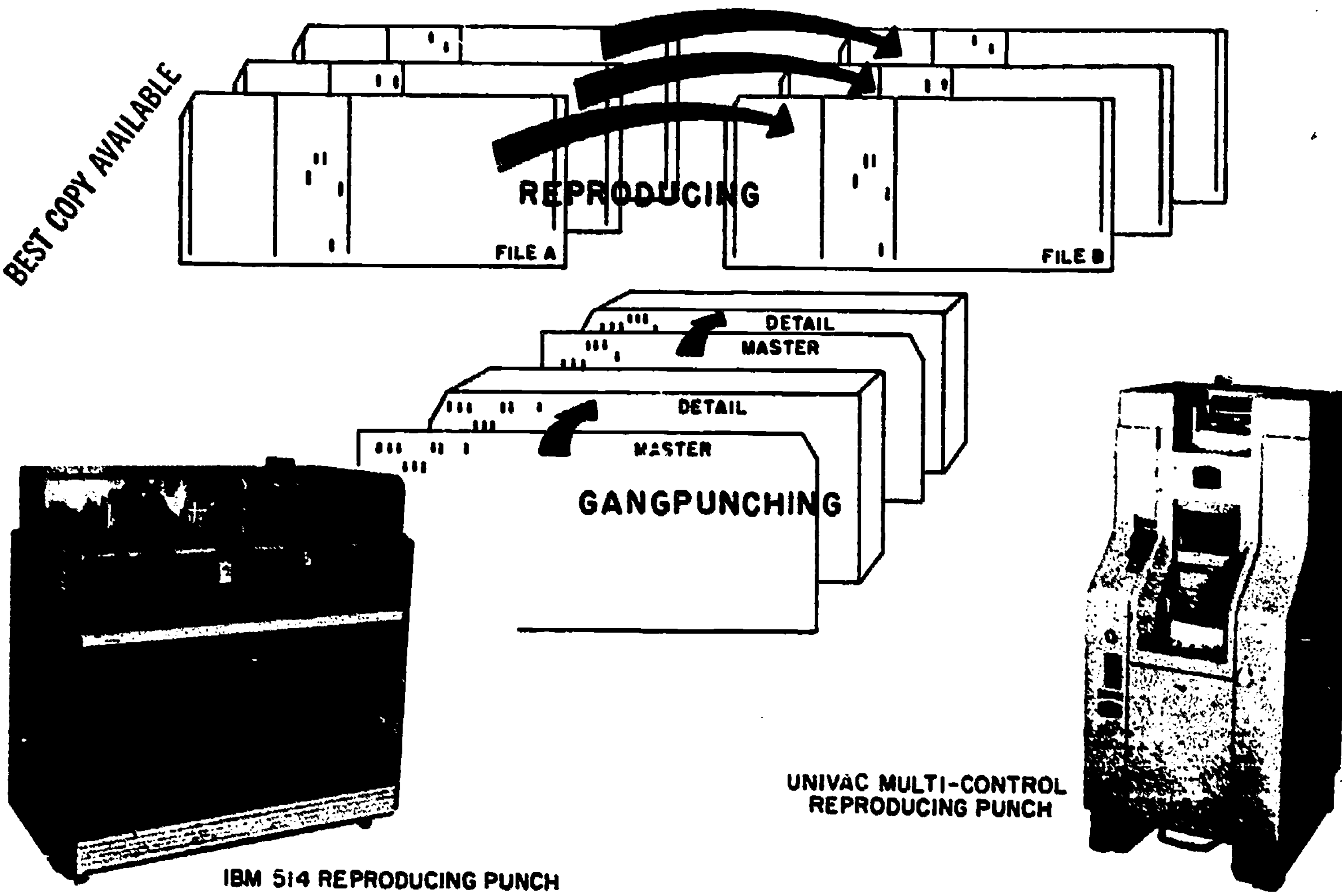

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Figure 2-18.—Automatic reproducing and gangpunching.

machines are sometimes overlapped by those that others can do, adding the advantages of versatility and convenience of interspersed operations to auxiliary equipment. Sometimes data required for printing operations on the accounting machine must be obtained from two or more card files. This MERGING, or combining two sets of punched cards into one of a given sequence to satisfy the needs of the tabulator, could be performed on the sorter but, for quicker and more accurate results, the collator is generally used. Peak workloads and periods of machine breakdown will also affect this overlapping of jobs between the basic and auxiliary machines. Additional collator functions include MATCHING, which is checking the agreement between two sets of cards; SEQUENCE CHECKING cards of an ascending or descending sequence and various types of CARD SELECTION.

BASIC PRINCIPLE

The basic principle of punched card accounting is that information, once recorded in punched cards, may be used time and time again. Data is punched and verified and may then be classified (sorted) and summarized to produce desired results through machine processing. (See fig. 2-20).

Basic Elements

RECORDING.—Transactions of an installation involve essential information vital to management. In processing data, single transactions

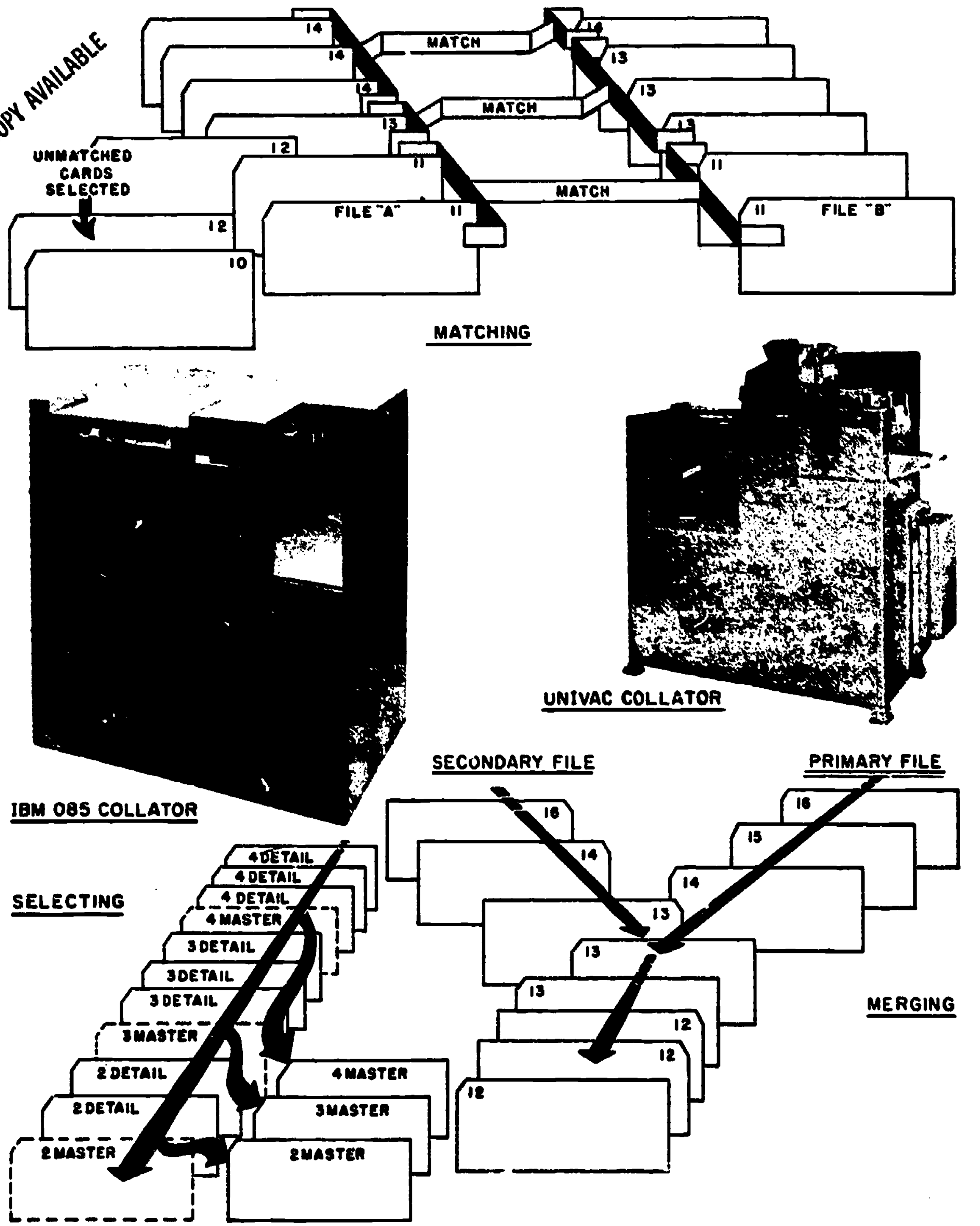

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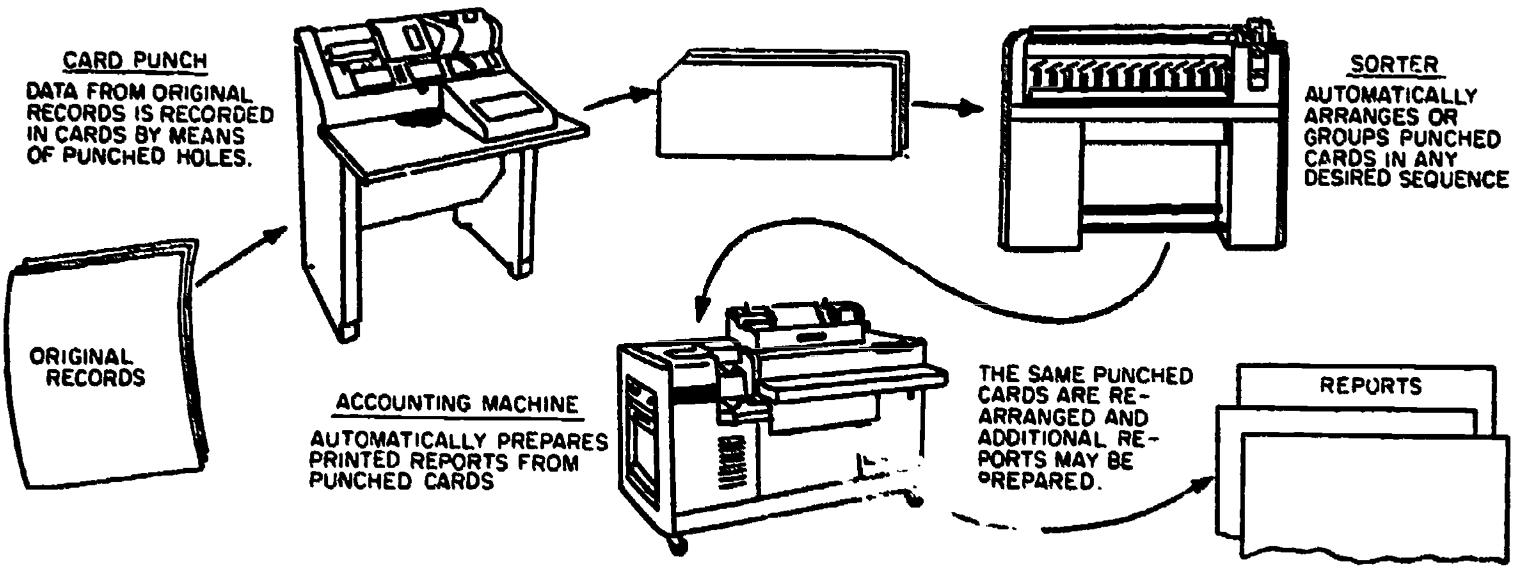
Figure 2-19.—Filing machines that arrange cards for subsequent operations.



49.225

Figure 2-20.—Principle of punched card accounting.

must appear in numerous records. Under the manual methods of accounting, each time information is used, it must be copied and checked. Machine accounting affords mechanical and automatic means of recording transactions which enable them to be read and transcribed by other machines. Recording is done by keypunching each transaction into a single card, offering the advantage of producing permanent records for automatic processing. This recording corresponds to a single entry made manually under other methods of accounting.

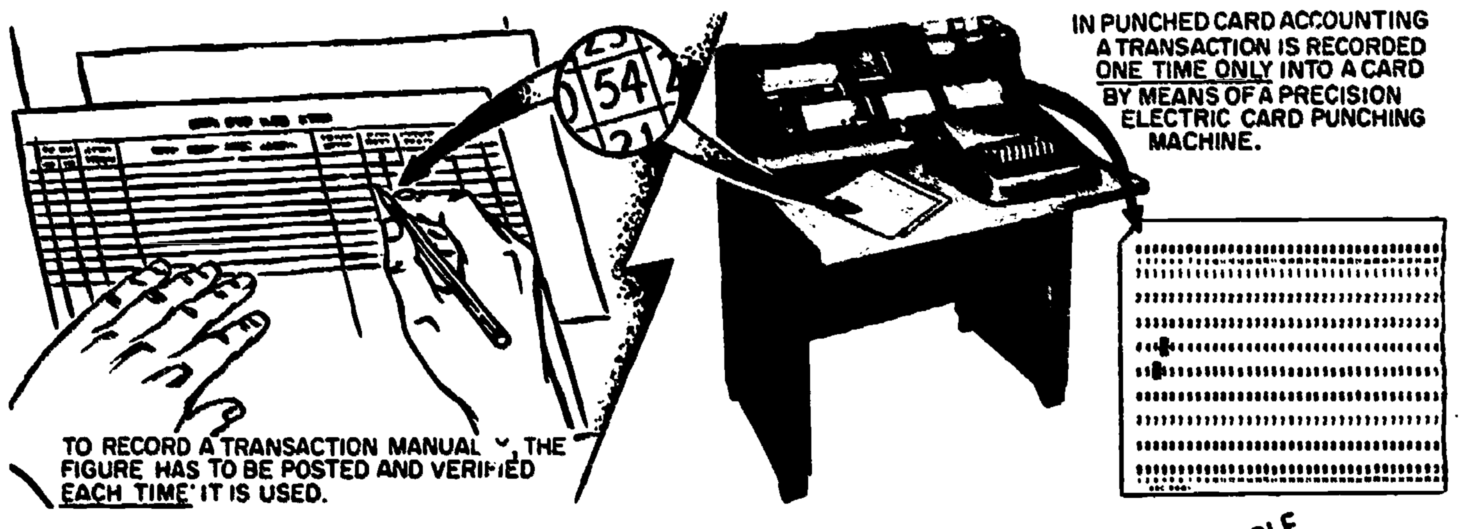
To ensure consistency of common data, such information is often DUPLICATED. This card punch function allows the operator to punch a field of common information once in the first card of a group; henceforth, the card punch will automatically punch it into the remaining cards of the group if proper control is utilized.

CLASSIFYING.—One transaction sometimes affects more than one account, or many transactions will affect but one account. Grouping these like items of information, or transactions, as a preliminary step toward report preparation, is a slow and tedious task when done manually.

Under the punched card accounting system, the machine solution to this problem of classifying or arranging transactions is the high-speed sorting machine. This machine groups cards in numeric or alphabetic sequence according to any classification punched in them. Thus, a fast automatic method is provided to classify and reclassify transactions for file or account processing and to facilitate their use in various reports—reports that use the same cards, but each requiring a different sequence or grouping of transactions.

SUMMARIZING.—The final step in any accounting procedure is the summarization of information to produce final reports and required records. Summarization includes not only accumulating totals of grouped transactions, but also the printing of these totals with identification data such as names and codes necessary for their proper interpretation. As transactions occur and are posted to accounts during a given period, totals are eventually taken and manually recorded on printed forms and documents.

Automatic detail listing and group printing accounting machines replace the above manual methods. These machines electrically sense group changes within series of cards and, as a result, subtotals within a report, and numerical or alphabetical descriptions of the totals, can be printed automatically. Also, many combinations of totals can be printed, involving adding, subtracting, and crossfooting operations, with totals of a given group subdivided and distributed horizontally across the report form. Vertical columnar totals are also possible. Cards



49.226

Figure 2-21.—The element of recording.

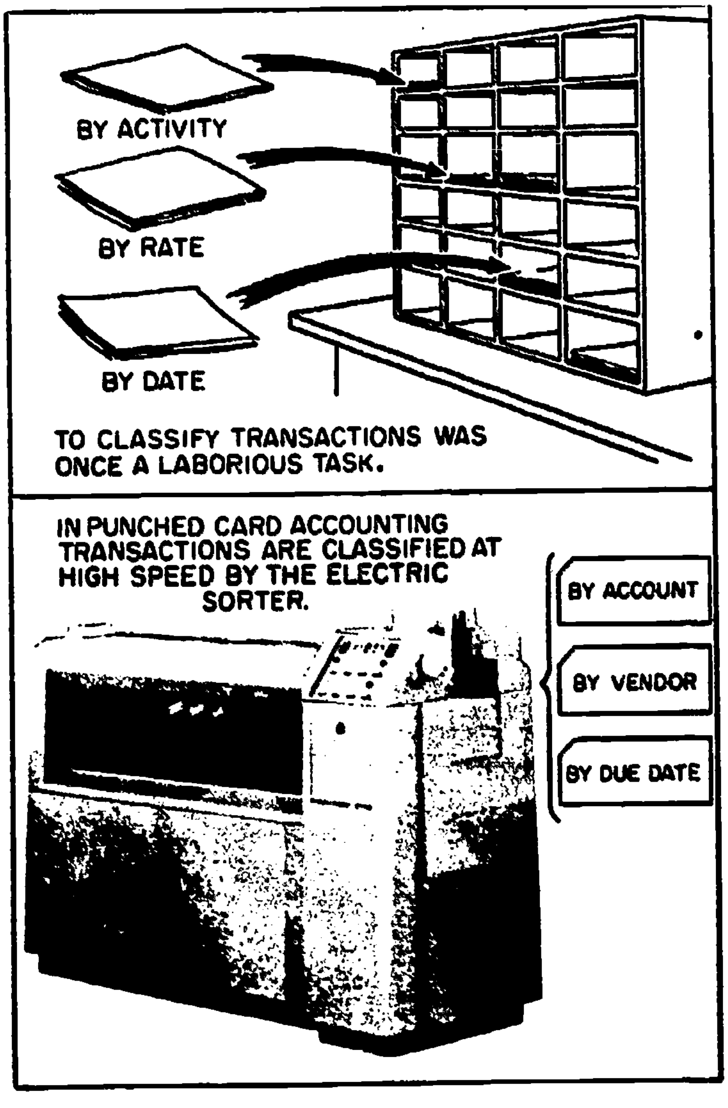
may be re-sorted to various group arrangements and resummarized by machine until all necessary totals have been taken. Because machine functions are flexible, many types of accounting and analytical reports can be produced. Figures 2-21 through 2-23 illustrate the above three basic elements of punched card accounting.

PRINCIPLE OF MACHINE PROCESSING

Most punched card equipment can accomplish more than a single function, but this equipment must know what function to perform and how to handle information it receives. The machines are capable only of following your instructions. They can make decisions only after you have predetermined the decisions to be made for each given set of conditions. Many of the instructions and most of the information depend upon the holes punched in the card and the wired control panel. The principles will be explained in chapter 5 of this manual.

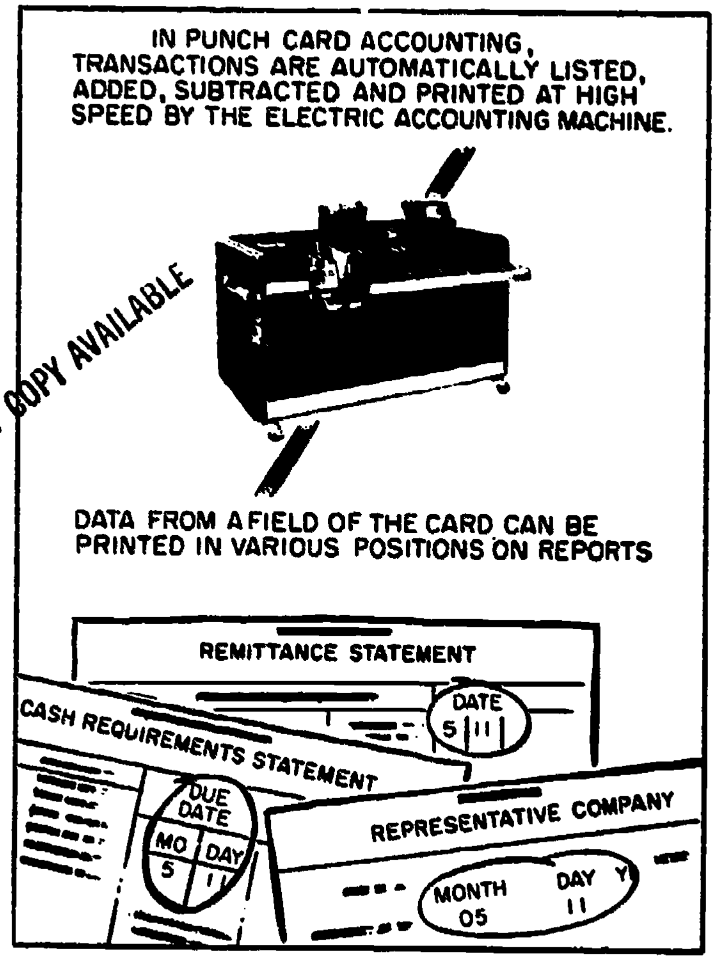
ELECTRONIC DATA PROCESSING

The trend in recent years has been toward the use of electronic data processing equipment, especially in those areas where huge volumes of data must be processed as rapidly as possible. The equipment enables an organization to expedite its data handling processes in the most economical manner, and yet provides for speed, accuracy, and flexibility in the production of results.



49.227

Figure 2-22.—The element of classifying.



49.228
Figure 2-23.—The element of summarizing.

When we speak of electronic data processing, we are thinking in terms of the computer and its many components as related to INPUT, PROCESSING, and OUTPUT functions. There are many different types of computers and computer devices with various data handling capabilities. They are classified generally as computers, electronic data processing machines (EDPM), electronic data processing systems (EDPS), and data processing systems (DPS). Regardless of what they are called, bear in mind that they have these characteristics: they process data automatically and at electronic speeds, (fig. 2-24).

DATA PROCESSING BY EDP

In certain respects, electronic data processing is similar to the unit record system in that punched cards may be used as input, and printed reports or punched cards may be produced as output. The unique difference lies in the manner of processing the data and the electronic equipment used in its processing applications. Whereas the unit record system requires the physical movement of cards from one machine to another, the electronic system permits many processing functions to be performed in one operation. (See fig. 2-25). This is made possible through the use of several interconnected devices which, working together, can receive, process, and produce data in one operation with minimal human intervention. These devices constitute an electronic data processing system.

The operations of preparing source documents, punching cards from source documents, and (for a punched card EDPS) presorting punched cards are accomplished by the same methods used in the unit record system. However, systems using magnetic tape for input generally have punched card data transcribed onto the tape, and it in turn is sorted into a sequence acceptable for processing by the computer. Once information has been entered into the system, all classification, identification, logical and arithmetic operations are performed automatically in one or several processing routines. This is accomplished by a set of written instructions called a PROGRAM which, when recorded onto punched cards or magnetic tape and fed into the system, controls operations automatically from start to finish.

Information used as input to an electronic data processing system may be recorded on

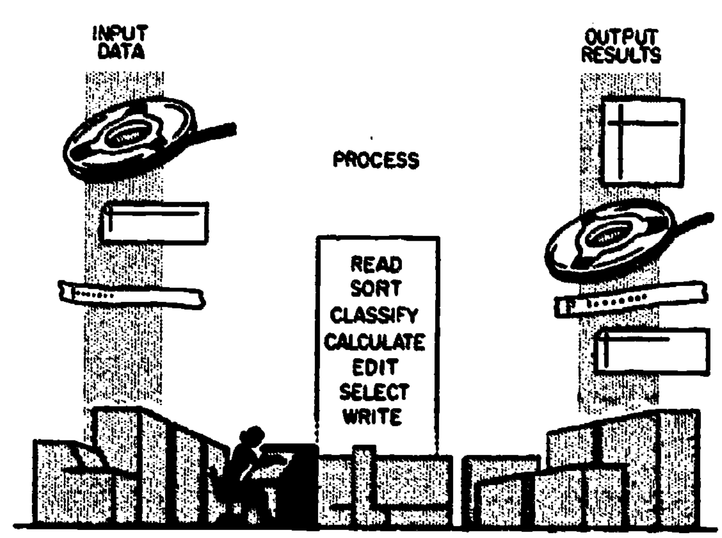


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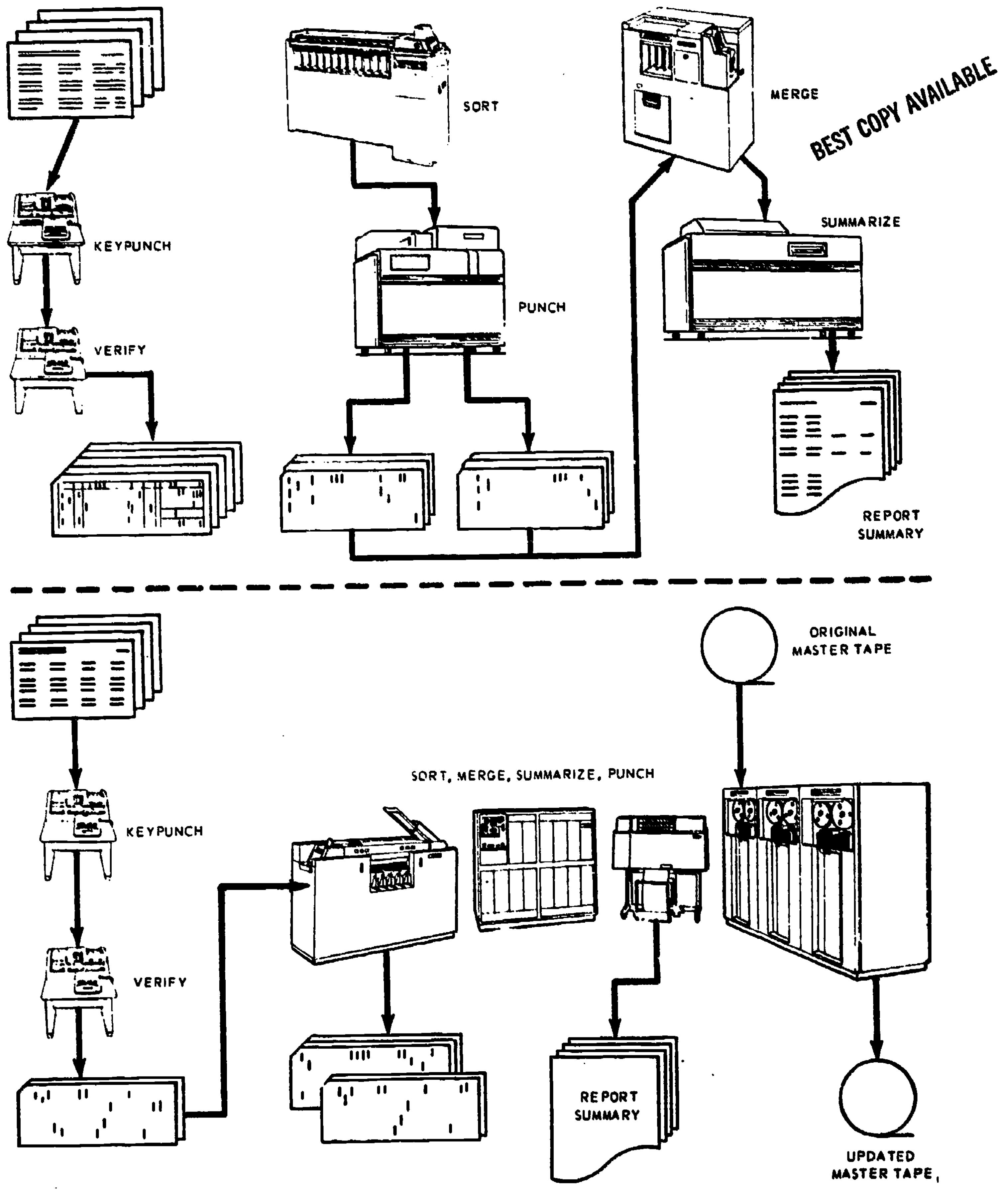
Figure 2-24.—Data processing by computer.



49.200

Figure 2-25.—A simple analogy of EAM vs EDP processing applications.

punched cards, paper tape, magnetic tape, magnetic disk, magnetic drum, magnetic data cell, magnetic ink or optically read documents, depending upon the system requirements. Similarly, output may be in the same forms with the addition of printed reports, again depending upon the system (fig. 2-26).

The Electronic Brain

The computer has earned for itself the reputation of an electronic brain, but this is a gross misrepresentation and exaggeration. Computers can accept data at the rate of thousands of digits per thousandth of a second (millisecond), perform arithmetic computations in millionths of a second (microsecond), and print results at thousands of characters per second. But in spite of its remarkable achievements, the computer can only do what it is told by human beings. We might say that the computer is comparable to the human brain to the extent that it has the ability to accept, retain, make calculations on and send out data given it. Unlike the human brain, it is incapable of creative thought. It is a complicated mechanism made up of basic elements that imitate certain functions of the human brain. It surpasses the human brain in speed and reliability, and it is notable among machines for both speed and flexibility.

What is a Computer?

Simple in its makeup, the computer consists of an input section which introduces data into the system. Once interpreted, the information is sent to a control section where it is further directed according to programmed instructions. As specified, the data is sent to storage or memory, a high-speed device able to read in and read out data in a few millionths of a second. Data in storage can be used over and over, or can be used only once and replaced. If the computer is so instructed, the data can be directed to the processor or arithmetic section. It is here that the computer really computes; adding, subtracting, and comparing numbers. The organized results are transferable to an output section for the creation of reports, or to produce new media for further processing needs.

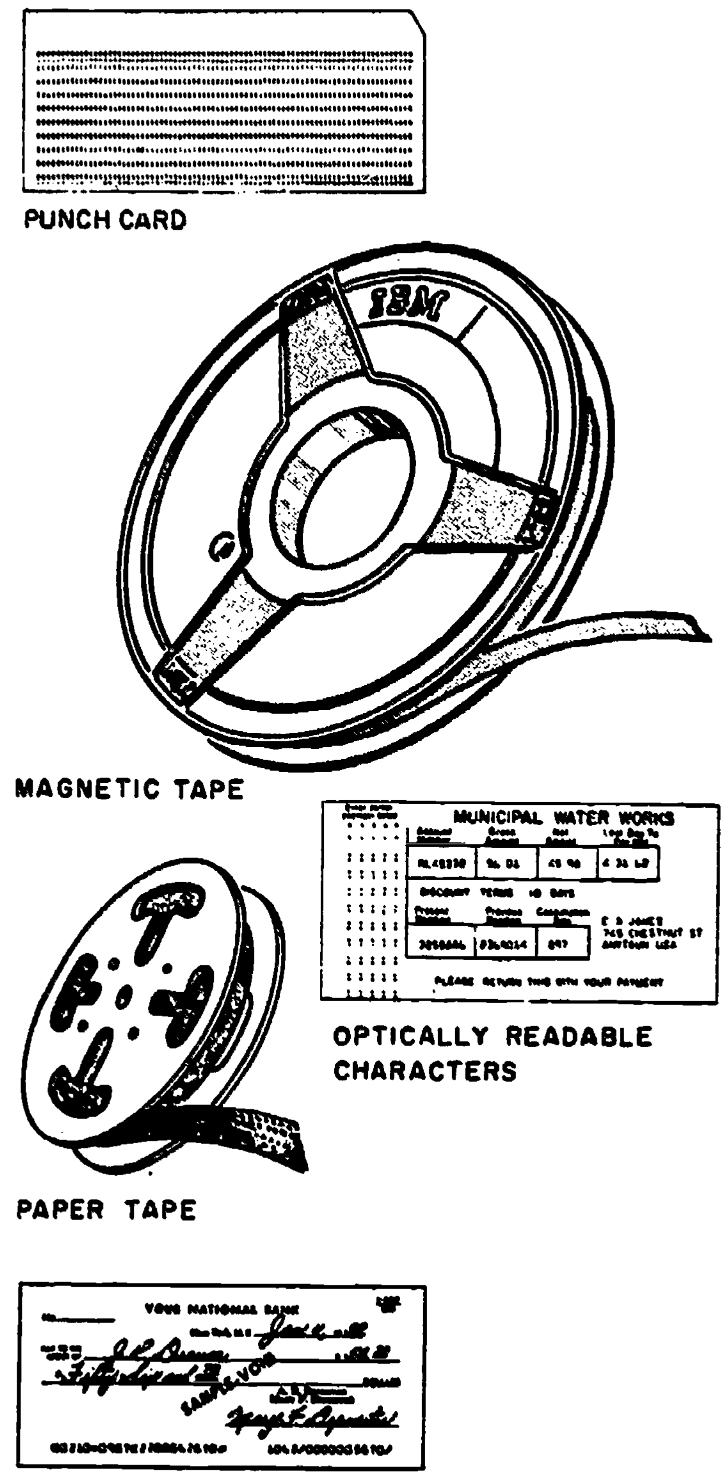


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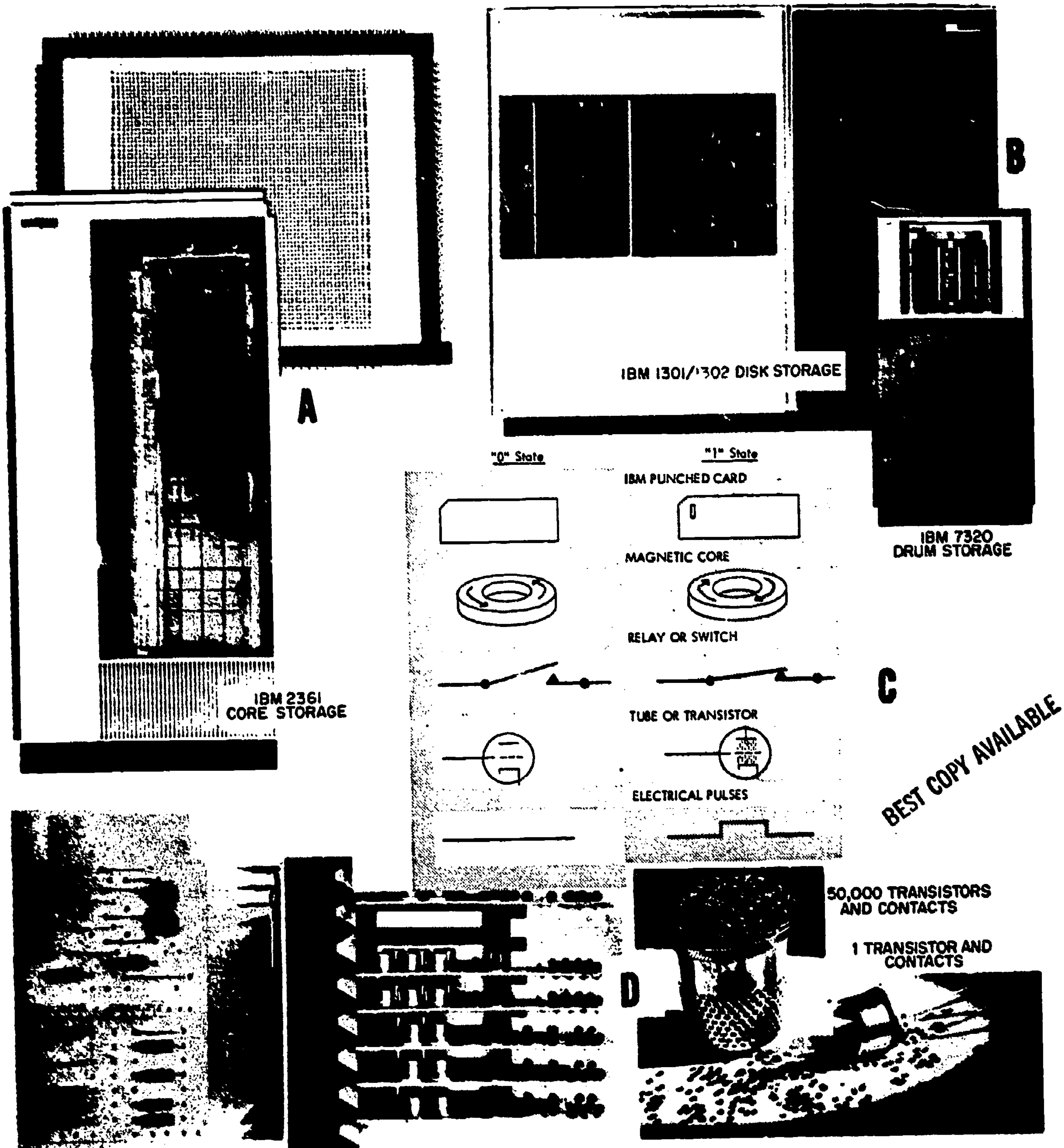
Figure 2-26.—Examples of EDP input media.

What Makes It Work?

The calculating mechanism of the computer has electronic circuit devices (fig. 2-27) which allow speeds of response in a billionth of a second (nanosecond). When data is written in a



A. MAGNETIC CORE STORAGE
B. ADDITIONAL MAGNETIC STORAGE DEVICES
C. TWO-VALUE OR BINARY SYSTEM
D. SOLID-STATE CIRCUITRY AND TRANSISTORS

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Figure 2-27.—Some of the essentials in making a computer work.

code acceptable to the computer and fed into it, electric impulses flow through the solid-state electronic circuitry in a pattern which causes the transistors to switch the signals, count certain impulses flowing through, or direct their flow according to programmed commands. Other factors which add to and form the basis for fast manipulation are: (1) memory units made up of magnetic cores, which are tiny rings consisting predominantly of ferrite, a magnetic material that is easily magnetized and remains so indefinitely after the magnetizing force has been removed; (2) magnetic storage devices such as tapes, disks, and drums, upon which data is encoded by means of magnetic spots; and (3) the binary mode of representing data, a two-value system which can represent alphabetic or numeric information by combining ones and zeros in various ways.

How Does It Work?

To answer this question, suppose we compare the simple adding machine to its larger counterpart—the electronic computer (figs. 2-28 through 2-34).

INPUT.—We use the term INPUT to describe the act of introducing data into a system. Since the keyboard is used to feed data into the adding machine, we can call it an INPUT DEVICE (fig. 2-29). The SOURCE MEDIA, or documents from which information is obtained, could be an invoice, pay record, or supply requisition. Unlike the adding machine, wherein data is introduced directly through the keyboard from the source media, a computer system necessitates the conversion of data onto a type of medium that will lend itself to automatic processing prior to its being read into the system. Therefore, INPUT DATA is data that has been recorded from a source medium onto a type of INPUT MEDIUM acceptable to a system. Computer input devices read from their prescribed media, and translate that data into electronic impulses for transmittal into the computer. Input devices, among others, could consist of high-speed card readers, paper tape readers or magnetic tape units.

PROCESSING.—Racks, gears, counting wheels, and so forth are used by the adding machine to compute the data fed into it. The CENTRAL PROCESSING UNIT (fig. 2-30) is the computing center of the electronic data processing system. The system is made up of two functional units in addition to the CPU, which are INPUT, and OUTPUT. The CPU consists of CONTROL, ARITHMETIC/LOGIC and MEMORY units.

The CONTROL UNIT (fig. 2-31) automatically directs the step-by-step operation of the entire system, including the operation of input and output devices as well as the selection, interpretation, and execution of instructions from memory. Areas of the adding machine keyboard that contain buttons (plus, minus, total, and others) used by its operator to exercise control over the machine, might be likened to the control panel of the computer CONSOLE. The console itself provides external control over the entire system, for through it, the operator can monitor the central processor (fig. 2-32) and maintain manual control over all operations. Remember, the computer does not rely on the operator to feed it data and initiate its every command; the control panel and electric typewriter (provided by some systems) of the console simply permit human beings to communicate with the various units that make up a total computer system.

Looking closely at the adding machine mechanism, you will find a set of rachets used to turn the counting wheels and cause the arithmetic functions to be performed. Likewise, the ARITHMETIC UNIT of the computer (fig. 2-33) performs arithmetic operations of adding, subtracting, multiplying, and dividing. Through its logical ability, it can also test various conditions encountered during processing and take action called for by the results.

Because the counting wheels store the results of arithmetic operations until changed or totaled, they might be thought of as the memory unit of the adding machine. However, the MEMORY UNIT of a data processing system differs in that it can be used to store data and/or programmed instructions for an indefinite period of time.

OUTPUT.—We define OUTPUT as data that has been processed or the act of extracting such

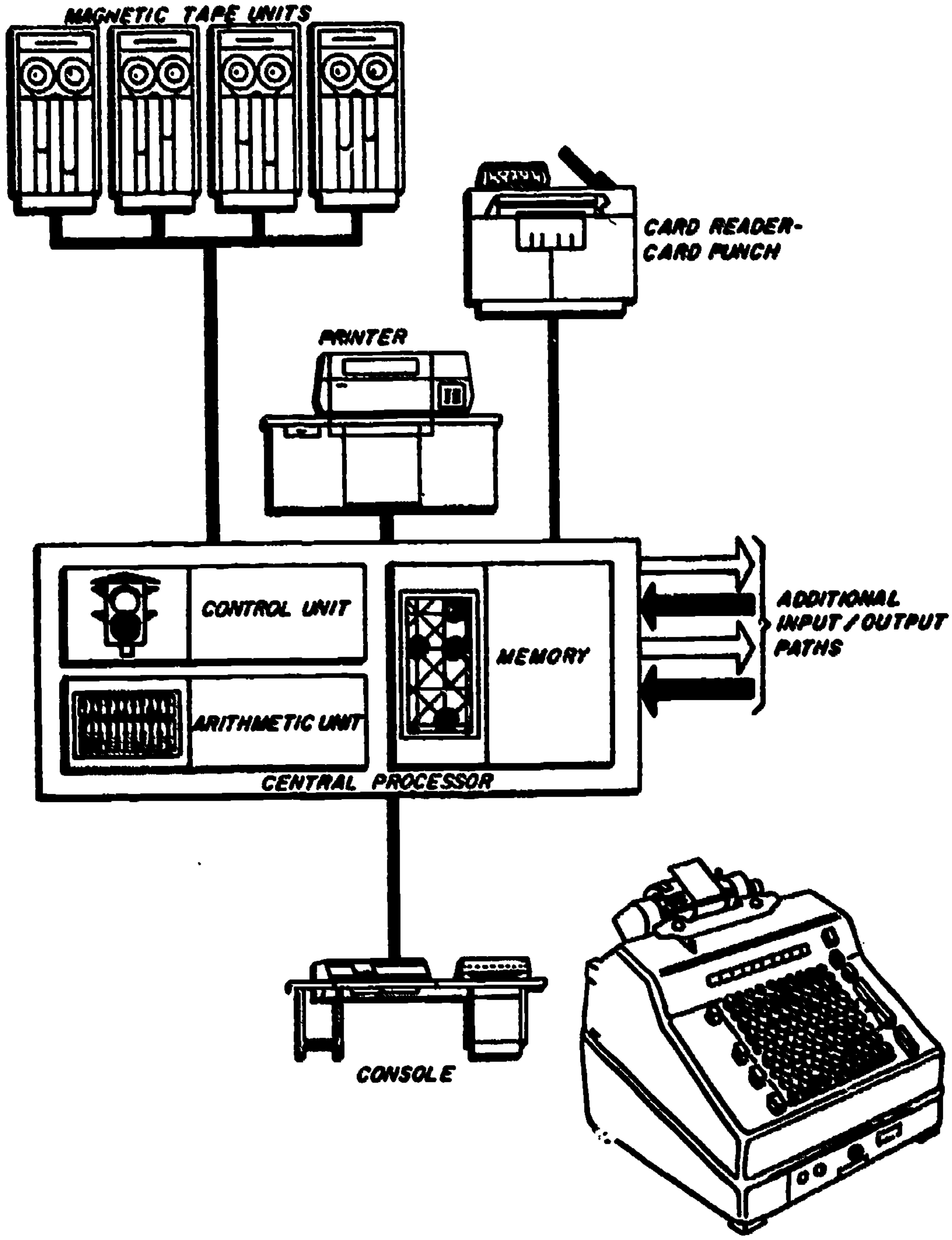

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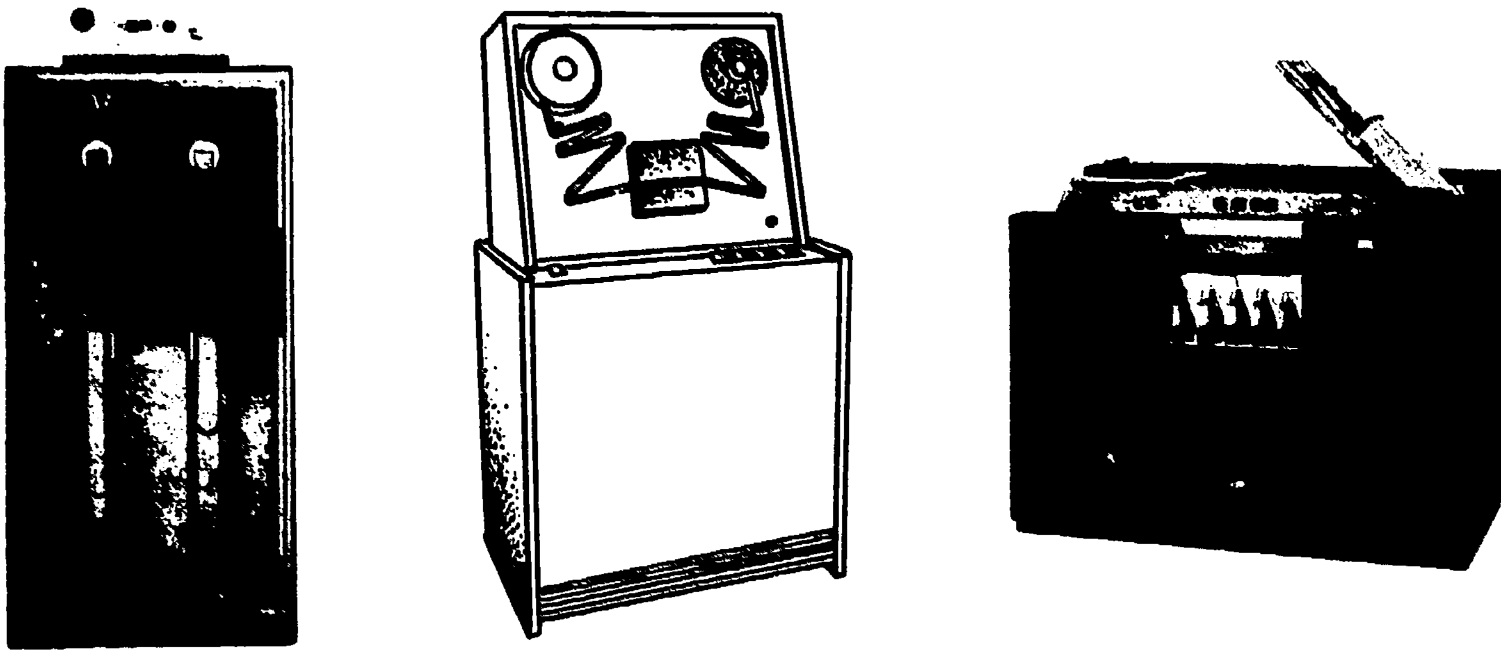
Figure 2-28.—The adding machine and the computer.

data from the central processor. Results of the adding machine's calculations are printed by its OUTPUT DEVICE, a printer (fig. 2-34), onto a listed tape or inserted document. The basic function of a computer output device is to receive, convert and record output data onto its particular medium. The most commonly used output devices are card punches, magnetic tape units, paper tape punches, and printers; their output media being punched cards, coded magnetic spots on magnetic tape, punched paper tape, and printed reports.

What Are Its Tools?

Components or tools of a computer system are categorized as either hardware or software.



IBM 2401 MAGNETIC TAPE UNIT

MODEL 322 RCA PAPER TAPE READER

IBM 1402 HIGH-SPEED CARD READER

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Figure 2-29.—EDP input units.

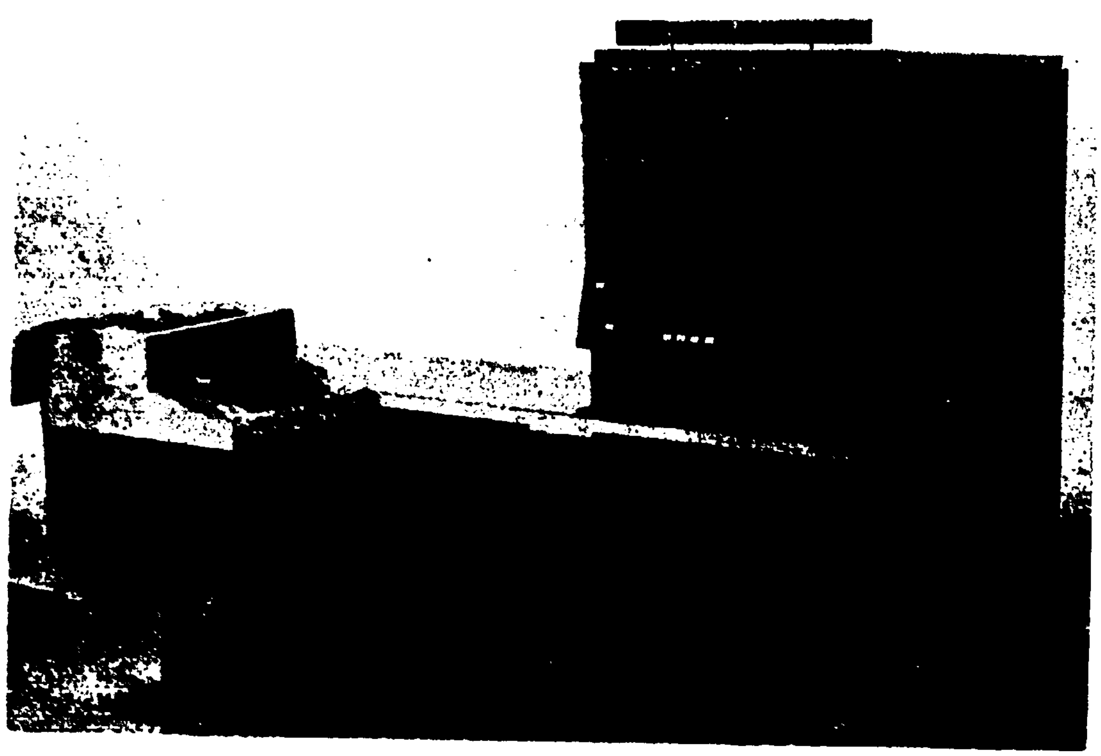

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Figure 2-30.—Central processing unit and console.

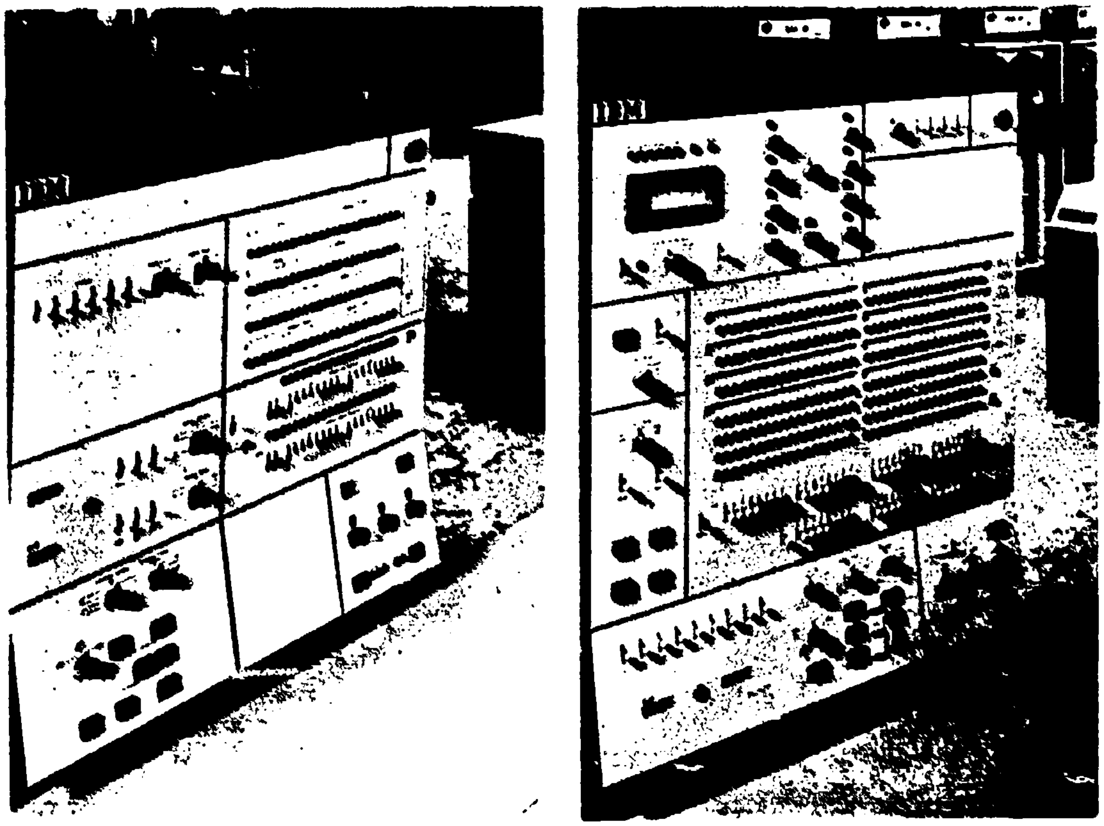

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Figure 2-31.—Typical control panels of computer consoles.

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Figure 2-32.—Monitoring and communicating with the central processor.

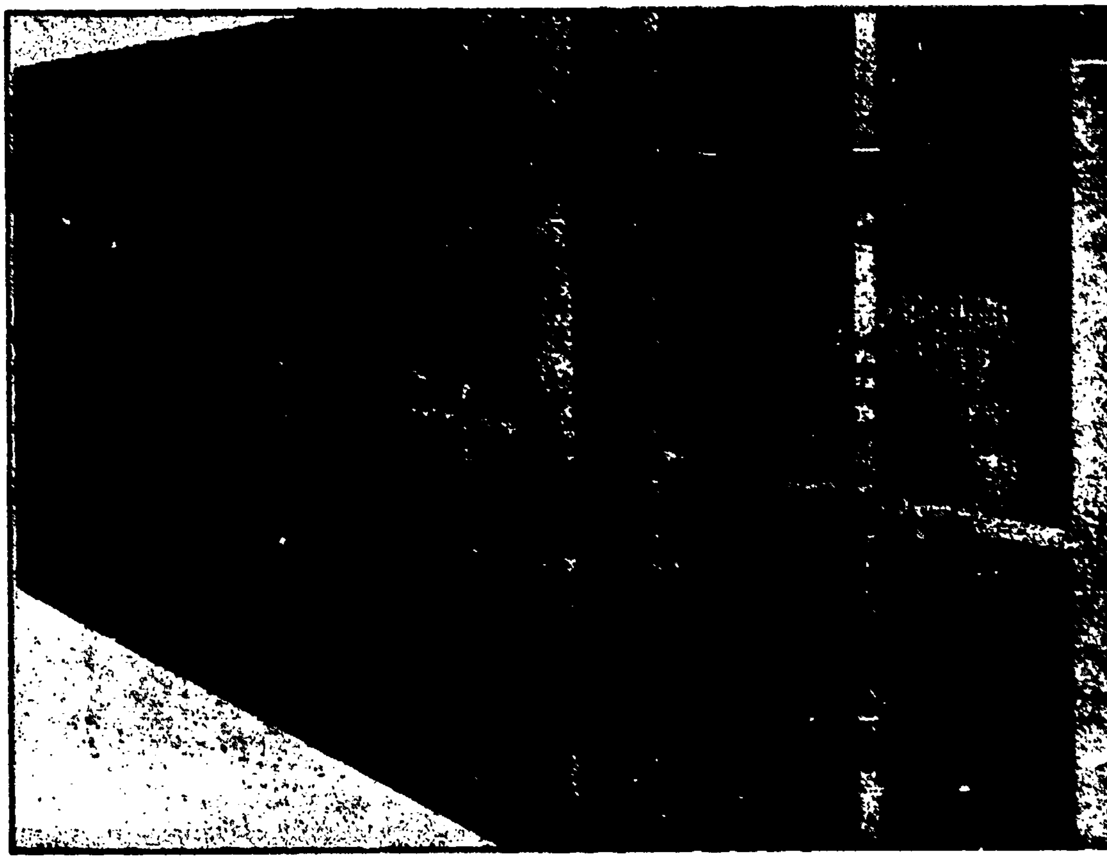

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Figure 2-33.—Control and arithmetic-logical sections.

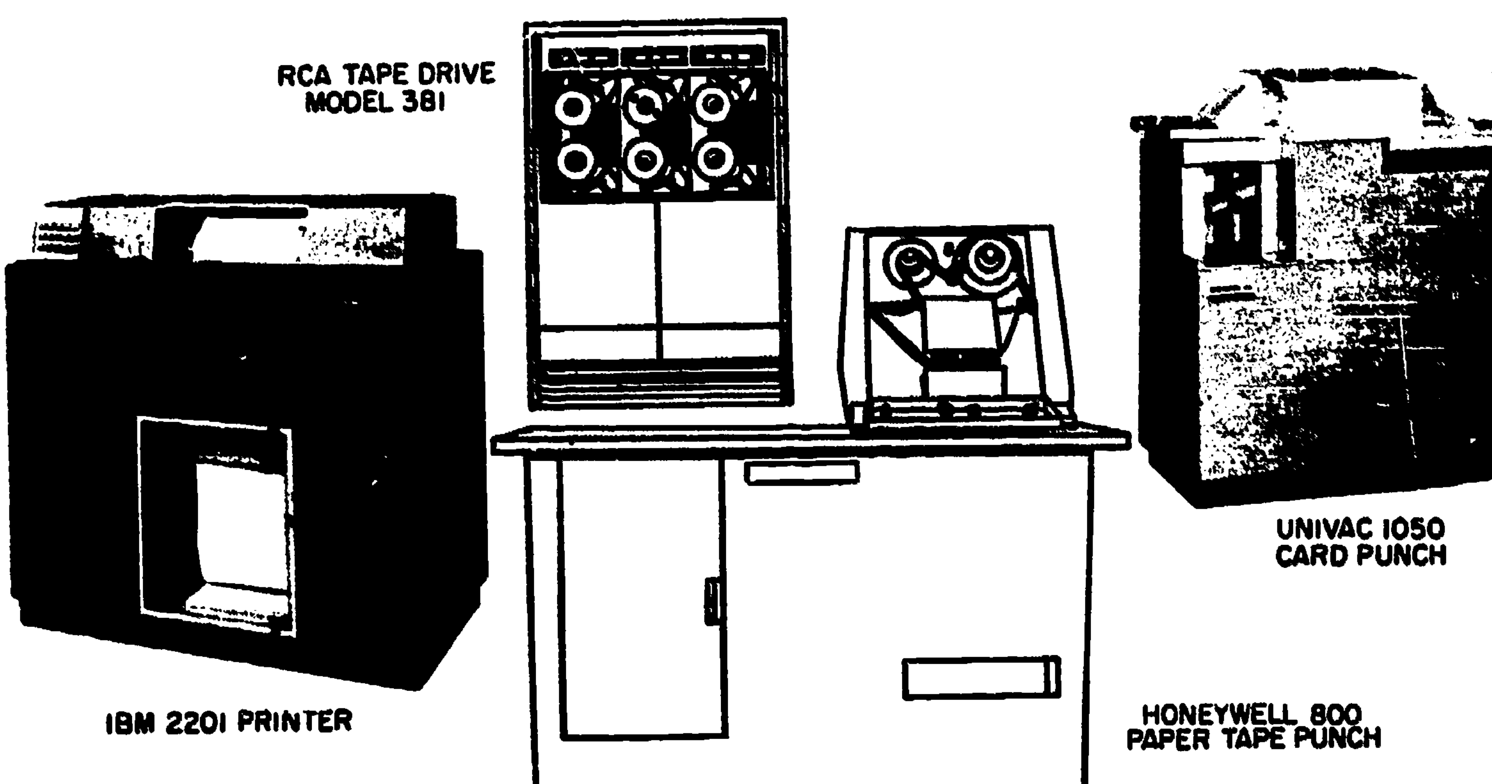

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Figure 2-34.—Various EDP output devices.

Hardware includes all the mechanical, electrical, electronic, and magnetic devices within a computer system. Software consists of the automatic programming techniques developed for the most efficient use of the hardware and isusually supplied by the manufacturer of particular systems.

HARDWARE.–Computer hardware falls into two categories, peripheral equipment and the central processor. PERIPHERAL EQUIPMENT includes all input and output devices associated with specific recording media such as, a card reader and punch, or magnetic tape units. This peripheral equipment can operate ON-LINE, under direct control of the central processor (see fig. 2-35) or OFF-LINE, independently of the central processor. (See fig. 2-36.)

During on-line operations, data can be transferred to and from peripheral devices and the central processor via CONTROL UNITS. These units may be free-standing, or built into either the central processor or the peripheral device, and receive their signals or instructions from the stored program.

In off-line or AUXILIARY operations, the input and output devices are used in conjunction with other peripheral devices not directly connected to the system. Since input and output data conversion operations are relatively slow compared to the speed of the central processing unit, off-line operations free the computer of time-consuming procedures and provide more time for the computing and processing of data by the central processor. For example, a system's output data could be written on magnetic tape and converted to some other record form in an off-line operation while the computer continues processing new data.

SOFTWARE.–This is the totality of programs and routines used to extend the capabilities of automatic data processing equipment such as operating systems, compilers, assembler routines and subroutines. In general if it isn't hardware, it is software.

CARD ORIENTED SYSTEM

A system whereby information is fed into its input unit only by means of cards, and with its output also in the form of cards and/or printed reports, is commonly referred to as a CARD SYSTEM. These systems are usually relatively small, especially in their memory capacity and other storage facilities. Input data must be prearranged before being fed into the system but can remain in its memory unit until the programmed instructions call for its release, or replace it with new information. (See fig. 2-36.)

TAPE ORIENTED SYSTEM

Systems whose source of input data is from almost any medium, but essentially from perforated paper or magnetic tape, are referred to as TAPE SYSTEMS. Because these systems are large and complex, they demand more processing ability, and therefore require faster input media than the much slower punched card input. In addition to larger memory capacities and other storage facilities, input and output devices may vary as to the type of media used and consist of several or many in number.

ELECTRIC ACCOUNTING VERSUS ELECTRONIC DATA PROCESSING

Electronic data processing systems should not be thought of as replacements for electric accounting machine systems. The EDP systems are capable of performing functions which EAM systems cannot perform. While it is true, however, that EDP systems can carry out the accounting operations of an EAM system, these operations are still most economically carried out in many places by electric accounting machines. Furthermore, electric accounting machines are used in support of automatic computer systems–they are the peripheral equipment off-line to the central processing unit of an automatic computer system.

If we compare an electric accounting machine system with the central processing unit of a computer as they execute the same accounting function, we shall see that the chief difference between the EAM system and the central processing unit is in the speed at which this function is carried out. The central processing unit completes the job in much less time.

It is easy to see why the central processing unit is more efficient than the electric accounting machine system. First, the amount of data

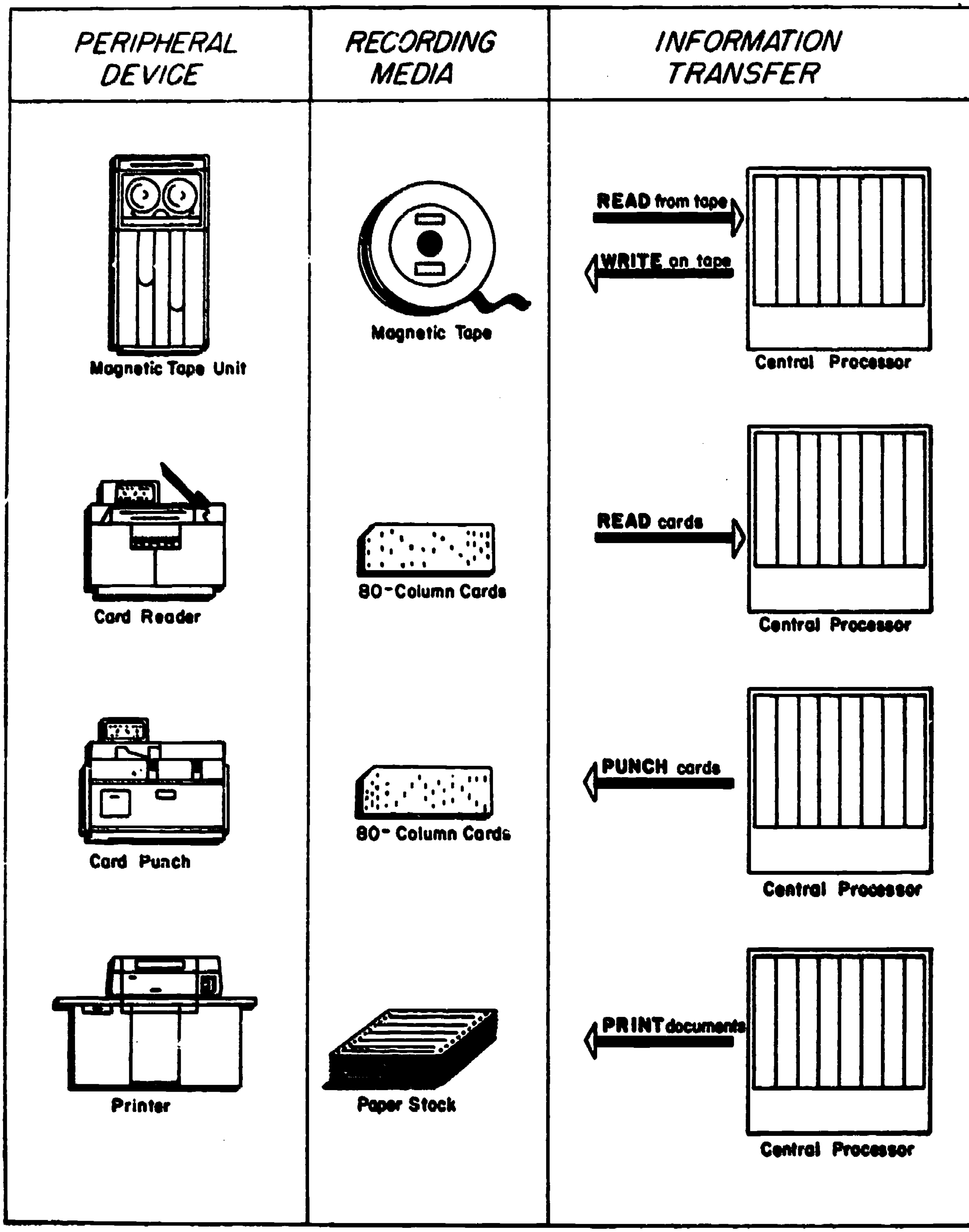

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Figure 2-35.—On-line peripheral equipment and recording media.

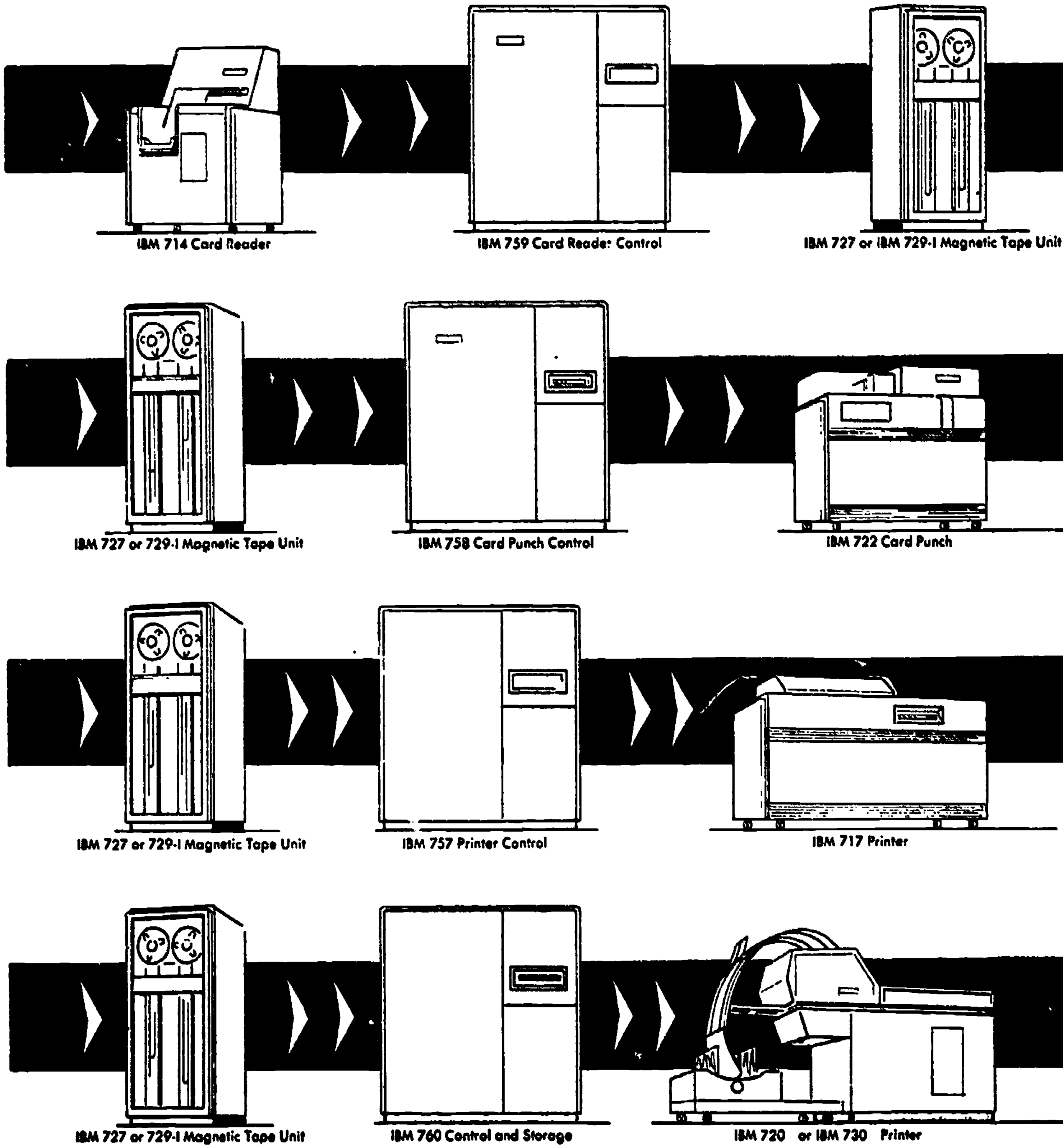

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Figure 2-36.—Off-line data conversion operations.

that can be held in the storage component and in the registers of the central processing unit far exceeds the storage capacity of the electric accounting machine system, so that data transfers and arithmetic and logic operations are carried out faster by the central processing unit. Second, no intervention is required during the operation of the central processing unit, while

stacks of cards must be shifted between the various accounting machines to complete the EAM operation. Third, when magnetic tapes constitute the input and output media of the EDP system, faster input to, and output from, the central processing unit are possible.

SCOPE OF DATA PROCESSING

Data processing performed by Data Processing Technicians has greatly expanded and become extremely diversified since the establishment of the Machine Accountant rating in 1948. Models and types of data processing equipment employed by the Navy today, vary in size, dimension, and performance.

You may at present be serving a tour of duty in an installation using some of the aforementioned machines and devices. Subsequent orders may place you in a naval activity where a knowledge of EAM equipment is all that will be required, such as a naval training center or naval station electric accounting machine unit (EAMU), or filling a billet in a stock control system aboard ship. You might find yourself in a shipboard maintenance and material management system (3M system) operating the Univac 1500 data processing system or filling any number of billets within a fleet PAMI, a statistical or guided missile unit, or in supply, security, communications, or personnel research activity. In any of these you may, with a reasonable amount of on-the-job training, be expected to operate and program some of the more complex computer systems of today.

Once you learn and understand the fundamental concepts and principles of automatic data processing as presented here and in the detailed chapters to follow, you will recognize the similarities of the data processing systems of various manufacturers.

CHAPTER 3

CARD PUNCHES AND VERIFIERS

There is a good possibility that one of your early assignments as a Data Processor in the Navy will be that of a card punch or card verifier operator. This is definitely one of the most important jobs in data processing.

The punched card is the most widely used method of data entry into a data processing system. This is true whether an installation is made up of EAM or EDP equipment.

Being assigned as a keypuncher or verifier brings with it the responsibility of ensuring correct data recording. This requires that you become more than just familiar with source documents and coding for numerous jobs. In a sense you will become a Storekeeper, Disbursing Clerk, Personnelman or whatever other rating your installation's main function pertains to.

Your knowledge of the card punches and verifiers is the first step in developing into a first rate Data Processing Technician.

IBM CARD PUNCHES, TYPES 24 AND 26

Two of the common card punch machines in use are the IBM types 24 and 26. These machines are essentially alike in design, features, and operation. The major difference is that the type 26 has a printing mechanism that allows for printing data on the card at the same time the card is being punched. Foldout 3-1 (at the end of this chapter) pictures the IBM type 26 printing card punch, with the operating features indicated.

Duplication under program control occurs at the rate of 20 columns per second on the type 24, and 18 columns per second on the type 26. Without program control, duplication proceeds at the rate of 9 or 10 columns per second and occurs only as long as the duplicate key is held down.

EXTERNAL FEATURES

Refer to foldout sheet 3-1 at the end of this chapter.

Card Hopper

The card hopper, with a capacity of approximately 500 cards, is on the right side of the machine. Cards are placed in the hopper face forward, with the 9 edge down. A sliding pressure plate ensures uniform feeding.

Card Bed

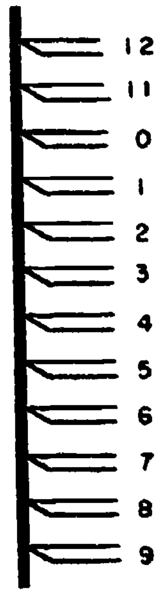
The card bed is that area of the machine which serves as the path of transportation. It starts where the card leaves the hopper and ends where the card enters the stacker.

Punching Station

Punching is performed at the first station along the card bed. At the beginning of an operation, two cards are normally fed into the card bed. While the first card is being punched, the second waits at the right of the punching station. When column 80 of the first card passes the punching station, that card moves on to the reading station, and the second card is positioned for punching. The punching station consists of 12 punching dies (figure 3-1) reacting to the depression of a character key on the keyboard.

Reading Station

The reading station is located to the left side of the punching station. A card enters this station at the same time a new card enters the punching station, and the two cards remain



49.241.1

Figure 3-1.—IBM 24/26 punching dies.

synchronized throughout. Thus, when a card at the reading station is at column 60, the card at the punching station is at column 60. Data in the card at the reading station may be duplicated into the card at the punching station, either by depression of the duplicating key, or by program control setup.

Card Stacker

As cards move from the reading station, they are stacked in the card stacker with the 12 edge down, and the backs of the cards facing the operator. Cards remain in their original sequence when removed from the stacker.

Main Line Switch

The main switch is located at the rear of the stacker. There is a delay of approximately one-half minute after the switch is turned on before punching can be started, in order to allow the electronic tubes time to warm up. When the stacker becomes full, this switch is automatically turned off by pressure of the stacking cards against it.

Backspace Key

The backspace key is located below the card bed, between the reading and punching stations. As long as it is held down, cards at both stations are automatically backspaced until column 1 is reached. Backspacing should not be attempted after column 78 is passed without first removing the card from the right side (ready position) of the card bed.

Column Indicator

The column indicator is located at the base of the program drum holder. The indicator consists of a pointer which always indicates the next column to be punched or read at the punch and read stations. The column numbers are written around the base of the drum, which turns synchronously with the cards being read and punched. You will find the indicator especially useful for locating a specific column when spacing or backspacing.

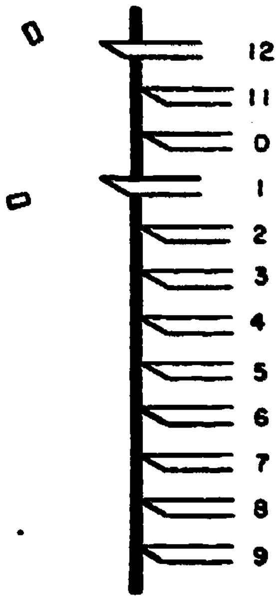
Pressure Roll Release Lever

Cards may be removed manually from either the punching or the reading station by depressing the pressure roll release lever. Care should be exercised in removing a card from either station to prevent tearing the card. If you should tear a card, use another card or a smooth edged metal blade to push out the pieces while holding down on the pressure roll release lever. Saw edged metal blades should not be used for removing pieces of cards.

KEYBOARDS

Foldout 3-1D illustrates two kinds of keyboards which may be used with card punch machines. The numerical keyboard contains keys for punching numerical characters and two special characters. The combination keyboard contains keys for punching numerical, alphabetic, and either three or eleven special characters. Keyboards are interlocked so that no two character keys can be depressed simultaneously. The home keys are more concave than the other keys to facilitate accurate touch operation.

Depression of a standard typewriter key will print a letter on a piece of paper. Depressing a key on a card punch will result in a hole or combination of holes being automatically punched into a card, as shown in figure 3-2.



49.241.2
Figure 3-2.–Schematic of dies punching the letter A.

Since the combination keyboard is the one you will most likely use, let us examine this keyboard, as illustrated in foldout 3-1D, and see what it contains. Notice that the letter keys are arranged to facilitate use of the typewriter touch system. However, because card punching operations primarily involve numerical information, the digit keys (unlike the typewriter) are closely grouped for a one-hand, ten-key operation. This arrangement affords a right-hand, three-finger touch system, freeing the left hand for document handling. Each key is numbered for illustration purposes only; these numbers do not appear on the keyboard.

Functional Keys

Keys 30 through 39, and key 44 are the functional keys. They are used to control the functions of the machine. All the keys will not be covered at this point. They will be presented in a logical sequence in this chapter.

35. FEED (card feed) causes one card to feed from the hopper, registers a second at the punching station, registers a third at the reading station, and stacks a fourth card.

37. REG (card register) is used primarily when inserting cards into the card bed manually. Depression of this key registers the cards at the punching and reading stations, and stacks another card from the left of the card bed, but does not cause card feeding.

34. REL (release) causes the cards at the punching and reading stations to be moved completely past those stations. If the automatic feed switch in ON, a card will also feed from the hopper.

Depressing the REL key followed by a depression of the REG key in sequence two or more times will clear the card bed at the end of the operation.

Space Bar

The space bar can be depressed at any time to cause spacing over unused columns except when automatically skipping or duplicating. If the machine is not equipped with a multiple punch key, this bar can be held down to permit multiple punching in one column.

Function Control Switches

Referring to foldout 3-1E, you will notice three switches located on the keyboard. Two of these will be discussed at this time. The two switches control machine operations as follows:

With the AUTOMATIC FEED SWITCH turned on, whenever column 80 of the card passes the punching station, either by punching, skipping, or releasing, a new card is fed automatically. At the same time, the card at the left of the card bed is stacked, the card at the center is registered at the reading station, and the card at the right is registered at the punching station.

When the PRINT SWITCH on the type 26 card punch is turned on, printing occurs across the card directly above the columns being punched. When it is turned off, all printing is suppressed.

KEYPUNCH SETUP

You now have enough information to set up a 24 or 26 keypunch for operation. The sequence of steps for setup is as follows:

1. Turn OFF all keyboard function control switches.
2. Insure that the program control lever (see foldout 3-1A) is OFF (right side of lever down).
3. Turn ON main line switch.
4. Depress (once) the REL key.

When the machine has warmed up, it will then automatically position the column indicator for position one. You will hear the program drum spin and a faint click when it is ready for operation.

5. Insert blank cards in the card hopper, insuring that the pressure plate is against the cards.
6. Depress the FEED key for the first card to enter the card bed. Depress the key again. This will cause the first card to REGISTER at the punch station and the second card to position at the READY on the card bed.
7. Turn ON the function control switch labeled AUTO FEED. If this switch is turned on prior to turning on the main line switch, it may cause misfeeding of cards or jamming at the punch station.
8. If printing is desired, the PRINT switch may also be turned ON.

By following the eight steps just explained you have readied the keypunch for practice operations. It is recommended, however, that you continue reading this text and gain as much knowledge about the keypunches as possible prior to utilizing the machines.

After step 8 has been completed, the keypunch will be locked in ALPHABETIC SHIFT.

Alphabetic characters and certain special characters can be punched when the combination keyboard is in alphabetic shift, and numbers and other special characters can be punched when the keyboard is in numerical shift. For instance, depression of the dual purpose 7M key (key #27) will punch a 7 in numeric shift or an M when in alphabetic shift. This action is comparable to upper or lower case shifting on a standard typewriter. Shifting from alphabetic to numerical punching, and vice versa, is controlled either by depressing the appropriate shift key, or by program control. When program control is used, the keyboard is under control of a program card and will be in numerical shift unless otherwise programmed. When program control is not used, the keyboard is in alphabetic shift.

FUNCTIONAL KEYS

30. NUM (numerical shift) puts the combination keyboard in numerical shift for as long as it is held down. It is normally depressed to allow punching of numbers in an otherwise alphabetic field.

44. MULT PCH (multiple punch) is held down to prevent normal spacing, so that more than one digit can be punched in any one particular column. The keyboard is in numerical shift when this key is depressed. This key allows the keypuncher to produce the correct combination of punches for a special character that is not standard on the keyboard.

45. CORR (card correction) is installed only on those machines having the card correction feature. Upon detecting an error, depression of this key moves the error card to the read station and duplicates the information (up to the error column) into a new card at the punch station.

PUNCHING KEYS

Keys numbered from 1 through 18 can be depressed only when the keyboard is in alphabetic shift, to punch the alphabetic characters indicated. If one of these keys is depressed while the keyboard is in numerical shift, the machine locks. Operation can be resumed by releasing the card, or by depressing the back space key or the alphabetic shift key. The letter will punch if the alphabetic shift key is depressed.

Combination keys 19 through 29 can be depressed when the keyboard is in either alphabetic or numerical shift. When the keyboard is in alphabetic shift, the characters printed at the bottom of the keys will be punched. When in numerical shift, the characters printed at the top of the keys will be punched. The numbers 8 and 9, located on keys 28 and 29, will be punched with the keyboard in either alphabetic or numerical shift.

Keys 40 through 43 are additional special character keys. When the keyboard is in alphabetic shift, the characters at the bottom of the keys will be punched. When in numerical shift, the characters at the top of the keys will be punched.

PROGRAM CONTROL

The card punch program unit controls automatic skipping over columns not to be punched, automatic duplicating of repetitive information and the shifting from numerical to alphabetic punching mode and vice versa. Each of these operations is controlled by a specific code punched in a program card. The program card is fastened around a program drum (see foldout 3-1B). When the drum is inserted in the machine, the codes punched in the program card are read by a set of star wheels in the sensing mechanism. The drum revolves in step with the movement of the cards past the reading and punching stations so that the program codes can control the operations being performed, column for column. These program codes also control printing functions of the keypunch.

Program Card

A program card, which is a basic part of the program unit, is prepared for each punching application and can be used repeatedly. Proper punching in this program card controls the automatic operations for the corresponding columns of the cards being punched.

The control punching required in the program card depends on the functions to be controlled, that is, skipping, duplicating, and alphabetic punching. Each row in the program card serves a specific purpose in this respect.

Program Drum

The program card is mounted on a program drum for placement in the machine. (See foldout 3-1B). Note that the program drum has a clamping strip which holds the card, and a handle on top to tighten or release the strip. The following steps describe the procedure for placing a program card around the program drum.

1. Turn the handle on the program drum counter-clockwise as far as it will go. This loosens the smooth edge of the clamping strip.
2. Place the column 80 edge of the card under the smooth edge of the clamping strip. Two alignment check holes in the strip make it possible to see that the card is flush with the metal edge under the strip. The card should be positioned so that the 9 edge is against the rim of the drum.
3. Turn the handle to the center position. This tightens the smooth edge of the clamping strip and loosens the toothed edge.
4. Wrap the card tightly around the drum and insert the column 1 edge under the toothed edge of the clamping strip.
5. Turn the handle clockwise as far as it will go. This fastens the toothed edge of the clamping strip. The drum is now ready to be inserted in the machine.

Program Control Lever

Operation of the program unit is controlled by the PROGRAM CONTROL LEVER, which raises and lowers the sensing mechanism. (See foldout 3-1A). When this lever is turned ON (left side of lever down), the program sensing mechanism is lowered so that the star wheels of the mechanism rest on the program card placed around the drum.

The drum has 12 grooves in the same position as the punching positions of the card. The star wheels, upon detecting holes in the program card, fall through and close contact points that direct the card punch to perform specific operations. These operations are then continued for the required number of columns as per program card codes.

The star wheels should never be lowered (program control ON) when the drum does not hold a card. This would result in the star wheels reacting as though they had detected holes in several rows simultaneously, and would damage the card punch by giving it contradictory instructions.

Also, to prevent damaging the star wheels, the program control lever must be turned OFF (right side of lever down–star wheels raised) when inserting or removing the drum.

Remember, the card punch is in alphabetic shift when program control is off. Contrariwise, with program control ON, the card punch is in numerical shift IF a card is on the program drum. Use of the two shift keys is necessary to punch letters or numbers out of shift, if not programmed to do so.

When inserting the program drum in the machine, (program control OFF) place the drum on its spindle under the center cover of the machine, positioning it so that the aligning pin falls in the aligning hole in the column indicator dial. Turn the program control lever ON and depress the release key to engage the sensing mechanism fully.

PROGRAM CARD CODES

Refer to foldout 3-2 for examples of the following codes. Each row of punches in the program card controls a specific function as follows:

BLANK (Numeric Shift) A blank column at the beginning of a field in a punched program card identifies it as one to be manually punched with numeric information. With a completely blank card on the program drum, the card punch remains in numerical shift.

12. (Field Definition.) A 12-punch is placed in every column, EXCEPT the high order position, of every field to be skipped, duplicated, or manually punched. These 12-punches DEFINE the length of the field or operations and serve to CONTINUE any skip or duplication, started within a field, to the end of that field. Consecutive fields that are to be treated the same way should be programmed as a single field. A field consisting of a single column should not be programmed with a 12-code.

11. (Automatic Skip.) An 11-punch is placed in the high order position of any field which is to be skipped automatically. Skipping is continued over that field by the 12-punches in the remaining columns of the field. The automatic skip and duplicate switch must be ON in order for automatic skipping to be effective. If this switch is off, the field is treated as a manual numeric shift field.

0. (Automatic Duplication.) A zero punch is placed in the high order position of any field which is to be duplicated automatically. Duplication is continued over that field by the 12 punches in the remaining columns of the field. This duplication control is usually utilized for a numeric field, as there are to be no intermittent or ending blanks in a numeric field (e.g., 12 34 or 1234). This is a method of helping to insure correct data is punched. The automatic skip and duplicate switch must be ON.

1. (Alphabetic Shift.) The combination keyboard is normally in numerical shift when the program card is in the machine, and depression of a combination key causes a number to be punched. In order to punch a letter, the keyboard must be shifted to alphabetic punching. This shifting is done automatically by a 1 punched in the program card for each column of the alphabetic field. This code is used in combination with the zero punch in the high order position of a field when duplicating alphameric information. The 1 punches permit automatic spacing over blank columns, valid only in alphabetic fields, and prevent skipping when letters containing 11 punches are duplicated.

2. (Left Zero Print.) With program control effective, the type 26 card punch will not print zeros to the left of the high order significant digit in a numerical field unless a special code is placed in the program card. In order to print these zeros, a 2 must be punched in each column of the field in the program card. A zero in the units position of a field will always print, unless all printing is suppressed. These same rules of left zero print also apply to special characters.

3. (Print Suppression.) When the print switch is ON, printing normally occurs for each column that is punched. Printing can be suppressed by punching a 3 in the program card for each column in which print suppression is desired.

Function Control Keys

31. ALPH (alphabetic shift) places the combination keyboard in alphabetic shift for as long

as it is held down. Depression of this key allows alphabetic punching in a numerical field.

32. DUP (duplicate) operates in two ways. With program control, one depression of this key causes the field for which it is depressed to be duplicated from the same field of the card at the read station. Without program control, duplication occurs for as long as the key is held down.

33. DASH SKIP (or) DASH also operates in two ways. When the keyboard is in numerical shift, depression of this key will punch an 11 and cause skipping. When the keyboard is in alphabetic shift, punching of an 11 without skipping will occur.

36. SKIP causes skipping of the particular field for which it is depressed. It is normally used for skipping over unused columns in an alphabetic field. This key controls in the same way as a space bar if the keypunch is not under program control.

When the AUTOMATIC SKIP and DUPLICATE SWITCH is turned on, codes punched in the program card to control automatic skipping and duplicating are effective. When turned off, automatic skipping and duplicating are suspended.

Alternate Program

An alternate program unit can be installed in card punch machines as an optional feature, so that two program setups can be punched in one program card. Coding for alternate program consists of 4-9 codes used in the same manner as the 12-3 codes for normal program. Alternate programming is especially useful when two different types of cards are to be punched from the same source document in one keypunching operation. This permits punching of both types of cards without changing program cards. The program card is set up with normal programming for punching one type of card, and alternate programming for the other. Both normal and alternate program codes are summarized as follows:

Normal Code	Alternate Code	Function
12	4	Field Definition
11	5	Start Automatic Skip
0	6	Start Automatic Duplication
1	7	Alphabetic Shift
2	8	Left Zero Print
3	9	Print Suppression

39. ALT PROG (alternate program) is supplied only if the machine is equipped with the alternate program unit. This key is depressed either at the beginning of, or during the card cycle for each card that requires alternate program control instead of normal program control. The alternate program is effective for the REMAINDER of that card, and drops out at the end of that card.

Optional Key

38. AUX DUP (auxiliary duplicate) is supplied only if the machine is equipped with the auxiliary duplication feature. When depressed, this key causes duplication from a master card, mounted on the auxiliary duplicating drum. With program control, one depression duplicates an entire field from the master card. Without program control, only one column is duplicated from the master card for each key depression.

CARD PUNCH, TYPE 29

The IBM type 29 card punch, pictured in foldout 3-3 is essentially like the types 24 and 26 in design and operation, with additional features such as the unlimited use of two program levels and expanded character keyboards. Other differences are noted as follows:

Card Stacker

The card stacker, when filled to a capacity of approximately 500 cards, operates a switch that interlocks the card feed. Power is not turned off, however, and the machine is ready for immediate operation as soon as the cards are removed from the stacker.

A scale is in the stacker so that an estimate can be made of the number of cards processed.

Main Line Switch

The main line switch is located on the front right side of the cabinet under the reading board. The machine is ready for immediate use when the main line switch is turned on.

KEYBOARDS

Foldout 3-3C illustrates the numeric and combination keyboards that are used on the type 29. The combination keyboard can be either a 48-character or a 64-character model. Foldout 3-3 shows a 64-character keyboard, and the characters that can be punched by a single key depression. These 64 characters are arranged to be compatible with the IBM System/360.

Figure 3-3 is a chart of the keytop graphics and punched-hole codes associated with each key.

Note that key 5 punches a combination of the zero, two, and eithg holes in the card. No graphic has been assigned to this combination.

Functional Keys

The functional keys perform all operations previously described for the type 24 and 26. They differ somewhat, as indicated in foldout 3-3A, and as explained below.

34. REL (release) and register cycles are not required to clear the card bed of cards. Use the clear switch for this operation.

Key Number	ALPHABETIC		NUMERIC	
	Card Code	Graphic	Card Code	Graphic
1	11-8	Q	12-8-6	+
2	0-6	W	0-8-5	_
3	12-5	E	11-8-5	)
4	11-9	R	12-8-2	¢
5	0-3	T	0-8-2	0-8-2
6	0-8	Y	12-8-7	|
7	12-1	A	none	none
8	0-2	S	0-8-6	>
9	12-4	D	8-2	:
10	12-6	F	11-8-6	;
11	12-7	G	11-8-7	¬
12	12-8	H	8-5	'
13	0-9	Z	none	none
14	0-7	X	0-8-7	?
15	12-3	C	8-7	"
16	0-5	V	8-6	=
17	12-2	B	11-8-2	!
18	11-5	N	12-8-5	(
19	11-7	P	12	&
20	0-1	/	0	0
21	0-4	U	1	1
22	12-9	I	2	2
23	11-6	O	3	3
24	11-1	J	4	4
25	11-2	K	5	5
26	11-3	L	6	6
27	11-4	M	7	7
28	0-8-3	,	8	8
29	12-8-3	.	9	9
33	11	-	11	-
40	8-4	@	8-3	#
41	0-8-4	%	0-8-3	,
42	11-8-4	*	11-8-3	$
43	12-8-4	<	12-8-3	.

& Ampersand
\- Minus or Hyphen (Dash)
/ Slash
. Period
$ Dollar Sign
, Comma
\# Number Sign
< Less Than Sign
* Asterisk
% Percent Sign
@ At Sign
¤ Lozenge
¢ Cent Sign
! Exclamation Point
: Colon
(Left Parenthesis
) Right Parenthesis
_ Underscore
' Prime or Apostrophe
\+ Plus Sign
; Semicolon
\> Greater Than Sign
= Equal Sign
| Vertical Bar, Logical OR
¬ Logical NOT
? Question Mark
" Quotation Mark

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Figure 3-3.—IBM 29 key graphics and punch codes.

35. FEED (card feed) if held depressed, moves two cards from the hopper into the punch and preregister stations. When a card is registered at the punch station, the feed key is inoperative.

39. PROG TWO (program two) causes immediate transfer to program two. Program two on the program card is essentially the same as alternate program on the types 24 and 26 (card columns 4-9) keypunches.

45. PROG ONE (program one) causes the immediate transfer to program one.

46. MC (master card) is installed only on machines having the master card insertion device.

47. ERROR RESET unlocks an interlocked keyboard. On Model B this key also allows erasing storage for left zero keyed fields.

48. LEFT ZERO, when installed (on Model B), initiates punching of zeroes to the left of the first significant digit in a field when programmed for that operation.

Functional Control Switches

The switches labeled AUTO SKIP/DUP, AUTO FEED, and PRINT on the keyboard panel control automatic skipping and duplication, automatic feeding, and printing operations common to all card punches.

Program Selection Switch

With a program card in place and the program control lever in the operative position, the position of this switch determines whether program control starts in program one (12-3) or program two (4-9). The switch setting selects the program level as a new card is registered for punching. The program level may be changed at will during punching by using the program selection keys. However, each time a card is registered for punching, the switch setting selects the starting program level.

Clear Switch

The clear switch is a spring-loaded, self-restoring switch used to clear all cards from the feed bed, without feeding additional cards from the hopper. One operation of the switch initiates the multiple cycles necessary to complete this operation, except when a single card is to be cleared from the preregister position. In this case, hold the clear switch operated until the card has been registered; it will then proceed to clear from the feed bed.

When the print switch is on, zeros, dashes, and ampersands to the left of the first significant digit in a field are suppressed unless the LZ PRINT (left zero print) switch is turned on.

PROGRAM UNIT

The operation of the program unit is similar to the types 24 and 26. The major difference is that the normal program unit is known as program level one, while the optional alternate program unit is a standard feature, and is program level two. Either program can be selected for card to card use by switching the program selection switch. If it is desired to use both program levels to control punching on a single card, alternation from program to program can be made by program selection keys on the keyboard. Programs can be alternated at will, while punching a single card, by means of these keys. Shifting between program levels 1 and 2 is UNLIMITED during the punching of a card.

In one-program application, if the second level is not coded on the program card depressing this key suspends programming, making it necessary to raise the starwheels for program suspension.

If either program key is depressed when a card is not registered at the punch station, a feed cycle will occur.

PROGRAM CARD CODING–MODEL A

Field Definition (12, 4)

The 12-punch is the field definition punch for program one; the 4-punch is the field definition

punch for program two. A field definition punch for the program level being used must appear in every column except the first (high order position) of every field to be automatically skipped, duplicated, or manually punched.

The field definition punch causes any skip or duplication operation started within a defined field to continue to the end of that field. Several consecutive fields to be automatically skipped or duplicated as one field can be programmed as a single field. Do not program a single column field with a field definition punch.

Field definition codes punched in the program card for manually punched fields permit occasional skipping or duplicating. This skipping or duplicating is started by keyboard control keys.

Automatic Skip (11, 5)

The 11-punch is the auto-skip start code for program one; the 5-punch is the auto-skip start code for program two. In either program level, punching the auto-skip start code in the first column of the field to be skipped starts an automatic skip, which continues to the end of the field defined by the field definition punches.

This operation is also under control of the functional control switch (AUTO SKIP/DUP) on the keyboard. If this switch is off, the program card codes for auto-skip start are not recognized.

Automatic Duplication (0, 6)

The 0-punch (zero) is the start-automatic-duplication code for program one; the 6-punch is the start-automatic-duplication code for program two. In either program level, punching the start-automatic-duplication code in the first column of the field to be duplicated starts automatic duplication, which continues to the end of the field defined by the field definition punches.

This operation is also under control of the functional control switch (AUTO SKIP/DUP) on the keyboard. If the switch is off, the program card codes for start automatic duplication are not recognized.

Alphabetic Shift (1, 7)

The 1-punch is the alphabetic shift code for program one; the 7-punch is the alphabetic shift code for program two. When a program card is in the machine, the combination keyboard is normally in numeric mode or shift. Therefore, to punch any alphabetic characters or special characters that are part of the alphabetic shift, the keyboard functions must be shifted to the correct mode. The shifting is accomplished by punching the alphabetic shift code, for the program level being used, into the columns of the program card that correspond to the columns of the card being punched with the alphabetic information. Every column to be punched as alphabetic must contain an alphabetic shift code in the program card. FIELD DEFINITION DOES NOT EXTEND ALPHABETIC SHIFT. A 1-punch is required for each column that has field definition. (This applies to the types 24 and 26 also.)

IBM 29 MODEL B

Besides the ability to alternate at random between two programs, Model B of the IBM 29 offers automatic left-zero insertion. This is not a special feature of all models but is peculiar to and exclusive with the Model B card punch.

Keyed Storage Entry

In a left-zero field, keying the significant digit does not simultaneously punch the digits in the card; they enter into storage instead. After all the significant digits of the field have been keyed, press the left-zero key to start punching. The machine adds the necessary number of zeros to the number of significant digits to equal the number of columns defined for the field (1st column coding in program card). The zeros, followed by the digits, are punched in the card.

Storage Clearout

At any time before the left-zero key is pressed, storage can be cleared, if the operator recognizes that he has made a keying error, by pressing the error reset key. The correct digits can immediately be rekeyed.

Exceeding Field Capacity

One recognizable error condition that requires storage clearout or erasing, is overkeying the left-zero field capacity. Additional digits that are entered in excess of the programmed left-zero field size cause erroneous punching from storage. If recognized before the left-zero key is pressed, storage can be cleared with the error reset key, and the field rekeyed. There is no "built-in" interlock to prevent overkeying a left-zero field; operators have to guard against it.

Skipping

Left-zero fields can be manually skipped if no punching is desired, but the decision to skip the field should be made before any digits are keyed into storage. The manual skip is executed without punching from storage. Therefore, any inadvertent entries into storage should be erased before or immediately after skipping by pressing the error reset key. This clears the storage of invalid digits before the next data is entered.

Duplication

Left-zero fields of identical data can be duplicated from one card to the next by manually pressing the dup key. When manually duplicating a left-zero field, duplicate the whole field; keying part of the information and manually duplicating the remainder is not possible. Any inadvertent entries into storage should be erased by pressing the error reset key to avoid incorrect punching in subsequent left-zero fields if they are not to be duplicated.

Blank Fields

A blank left-zero field can be zero-filled by a single operation of the left-zero key. This causes punching of zeros in every position of the left-zero field without keying any significant digit.

Completely Keyed Field

A left-zero field completely filled with keyed data will not automatically punch out; the left-zero key must be pressed. This permits the correction of an error in the units position of the left-zero field.

Program Card–Model B

The Model B is the Left-Zero Insertion Card Punch. Preparing a Model B program card, except for fields where left zeros are to be inserted, is identical to preparing one for the Model A. The Model B too, can be programmed to auto skip, auto duplicate, and shift alphabetic.

To program a field for left-zero insertion, count the number of columns in the field and from the following table select the code in the proper program level for the exact column count. Punch the chosen code into the first, or high-order, column of the left-zero field. Punch the remaining columns of the field with field definition punches.

FIELD SIZE (COLUMNS)	PROGRAM ONE	PROGRAM TWO
8	2	8
7	3	9
6	2-3	8-9
5	1-2	7-8
4	1-3	7-9
3	1-2-3	7-8-9

Left-zero fields of various lengths, from 3 to 8 columns, may be on one card. Handle every left-zero field in the manner just described.

IBM KEYPUNCH OPERATING SUGGESTIONS

Before any keypunching operation is started, you should check to make sure that you have the correct program card mounted on the program drum, the proper type of cards in the card hopper, and the card punch cleared of all items not related to the job to be performed. The keyboard and source documents should be arranged in a manner to provide maximum reading and punching ease.

There is no set procedure that governs all keypunching operations. The procedures to be followed depend upon the requirements of the particular job. The program card layout must be

determined by the type of data to be punched, and the manner of punching. Factors such as duplication, skipping, and combined alphabetic and numerical punching in the same field must be taken into consideration in order to prepare a program card for maximum punching efficiency. (This information is related to the discussion of card design and layout in chapter 2.)

Speed and accuracy in keypunching can be attained only through practice, and observance of the best methods to be followed. The following procedures and suggestions are listed as an aid in attaining efficient operation of card punch machines.

Corner Cuts

An important point to remember about any keypunching operation is to avoid using cards with lower corner cuts. Such cards, unless the corner cut has been specially designed, will not feet through the card bed properly.

Inserting Cards Manually

In certain instances keypunching will involve only one card, such as punching a header card, making over a damaged card, or correcting an erroneous card. All that is necessary to punch a single card is to insert the card directly into the card bed to the right of the punching station, depress the register key and start punching. For such an operation, program control is not required. When program control is not used, the keyboard is in alphabetic shift. Therefore, the numerical shift key must be held down while punching numbers from the combination keys.

In order to duplicate one card, the card to be duplicated is placed in the card bed to the right of the reading station and a blank card placed to the right of the punching station. Depression of the register key registers both cards. The duplicate key is then depressed and held down for as long as duplication is required.

Error Correction

Errors in punching will often be noticed and corrected at the time they are made. For operations involving program control, correction is easily accomplished with a minimum of repunching, by performing the following steps:

1. Depress the release key when an error in punching is detected. The card automatically skips over fields which are coded for manual punching, and fields coded for duplication beyond the point of the error are automatically duplicated.
2. All correct fields to the left of the error field can be duplicated into the new card either by automatic duplication as set up in the program card, or by manual depression of the duplicate key for each field which is not programmed for automatic duplication.
3. Repunch the field in which the error occurred, and continue normal punching.
4. Remove the error card from the stacker and destroy.

Engaging the Program Sensing Mechanism

When the program control lever is turned on to lower the starwheels, the sensing mechanism may not be fully engaged. Therefore, it is necessary also to depress the release key. For this reason, once the program is turned on, it should be left on, and whenever possible, any temporary changes or interruptions in the punching routine should be handled by the functional switches and keys.

Keyboard Locking

The keyboard will become locked under any of the following conditions:

1. When the main line switch is turned off, and then on, while a card is registered at the punching station. The keyboard can be unlocked on types 24 and 26 by depressing the release key. On type 29, the clear switch should be operated to move the card to the stacker; however, the card at the punch station need not be removed. Depressing the feed key once will bring a second card down without advancing the first card, and restores the machine to operating condition.
2. When an alphabetic key, other than a combination key, is depressed in a field pro-

grammed for numerical punching. The keyboard can be unlocked either by depressing the back-space key (then manually space to the next column), the release key (the card is released without punching), or the alphabetic shift key or error reset key (each will allow the erroneous alphabetic character to be punched).

3. When a blank column is duplicated in a field programmed for numerical punching. This acts as a blank column detection device to assure that a digit is punched in every column of a numerical field which is being duplicated. The keyboard can be unlocked by depressing either the back-space key or the alphabetic shift key.

4. When a card is not registered at the punching station. Punching or spacing cannot be accomplished unless a card is in position to be punched. When the automatic feed switch is ON, either the register, feed, or release key can be depressed to move a card into punching position.

5. When the register key or the feed key is depressed while a card is registered at the punching station. The keyboard can be unlocked by depressing either the release or backspace key.

NOTE: On the type 29, the backspace key is not used for resetting a locked keyboard. The error reset key serves this function.

Ribbon Replacement

The ribbon on printing card punches feeds between two spools, through ribbon guides, and under the punch die, as shown in foldout 3-1C. The old ribbon is removed and a new one is inserted as follows:

1. Turn off the main line switch.
2. Remove the ribbon-spool retaining-clamp.
3. Cut or break the old ribbon.
4. Remove both spools from their spindles and pull out the two pieces of ribbon. Empty one of the spools.
5. Place the spool of new ribbon on the right-hand spindle, positioning it so that the ribbon feeds from the top of the spool toward the front of the machine. Lift up the right end of the ribbon-reversing arm, if it is not already up, and unroll about a foot and a half of ribbon; then push down the right end of the ribbon-reversing arm to hold the spool steady.
6. Feed the metal leading-end of the ribbon between the punch die and the card bed, sliding it through the groove in the center of the card bed (between the "3" and "4" punching positions). The groove permits the extra thickness of the metal end and the reversing eyelet to pass between the punch die and the card bed. Be sure to keep the ribbon straight, with the "top" edge up at all times.
7. Hook the metal leading-end of the ribbon in the slot in the center of the empty spool and wind the ribbon onto the spool until the reversing eyelet is on the spool.
8. Place the spool on the left spindle, positioning it so that the ribbon feeds onto the spool over the top. Be sure that the ribbon is not twisted and that the "top" edge of the ribbon is still up.
9. Hook the ribbon around the right and left wire ribbon guides, and slide it through the right and left ends of the reversing arm and over the rollers in front of the ribbon spools.
10. Slide the ribbon up under the punch die so that it is in the upper groove provided for it in card-printing position (above the "12" punching position), and take up the slack.
11. Replace the ribbon-spool retaining-clamp.

Multiple Punched Columns

Normal spacing is suspended when the multiple-punch key is depressed. This permits you to punch as many digits as you wish in one column, for as long as the multiple-punch key is held down. If your machine is not equipped with a multiple-punch key, the space bar can be held down for this operation. The keyboard is in numerical shift when either the multiple-punch key or the space bar is depressed.

Punching and duplicating multiple punches on the 26 and 29 card punches must be limited to printable characters to eliminate possible damage to the printing mechanism.

Checking Registration

Card punches should be checked daily to ensure that punching is being aligned correctly in the card. Visual checking of the punched card

is not reliable, since the printed numbers in the cards may not be aligned perfectly. A punch should be placed in each of the 80 columns of a card. This card should then be placed on a CARD GAGE which is designed to indicate the exact location of every punching position in a card. If the cards are off-punched, the punches may not be read correctly by other machines. A customer engineer should be contacted to adjust the punching registration of the card punch.

IBM CARD VERIFIERS

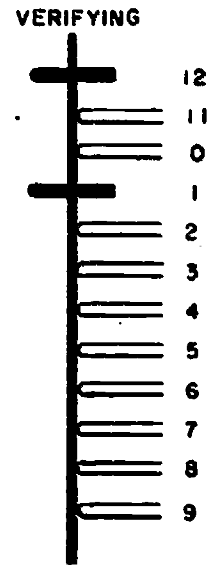
Card verifying is simply a means of checking the accuracy of the original keypunching. A second operator verifies the original punching by depressing the keys of a verifier while reading from the same source document that was used to punch the cards.

This may seem like a repetitious step, but remember that the punched card is the main input medium for data processing. It is, therefore, very important to take the time to verify (edit) the data.

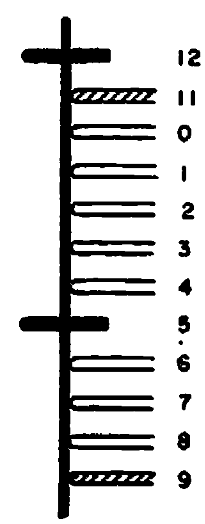
CARD VERIFIER, TYPE 56

The IBM type 56 card verifier closely resembles the 24 card punch in design and operation. Card feeding, stacking, and program control operate the same in both machines. Features differing from the card punch are illustrated in foldout 3-4 and are discussed in this section.

Verification is performed at the first station in the card bed. Instead of punch dies, the verifier contains a sensing mechanism consisting of 12 pins. (See fig. 3-4.) So long as the verifier operator depresses the same key as the card punch operator depressed in punching the original hole(s), the card will proceed to the next column to be verified. However, if the hole pattern detected by the pins of the sensing mechanism does not agree with the key depressed, an error is signaled. When a card is verified and found correct, a notch is automatically cut into the right end of the card. If the card is incorrect, a notch is cut in it over the column containing the error. (See foldout 3-4D.)



SCHEMATIC OF SENSE PINS IN AN IBM 56 VERIFIER CHECKING HOLES IN A CARD UPON DEPRESSION OF THE A KEY. IN THIS CASE THERE IS AGREEMENT SO THE CARD WILL ADVANCE TO THE NEXT COLUMN TO BE CHECKED.



SCHEMATIC OF PINS DETECTING AN E ETC.

R-KEY IS DEPRESSED BY VERIFIER INSTEAD OF E, CAUSING THE ERROR LIGHT TO COME ON ETC.

R49.245X

Figure 3-4.—IBM 56 sensing pins.

Error Light

The card verifier is equipped with an error light in place of a backspace key. When an error is detected, the light goes on, and the keyboard becomes locked. The procedure to be followed in such a situation is described later in this chapter under Operating Suggestions.

Combination Keyboard

All keys on the type 56 card verifier operate the same as the corresponding keys on the type 24 card punch, with the exception of the following functional keys. Refer to foldout 3-4E for location of these keys.

32. VER DUP (verify duplication) causes verification of the card at the verifying station by comparing it with the preceding card. With program control, a single key depression causes the field for which it is depressed to be verified at the rate of 20 columns per second. Without program control, verification is performed at the rate of 10 columns per second for as long as this key is held down.

It should be noted, however, that though program cards are interchangeable between machines, the "O" code will initiate automatic verification (versus duplication); that is, designated fields may be automatically compared with the same fields of the card at the reading station. (Automatic verification is often used in the verification of fields that were duplicated in the original punching operation.)

38. AUX VER (auxiliary verify) operates only if the machine is equipped with the auxiliary verification device. This key causes verification by comparing the card at the verifying station with a master card mounted on an auxiliary program drum.

44. MP-ER (multiple punch, error release) performs two functions. It prevents normal spacing of the card in order to verify two or more punches in one column. It also releases the keyboard when the keyboard becomes locked during a verifying operation. The keyboard is in numerical shift when this key is depressed.

Function Control Switches

Referring to foldout 3-4A, you will notice that the automatic skip and verify switch replaces the automatic skip and duplicate switch of the card punch.

The AUTOMATIC FEED SWITCH performs the same functions as the card punch except feeding is suppressed when an error card moves from the verifying station. This allows the error card to stop between the verifying station and the reading station so that the correct information can be written on the card.

CARD VERIFIER, TYPE 59

As the type 56 card verifier closely resembles the type 24 card punch, the IBM type 59 verifier shown in foldout 3-4B, is the same in design and features as the type 29 card punch. The operation of the two generations is very similar. The type 59 card verifier, however, uses fiber-optics and phototransistors for sensing holes in the card.

Automatic Verification

Depending on the program level, a 0 (zero) or a 6 punched in the first column of any field starts automatic verification which operates at the rate of 50 columns per second. High speed automatic verification at the increased speed of 80 columns per second is programmed by addition of a 3-punch or a 9-punch, depending on the program level, to the original 0-punch or 6-punch (0-3, 6-9).

Keyboards

The NOTCH key (46) causes an error notch to be cut in the 12 edge of the error column. The only condition in which this key is operative is a high speed error condition.

The error light on the keyboard is turned off by depressing the ERROR-RESET key. In a high speed automatic verification operation, the light does not go out when the ERROR-RESET key is depressed; it remains on to signal a high speed error. The CLEAR, RELEASE, or NOTCH key must de depressed, following the ERROR-RESET key depression, to continue the error handling routine.

IBM VERIFIER OPERATING SUGGESTIONS

The procedures to be followed for setting up a verifying operation are the same as for keypunching. Therefore, some of the suggestions listed under Keypunches, such as starting a

punching operation and engaging the program sensing mechanism, apply equally to verifying. Other suggestions for verifying are listed as follows.

Multiple Punch Verification

The MULTIPLE PUNCH key, when held depressed, prevents normal spacing of the card, thus permitting the verification of two or more punched holes in one column. All punches in a column must be verified unless the machine is equipped with a verification-elimination device.

OK Notch

When a card is verified, a notch is cut in the right end of the card. Every field of the card must be either verified or programmed to skip in order for the final OK notch to be cut. The card is not notched if released. Therefore, if a card is to be verified without program control, each column must be keyed, spaced, or automatically verified in order to obtain the OK notch.

Since cards passing the verifier test are notched on the column-80 end of the card between the 0 and 1 rows separating the incorrect cards (those not having the OK notch) for repunching is simplified. An upper right corner cut card should not be used for a program card as it may interfere with the check notching.

Inserting Cards Manually

Improper manual registration of a card at the reading station may cause false errors during an operation. When manually inserting a card at the reading station, do not push the card in all the way to the stop. Insert the card about 1 inch beyond the pressure roll so the card will be machine registered by the pressure roll when the register key is depressed.

Keyboard Locking

If a key is depressed which does not correspond to the hole punched in the card, the keyboard will lock. The procedure for unlocking the keyboard and reverifying the column is described under Operating Procedures. Other locking of the keyboard may be caused by any one of the following situations:

1. When the main line switch is turned off and then on while a card is registered at the verifying station. The keyboard may be unlocked by depressing the release key.
2. When a card is registered at the verifying station, and the register key is depressed unnecessarily. This causes the feed and release keys to lock. They are unlocked either by depression of a character key, the space bar, or the error release/reset key.
3. When a card is registered at the verifying station, and the feed key is depressed unnecessarily. This causes the register and release keys to lock. They are unlocked either by depressing a character key, the space bar, or the error release/reset key.

Error Routine

The operating principle for verifiers is the same as for the card punches, with the exception of the error routine. Errors may be committed either in the punching of a card or in the verification. Therefore, provision is made for three trials in the verification of a column. If an error is made while verifying, you have two more chances to depress the correct key. When the error light comes on, the following routine should be followed:

1. Depress the error release/reset key to free the keyboard.
2. Make a second attempt to verify the column. If on this trial the card registers correct, the error light goes out, and verification can be continued. If it registers incorrect, the error light remains on and the keyboard becomes locked again.
3. Depress the error release/reset key again.
4. Make a third attempt to verify the column. At this time the light goes off and verification can be continued whether the card is correct or not. If it is incorrect, the column is error notched. When it is evident that a character has been omitted, the skip key can be depressed in lieu of making the second or third attempt to verify the error column. The error column is

then notched, the error light turns off, and the remaining portion of the field is skipped.

UNIVAC

The UNIVAC Verifying Punch and the UNIVAC Verifying Interpreting Punch, as their names imply, are multifunction (multiuse) machines. Refer to foldout 3-5 for the UNIVAC machines. The UNIVAC 1701 VP, Verifying Punch is both a key punch and a verifier. The UNIVAC 1710 VIP, Verifying Interpreting Punch, is a key punch, with or without printing, a verifier, with or without printing and an interpreter.

The VIP has the ability to print (interpret) on the cards; the VP does not. This is the big difference in the two machines.

The principal use of a VP or VIP is as a key punch. Most of the features used for key punching apply to the other uses. Your knowledge of these features for key punching leads directly to your understanding of their use for verifying and interpreting.

On this basis, discussion is divided into three major sections: key punching, verifying, and interpreting. First you will understand about the individual features as they apply to key punching, and then how these features are used both individually and in combination in the key punching operation. The same procedure is then followed for verifying and interpreting.

CORE STORAGE

One of the internal parts you should become acquainted with at the start is the magnetic CORE STORAGE. It is introduced to you at this time because it is the feature around which all operations are centered.

There are three parts in the core storage: program storage, data input storage, and data output storage. Each of these parts has the same capacity as an 80-column card, that is, 80 columns with 12 positions in each column.

There is a magnetic core for each of the 960 positions in each part. Each of these cores can be made to represent either a punched or a blank position.

Through the use of the core storage, the key punching operation is done in these two steps:

1. An image of the card to be punched is made by entering all the information for that card into the magnetic cores of data input storage. This is usually done by pressing the proper character keys on the keyboard.

Because NO PUNCHING of the card takes place as yet, you are free to make any corrections or changes to this image—usually called a SETUP—either as it is being made or after it is finished.

2. Only after you are satisfied with the setup you have made do you start the punching into the card.

The complete setup in data input storage is transferred automatically in 12.8 milliseconds to data output storage. 12.8 milliseconds in 0.0128 seconds or 128 ten-thousandths of a second.

A card is fed and punched automatically with the information contained in data output storage.

Thus, after you have finished the setup for one card, the VP or VIP is ready in an instant for you to start the entry for the next card in the data input storage while the punching of the last card and the feeding of the next card proceed independently. There is no waiting while the cards are moving.

INSTANT CORRECTION

When you feel that you have made an error while making a setup, all you have to do is backspace, press the correct key or keys to erase the old entry and make the new. You then go ahead with the rest of the setup.

If, after a setup is finished, you believe it to be partially or completely wrong, return to the point of error and correct it or make a new setup.

Because the card is not punched at the time the character keys are pressed, the card in the machine is not changed—it remains blank; the card is not spoiled, nor do you lose all of your effort of having to repeat the information from the beginning.

As you can see, this way of operating helps you to do away with wasted effort and spoiled

cards. It gives you a good chance, without extra effort, to produce accurately punched cards on the first try.

DUPLICATING AND SKIPPING

Data can be completely or partially punched, "duplicated," in the next card or as many other cards immediately following as you wish. This DUPLICATING feature requires a complete setup be made in storage for the first card of a group of cards that will contain fields of like information.

For each following card in the group, you will enter into storage only the new, variable information for the fields that need to be changed. You pass right through the fields in storage containing the information to be duplicated.

In addition to the fields to be duplicated, most card punching applications include fields to be partially or completely blank (unpunched). The SKIPPING operation is used to pass through these fields in the core storage with an ERASING action that CLEARS any information they might contain.

The duplicating and skipping operations are started at the first column of a field either by pressing a control key on the keyboard or automatically by programming. Once started, they are performed at the rate of 80 microseconds for each column duplicated or skipped. 80 microseconds is 0.000080 seconds or 80 millionths of one second.

With this speed, most duplicating and skipping operations are completed without a break in your usual operating rhythm.

AUTOMATIC RIGHT JUSTIFYING

Because of the core storage, RIGHT JUSTIFY (left-zero insertion) is included in all machines. With this feature, it is only necessary for you to enter the significant characters for a field (usually an amount field). When you have entered all of these digits, you press the +RJ key on the Keyboard.

At that moment, all of the digits you have entered shift automatically to the right in the amount field, and zeros enter automatically to the left in that field.

PROGRAMMING

Another use of the core storage is to house the PROGRAM for individual punching applications. This is the machine control setup. Among other operations, automatic duplicating and skipping are controlled by the program.

The program setup is made quickly and accurately merely by the automatic reading of a prepunched PROGRAM CARD. This card enters the controls (PROGRAM CODES) into program storage to remain there without change until the application is finished.

The basic control (usually program 1) for the card punching thus established from a program card can give full automation to the operation but can be varied for the punching of individual cards within an application by the use of controls on the keyboard and by an alternate program (usually program 2).

MODES OF OPERATION

The VP and VIP operate in one of four MODES at any one time. This is important to know at the start.

Two switches on the keyboard (foldout 3-5B) set the MODE OF OPERATION. You can switch from one mode to the other at will. The modes of operation are:

LOAD PROGRAM MODE.–The program codes punched in a program card are read automatically and entered into program storage.

LOAD DATA MODE.–The information in a prepunched master card is read automatically and entered into data input storage.

AUTOMATIC MODE.–The automatic starting and control of operation is obtained from the program. Operations can also be started and controlled from control keys on the keyboard.

MANUAL MODE.–Operations are started from control keys on the keyboard.

In the load mode, load program and load data, entry is made into program or data input storage only from prepunched cards.

In the operating modes, automatic and manual, entry is made only into data input storage

and only from the character keys and space bar on the keyboard.

EXTERNAL FEATURES

Power Switch

The power switch is located just beneath the right-rear corner of the reading board. See foldout 3-5. The red button, just above the power switch, is for the circuit breaker. If electrical trouble develops in the machine, the circuit breaker turns off the power immediately. To turn on the power, press in on this switch. If the power turns off again, see your supervisor.

Input Magazine

The supply of cards to be punched is placed face forward with the bottom (9) edge down in the input magazine. This magazine will hold about 600 cards.

Auxiliary Input

This slot, right in front of the input magazine, is used to inject individual cards into the machine without disturbing the cards in the input magazine. Inserting a card in the auxiliary input prevents card feeding from the magazine.

IMPORTANT: When you insert a card in the auxiliary input, there must either be cards in the magazine or the follower arm must be forward. If this is not done, the card will not be fed from the auxiliary input.

The auxiliary input is very valuable to you. Four major uses are:

1. Entering a program–in the load program mode
2. Entering constant data–in the load data mode
3. Remaking a damaged card–in the load data mode
4. Correcting a card–in the load data mode

Visible Station

When you are keying (manually entering) information into data input storage by pressing the keys on the keyboard, the card to be punched with that information is usually in the visible station at that time.

This current card is at rest behind plate glass with its surface visible to you. In many applications, the information to be punched into a card is recorded on its surface. The card stands completely still while you read and key in this information. This is most helpful to you especially if the characters are small or handwritten.

If you need a close examination of the card or an answer to doubtful information on that card, just press the EJECT key. That card will scoot out to the SELECT STACKER without being punched. You can then do either of the following:

1. If you are sufficiently satisfied so that you can go ahead with that card, insert it in the auxiliary input and press the FEED key. The card goes right back into place in the visible station so you can continue where you left off.

2. If you are still doubtful, turn the card around and put it at the back of the cards in the OUTPUT STACKER so that you can take care of it later. Press the FEED key to bring the next card from the magazine to the visible station.

An important point to remember about the card in the visible station is that nothing happens to that card until a card feeding cycle is taken. Up to that time, you are working with the setup in data input storage and can make any changes or corrections you desire.

It really is not necessary to have a card in the visible station when making a setup; it can be empty. When the setup is completed, the next card fed from the visible station will be punched with that setup.

Column Indicator

The two-digit column indicator is just below the visible station. This indicator shows the numbers from 1 to 80 in bold, 1-inch high characters.

This indicator shows the data input storage column with which you are working at any given instant.

When you press a character key, the entry for that key is made in the data input storage column shown by the column indicator at the time that key is pressed.

STACKERS

There are two stackers at the left side to receive the cards fed through the machine. The larger of the two stackers, the one at the front, is the OUTPUT STACKER. The smaller stacker at the rear is the SELECT STACKER.

Separating the two stackers is a stacking device. This device operates automatically on each cycle to direct each card to its stacker and to stack the cards properly.

The OUTPUT STACKER will hold about 600 cards. In the automatic and manual modes, this stacker receives the cards punched during a card feeding cycle.

The output stacker contains a FOLLOWER BLOCK. Before you start operating, be sure that this block is pushed all the way back toward the stacking device.

A FULL STACKER condition happens automatically when the capacity of the output stacker is reached. An arm in the base of the follower block closes a switch.

When there is a full stacker, you get what is called a KEYBOARD INTERLOCK. The red INTERLOCK INDICATOR, light at the left of the NUMERIC key glows, and the keyboard becomes inoperative. To unlock the keyboard, push back the follower block, remove the cards from the output stacker and press the CLEAR key on the keyboard.

The SELECT STACKER holds about 20 cards. It has no full stacker signal. In the load program and load data modes, the program and master card feed to the select stacker. In the automatic and manual modes, a card in the visible station is fed to the select stacker when a card is fed from the auxiliary input OR the EJECT key is pressed.

If you allow more than one card to remain in the select stacker, each following card directed to this stacker feeds in FRONT of the preceding card.

Read Station

The read station is just to the right of the visible station. As a card is fed from either the input magazine or the auxiliary input, it passes through this station without stopping on its way to the visible station. The reading is done by "photo-optics" (similar to an electric eye).

FUNCTION CONTROL SWITCHES

The function control switches located across the top of the keyboard unit are used to control the various operations of the VP or VIP. Those pertaining solely to the VIP will be discussed later.

Punch-Verify Switch

When set at PUNCH, the VP or VIP will function as a keypunch. When set at VERIFY, the VP or VIP will function as a verifier.

Mode Control Switches

The two switches available to control the mode of operation are the LOAD MODE and the OPERATING MODE.

The LOAD MODE may be set at one of three positions:

1. LOAD PROG (load program mode)—Set the switch at this setting when you want to enter a program from the program card into the data input and program storage.
2. LOAD DATA (load data mode)—Set the switch here when you want to enter information into data input storage from a prepunched card.
3. OFF—For either the manual or automatic mode, set this switch at this center position.

With the LOAD MODE switch set OFF, make either one of these two settings of the OPERATION MODE switch:

1. AUTO (automatic mode)—You can enter data from the keyboard. The program will be in full effect, and automatic operation will take place.
2. MANUAL (manual mode)—You can enter data from the keyboard. Only the field definition (12, 4) in the program will be in effect.

You will generally have the most use of these two switches at the beginning of a key punching

operation; to enter the program, to enter data to be duplicated, and then to set the mode of operation (automatic or manual) for the punching of the cards.

Program Selection Switch

Set this switch at PROG 1 or PROG 2 to determine whether program 1 or program 2 will provide the basic program control over the operation. You generally have no need to change this switch setting during a job.

When you change this switch setting, the new setting does not take effect until after you have taken a card feeding cycle or have pressed the HOME key.

Most applications use only one program. When two different programs are to be used during one job, the usual means of switching from one program to the other is by pressing the PROG ALT key.

When program 2 is in control, the green PROGRAM 2 indicator will be lit. It is not lit when program 1 is in control. This indicator is just above the top row of the keybank over the PROG ALT key.

Right Justify Fill Switch

If you are to use right justify (left zero insertion) for one or more fields, be sure to make the proper setting of this switch before starting operation. This switch setting determines whether zeros or blanks will be automatically inserted (filled) in the columns to the left of the first significant character in each field.

ZERO FILL–Zeros will be inserted.
BLANK FILL–The columns will be blank.

Character Keys and Space Bar

The thirty-four character keys and the space bar in the four row keybank are used to manually enter the 63 character and space codes into the data input storage.

The keys containing the numbers (12, 11, 0-9) and the space bar are off-white in color. The balance of the character keys are white.

The keyboard used for illustration (see foldout 3-5B) is the UNIVAC 9000 Keyboard. It may or may not be the one provided with your machine.

The standard keyboards differ from one another usually only in the special characters, their location, and the 80-column code related to those characters.

The characters other than the 12 numerical and 26 alphabetical are called special characters. Most of these characters are in the NUMERIC shift.

The KEYBOARD SHIFT functions in the following manner:

In the Manual Mode.–The keyboard will go into NUMERIC shift and remain there when the NUMERIC key on the keyboard is pressed; the green light in the top-center of the keyboard will NOT be lit. This green light is called the ALPHA indicator.

When the ALPHA key is pressed, the keybank will go into alphabetic shift and remain there; the ALPHA indicator is lit.

In the Automatic Mode.–The keybank is automatically in the NUMERIC shift and the green ALPHA indicator is off. Individual columns can be programmed to go into the ALPHA shift and turn on the ALPHA indicator.

With this automatic shifting, entry is made from the opposite shift by holding down the NUMERIC or ALPHA key when pressing a character key.

Operating Control Keys

The fifteen gray operating control keys are in the top row and at the left and right sides of the keybank. These keys give you full control over the key punching operation from the keyboard.

FEED–Row 2, Key 11.–The basic purpose of this key is to cause a card feeding cycle. Exactly what happens on a card feeding cycle depends on the mode of operation and whether the card is fed from the input magazine or the auxiliary input.

In the Manual Mode.–The FEED key is the only means of causing a card feeding cycle. If

the card is fed from the input magazine, a card in the visible station is punched with all of the information in data input storage at the time and is delivered to the output stacker while the card from the magazine feeds to the visible station without being read.

If the card is fed from the auxiliary input, a card in the visible station at that time is punched with all of the information in data input storage at the time and is delivered to the select stacker while the card from the auxiliary input feeds to the visible station without being read.

In the Automatic Mode.—There are several ways of causing a card feeding cycle. The automatic feed starts a card feeding cycle when the data storage is indexed through column 80 to the right margin to punch all of the information in data input storage at the time.

The FEED key may be used at any other time to obtain a card feeding cycle as described above for the manual mode.

In the Load Program and Load Data Modes.—The FEED key is the only way to get a card feeding cycle. If the card is fed from the input magazine, the card in the visible station is delivered to the output stacker while the card from the magazine is read as it feeds to the visible station.

If the card is fed from the auxiliary input, ONE depression of the FEED key will cause TWO automatic cycles:

On the first cycle, a card in the visible station is fed to the select stacker while the card from the auxiliary input is read as it feeds to the visible station.

On the second cycle, the card in the visible station is also fed to the select stacker. There is no feeding from the input magazine during this second cycle.

There is no card punching in either the load program or load data mode.

When a card is fed from the auxiliary input, regardless of the mode of operation, the card at the visible station at that time feeds to the select stacker.

GANGPUNCHING as many cards as desired is accomplished by repeated depressions of the FEED key in the manual mode. Each card produced will contain all of the information in data input storage at the time the operation started. You may wish to punch only one position or a field in blank cards or cards already punched. On the other hand, you may produce two or more cards exactly alike with complete information.

The operation caused by pressing the FEED does not start until you RELEASE the key. This is also true of the EJECT key. When you press and hold down either of these keys, nothing happens until you lift your finger. For the other operating control keys, the operation starts as the key is fully pressed.

If you press the FEED key while one card feeding cycle is taking place, the next cycle will start immediately after the first is finished. You do not have to wait for a cycle to end before you press the FEED key for the next.

EJECT—ROW 1, KEY 11.—Pressing this key will cause a card eject cycle regardless of the mode of operation. When pressed, a card in the visible station is fed to the select stacker without being punched. No cards feeds from either the input magazine or auxiliary input, and the data storage remains unchanged until a new entry is started.

The EJECT key is inoperative when there is a keyboard or a card feed interlock. It becomes operative when the reason for the interlock is corrected.

As mentioned under FEED key, the operation caused by pressing the EJECT key does not start until you RELEASE the key.

HOME—ROW 3, KEY 12.—Pressing the HOME key indexes the column indicator to column 1. There is no card feeding nor any change to data storage. If you find you have made a mistake when entering a setup but do not know exactly where, just press the HOME key to start again.

Because the HOME key gives you this opportunity to restart a setup, it functions to put the machine in the same condition that it was in before you started that setup. The machine is "reset." You can then use the same procedure you would follow for a new setup.

(BACKSPACE)-ROW 1, KEY 6.–One depression of the BACKSPACE (arrow) key retracts the storage indexing and the column indicator reading one column each time it is pressed. You can backspace as many columns as you wish until column 1 is reached. There will be no change to the contents of data storage.

In the automatic mode if you backspace to a column programmed to start an automatic operation such as skipping or duplicating, that operation will NOT take place. It can be obtained, however, by pressing the proper operating control key. If, however, you backspace into a column programmed for alphabetic shift, that shift WILL take place.

COL DUP (COLUMN DUPLICATE)–ROW 4, KEY 11.–One depression of the COL DUP key advances the storage indexing and the column indicator reading one column each time it is pressed. If you hold the COL DUP key depressed, you can advance at the rate of about 10 columns a second until you release the key. The action of the COL DUP key has no effect upon the contents of data storage; what is already in a column stays there.

In the automatic mode if you advance by means of the COL DUP key into a column programmed to start an automatic operation such as skipping or duplicating, that operation will NOT start automatically. It can, however, be obtained by pressing the proper operating control key. On the other hand, if you advance with the COL DUP key into a column programmed for alphabetic shift, that shift will take place. In either the manual or automatic mode, use of this key will not start a duplicating operation. The COL DUP key is one way of duplicating information already in data storage. It is usually used for this purpose when you want to disregard the program.

DUP (DUPLICATE)–ROW 1, KEY 7.–This key is used to start a duplicating operation in either the manual or automatic mode. Field definition in the program is used to cause the duplicating operation to continue for more than one column. If the next column in the program does not have the field definition code, only the column on which the key is pressed will be duplicated. The duplicating operation has no effect upon the contents of data storage.

SKIP–ROW 3, KEY 11.–This key is used to start a skipping operation to ERASE and thus to create blanks (space codes) in the data storage columns included in the skip. When you press the SKIP key (in auto mode), the column shown by the column indicator at that time will be skipped and will continue if under program control to the end of field definition.

NOTE: Pressing the space bar is the way you usually get a single-column skip (space).

Frequent use of the SKIP key is for description or name fields where the number of characters to be entered in the field will vary from card to card. After entering the last character, press the SKIP key to skip out of the field. This will assure you that all columns in the field following the last character you entered are blank.

When you press the SKIP key (in manual mode), the skip will be all of the way through column 80 to the right margin regardless of the program.

There are many times when you need to clear all of data storage or, at least, you want to make sure that it is clear. Two depressions of the SKIP key will do this instantly. The first depression is to assure yourself that the column indicator will be at column 1 for the second skip.

+RJ (RIGHT JUSTIFY, POSITIVE)–ROW 2, KEY 12; -RJ (RIGHT JUSTIFY, NEGATIVE)–ROW 1, KEY 12.–Both of these keys perform the right justify operation. The -RJ key does one small but important thing that the +RJ does not; it causes position 11 to be punched in the units column of a field that is right justified. This is usually referred to as an overpunch to indicate a negative amount field. Zeros or blanks, depending on the setting of the right justify fill switch, enter the empty columns to the left of the first significant character in the field. If any space codes are entered after the first significant character is entered, those spaces will be eliminated during the right justifying, leaving only the character codes in the final (justified) result.

To fill an entire field with zeros or blanks according to the setting of the right justify fill switch, merely press an RJ (+ or −) key. The −RJ does not enter position 11 in this case.

Usually, the setting of the right justify fill switch you make at the start of a job is not changed. On some applications, however, this switch setting may have to be changed for individual fields during a run. When this is necessary, the change can be made at any time before you press the RJ key for that field.

The right justify works as well with alphabetical and special characters as it does with numerals.

CORR (CORRECTION)–ROW 3, KEY 13.–This key is used only when verifying.

PROG ALT (PROGRAM ALTER)–ROW 1, KEY 10.–When two different programs are to control the operation during one job, this key is usually used to switch from one program to the other. You would press this PROG ALT key before starting certain cards or when the machine is stopped at specific columns while indexing through storage.

Before you start your manual entry for a card, the operation is under the control of the program determined by the setting of the program selection switch. This can be called the basic program. A single depression of the PROG ALT key at this time or later on during the entry will switch the control at once to the other program, called the alternate program. A second depression of this key during the entry for the card will switch the control back to the basic program. During the entry for one card, you can switch from one program to the other as many times as required.

The program control returns automatically to the basic program (program selection switch setting) following a card feeding cycle or a depression of the HOME key.

When program 2 is in control, the green program 2 indicator will be lit. When program 1 is in control, this indicator is not lit.

MULT PCH (MULTIPLE PUNCH)–ROW 1, KEY 1.–Hold the key depressed while you make the entry from two or more character keys in one column. The character keyboard will be conditioned automatically in the NUMERIC shift while this key is being held.

The MULT PCH key prevents the advance that usually happens when you press a character key. If you press the MULT PCH key and do not press a character key, there is no advance when the key is released.

CLEAR (CLEAR INTERLOCK)–ROW 3, KEY 1.–This key is pressed to release a keyboard interlock and to turn off the red interlock indicator light. When a keyboard interlock occurs the keyboard is inoperative and the red light just to the left of the NUMERIC key is lit in most cases.

The causes of a keyboard interlock include:

1. an empty magazine or the failure of a card to feed from the magazine
2. the misfeeding or jamming of a card in the read station
3. an empty visible station in the automatic and manual modes
4. the misfeeding or jamming of a card in the punch station
5. a full output stacker

When you know what caused the interlock and have corrected that cause, press the CLEAR key to make the keyboard again operative.

In addition, the keyboard will lock and the interlock indicator will light, but no storage entry will occur if you press a character key, the space bar, or an operating control key:

1. when you are loading a program or data
2. during the interval between cards (12.8 milliseconds) while the card image is being transferred from data input storage to data output storage
3. if you attempt to start the entry for a new card before the first of two preceding cards is delivered to a stacker

Pressing the CLEAR key is all that is necessary at this time.

NUMERIC (UPPER CASE) SHIFT–ROW 4, KEY 1; ALPHA (LOWER CASE) SHIFT–ROW 4, KEY 12.–In the manual mode when the

NUMERIC key is pressed, the codes related to the characters printed on the upper half of the character keys will be entered into data storage. The green ALPHA indicator at the top of the keyboard is NOT lit. The keybank remains in the NUMERIC shift until the ALPHA key is pressed. Also in the manual mode when the ALPHA key is pressed, the codes related to the characters printed on the lower half of the character keys will be entered. The ALPHA indicator is lit. The keybank remains in the alphabetic shift until the NUMERIC key is pressed.

In the automatic mode, the character keybank is always in the NUMERIC shift except for those columns that are programmed for ALPHA shift. The opposite shift is obtained for a column by holding the desired shift key (NUMERIC or ALPHA) pressed while making the character key entry.

Indicators

Four of the indicator lights are of interest to you in the keypunching use of a VP or VIP.

INTERLOCK.–The red indicator to the left of row 4 in the keybank. This indicator turns on and remains lit when the keyboard is interlocked (inoperative). The CLEAR key releases the keyboard and turns off this indicator.

NON-MATCH.–The yellow indicator to the left of row 2 in the keybank. When the stop right justify is programmed for a field, this indicator turns on and the keyboard interlocks if an attempt is made to enter an excess number of characters in that field. The CLEAR key releases the keyboard and turns off the indicator.

PROGRAM 2.–The green indicator above row 1 in the keybank. This indicator remains lit as long as program 2 is in control. It is off for program 1. This indicator will turn on regardless of whether program 2 control was obtained by the setting of the program selection switch or by pressing the PROG ALT key.

ALPHA.–The green indicator at the top center of the keyboard. This indicator is lit when the character keybank is in the ALPHA shift. It is off during the NUMERIC shift.

The red indicator to the left of row 2 operates only during the verifying use of a VP or VIP. The functions of this indicator and of the yellow, non-match, indicator are explained later on when verifying is discussed.

PROGRAM CODES

Program storage will hold two different programs, called program 1 and program 2. Both programs have the same ability to control the operation. Program items include: field definition, skipping, duplicating, and shifting, which are basically the same as discussed with the IBM machines.

When only one program is needed for the job, either program 1 or program 2 can be used. The program selection switch would be set for that program. When two programs are needed to control one job, both programs are punched in one program card so that they both enter program storage at the same time. You would then usually make the selection of the program you want at any instant by pressing the PROG ALT key.

VP Program Codes

The VP program codes for keypunching are shown in the unshaded part of figure 3-5. The figures in parentheses are for program 2 codes.

CODES		WHERE PUNCHED IN A PROGRAM CARD FIELD	FUNCTION	
PROG 1	PROG 2		KEY PUNCHING	VERIFYING
12	4	EACH COLUMN EXCEPT FIRST	FIELD DEFINITION	FIELD DEFINITION
11	5	FIRST COLUMN ONLY	START SKIP	START SKIP
0	6	FIRST COLUMN ONLY	START DUPLICATE	START DUPLICATE
1	7	EACH COLUMN REQUIRED	ALPHA SHIFT	ALPHA SHIFT
2	8	EACH COLUMN REQUIRED	NOT SIGNIFICANT	[illegible]
[illegible]	[illegible]	FIRST COLUMN ONLY	NOT SIGNIFICANT	[illegible]
12-11-1	4-5-7	LAST COLUMN ONLY	STOP RIGHT JUSTIFY	[illegible]

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Figure 3-5.–VP key punching program codes.

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CODE 12 (4). Field definition.

CODE 11 (5).-Start skip. All of the columns skipped are erased to the space code (made blank).

CODE 1 (7).--Alpha shift.

CODE 12-11-1 (4-5-7).-Stop right justify. This code holds the column indicator and storage entry in the units (last) column of a right justified field until an RJ key is pressed. It functions only in the automatic mode.

The stop right justify will NOT stop the advance at the units column of a field if the advance is obtained by the use of either the SKIP, DUP, or COL DUP key.

CODE OF BLANK.-Numeric shift.

Right Justify

For right justifying in a field when keypunching in either the manual or automatic mode, all of the programming required is field definition in all columns of that field except the first column.

You will notice that figure 3-5 has a code of 11-1 (5-7) for the first column to start right justification. This code is, however, insignificant when keypunching. Only the digits needed are entered from the keyboard. It is the +RJ or the -RJ key that causes the digits to be shifted to the far right—NOT program coding.

In addition in the automatic mode however, you have the option of using the stop right justify code in the last column of the field.

When stop right justify is used, you cannot advance out of that field until an RJ key is pressed. Whenever possible, you should use the stop right justify; no keystrokes or time are saved by not using it. It gives uniformity of operation and provides you with an automatic warning of an error.

OPERATION

This section tells you how to do some of the operations required of you as a VP or VIP key punch operator. This is not necessarily the exact way these operations must be done by you at all times. You may find a better way to do the job, or a different method may be needed. Your supervisor is the final authority.

With the many abilities of the verifying punch and the verifying interpreting punch, you can find the best way to do any job if you know your machine well enough.

Setup Procedures

At the start of a key punching operation, here is a suggested series of steps to be followed:

1. Load the magazine with a supply of the cards to be punched.
2. turn on the power by pressing in on the upper half of the power switch.
3. Set the punch-verify switch at PUNCH.
4. Set the PRINT switch of a VIP at PRINT if the cards are to be printed.
5. Set the PROGRAM SELECTION switch at PROG 1 or PROG 2.
6. If right justify is to be used, set the RIGHT JUSTIFY FILL switch at ZERO FILL or BLANK FILL.
7. To enter the program, set the machine in program mode, insert the program card in the auxiliary input and press the FEED key. Removal of the program card from the select stacker for immediate placement in your file is recommended.
8. Clear data input storage by setting the machine in the manual mode and pressing the SKIP key twice. This clears the program from the data input storage.
9. Enter any constant data. This is the data to be duplicated in one or more of the batches or groups of cards. There are several methods of entry.
   a. Master Card Entry. Set the machine in the load data mode, insert the master card in the auxiliary input and press the FEED key.
   b. Keyboard (Manual) Entry. Set in the manual mode and enter the data in the proper columns by means of the character keys.

To be sure the entry you made is right, press the FEED key to feed a blank card from the magazine, press the CLEAR key to remove a keyboard interlock, press the FEED key again to

punch the card, and to deliver it to the output stacker. Remove the card and check it.

If you find a mistake; just go to the column in error, press the right character key, press the FEED key again so that you get another card to check to be sure you are now right.

c. Master Card and Manual Entry. You may need to add to the data entered from a master card or make some change to that data. If so, use procedure 9a to make the master card entry. Then use the COL DUP key to index the column indicator to the first column of the added or changed entry. NEVER use the space bar to make this advance; you will erase data entered from the master card. Check the completed entry. (See 9b).

10. Set the mode of operation (automatic or manual) to be used for the key punching. If there is no card in the visible station, press the FEED key to feed a card from the magazine. Press the CLEAR key to release any keyboard interlock.

The VP or VIP is ready for operation.

REMAKING DAMAGED CARDS

You will be called on at times to interrupt your regular work to remake cards damaged during processing by other machines. If the card is in one piece and not severly torn, straighten it out as well as you can and then:

1. Leave the supply of cards for your regular work in the input magazine.
2. Enter the data from the damaged card automatically as follows:
   a. Set in the load data mode.
   b. Insert the damaged card in the auxiliary input.
   c. Press the FEED key. The damaged card is read and fed to the select stacker.
   d. Remove the damaged card and the blank card from the select stacker.
   e. Set in the manual mode.
   f. Insert a blank card in the auxiliary input. If the blank card from the select stacker is the same card form as the damaged card, use it.
   g. Press the FEED key once to feed the blank card from the auxiliary input to the visible station.
   h. Press the CLEAR key to release the keyboard interlock which happens because no card is fed from the visible station to the output stacker.
   i. Press the FEED key again. The blank card is punched and fed to the output stacker. A card feeds from the magazine to the visible station.
3. Check the remade card by removing the remade card from the output stacker and comparing it with the damaged card. If the damage to the card caused misreading, correct the setup and punch a new card as follows:
   a. Set in the manual mode.
   b. With the marked incorrect card as your guide, index the column indicator to where the correction is to be made and enter the proper data. Remember to use the COL DUP key for this advance rather than the space bar so as not to erase the correct portion of the setup.
   c. Insert the proper card form in the auxiliary input.
   d. Press the FEED key to feed that card to the visible station.
   e. Press the CLEAR key to release the keyboard interlock caused by no card feeding from the visible station to the output stacker.
   f. Press the FEED key again. The blank card is punched and fed to the output stacker. A card feeds from the magazine to the visible station.
4. Return to your regular work. If you were duplicating part of the data, you can restore that setup.

Set the machine in the load data mode and take the last punched card of your regular work from the output stacker. Insert it in the auxiliary input and press the FEED key. The punched card is read and fed to the select stacker together with the blank card in the visible station at that time.

Return the punched card to its place in the output stacker. Insert the blank card in the auxiliary input and press the FEED key to feed that card to the visible station. Press the CLEAR key to release the keyboard interlock.

If the card is not in one piece or it is badly torn, the procedure is the same as that you just read with the exception of paragraphs 2 and 3.

Instead, you will set the machine in the manual mode and enter the entire setup from the damaged card manually from the keyboard.

If the card form is the same as that of the blank card already in the visible station, press the FEED key to punch and deliver that card to the output stacker. If the card form differs from that in the visible station, insert the proper blank form in the auxiliary input. Press the FEED key twice to punch and deliver that card to the output stacker.

VERIFIER INTRODUCTION

With your basic knowledge of the machine, you only need to learn how the individual features apply to verifying, or more to the point, how these features apply to the one-pass UNIVAC card verifying method.

In the traditional methods of punched-card verifying, three steps are used:

1. The cards are punched from the documents by one operator.
2. All or part of the punching in these cards is verified by a second operator. This operator notes the errors detected.
3. A third operator corrects the errors.

With the UNIVAC card verifying method, because the VP or VIP is both a key punch and a verifier, the card verifying and correcting are performed in one pass of the cards through the machine.

As a punched card fed from the magazine passes through the read station on its way to the visible station, all of the punching in that card is read to enter a complete image of that card in the data input storage. With the card at the visible station, the manual verifying of that card is performed by a comparison of the stored image to the data entered from the keyboard.

If no error is found, the card is identified as "OK" and fed to the output stacker. When you discover an error in the image, the verifier automatically becomes a key punch to allow you to correct that column of storage. When that column is corrected, the machine again becomes a verifier automatically to allow you to continue verifying the rest of the card.

With the verifying of a "CORRECTED" card completed, the machine again becomes a key punch automatically. A blank card is fed from the auxiliary input. This card is punched with the corrected image and identified as "CORRECTED." It is then fed to the output stacker while the original card is segregated into the select stacker as an error card. The machine again becomes a verifier automatically for the next card fed from the magazine.

VERIFYING OPERATIONS

With the card at the visible station and its image in storage, individual columns and fields of that image are subject to one of the following four operations:

Manual Verifying

This operation is used for the information that varies from one card to the next.

Duplicate Verifying

This operation is used to determine if the information in a field of the current card is the same as it was in the preceding card.

Bypassing

This operation is used for fields NOT to be verified.

Skipping

This operation is used to verify fields that should be blank.

EXTERNAL FEATURES

The external features do not change in appearance simply by changing a switch setting. Some of the features do, however, change in their influence on operations. Only the few features directly related to verifying that differ from keypunching will be discussed in the following paragraphs.

Auxiliary Input

In addition to its use when entering a program or constant data, the auxiliary input has a very important function during verifying.

When a correction has been made to one or more columns of the stored image of the card being verified, a card feeding cycle cannot be taken when the verifying of that card is completed until a blank card is inserted in the auxiliary input.

At this time, a blank card is inserted in the auxiliary input and the FEED key is pressed; two automatic cycles then take place. The original card is fed from the visible station to the select stacker as an ERROR card.

The blank card from the auxiliary input is punched with the corrected setup and delivered to the output stacker as a CORRECTED card. The next card to be verified is fed to the visible station from the magazine.

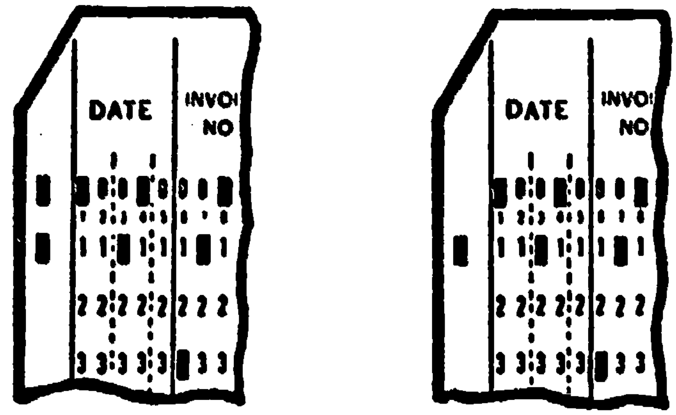
Read Station

The read station is active automatically when verifying. As a card to be verified is fed through the read station on its way from the magazine, each of the 80 columns of the card is read. The contents (punched and blank positions) of the card column are compared with the setup remaining in the same data input storage column from the previous card. If they differ, an electronic NON-MATCH MARK is entered into the related column of data output storage. The contents of that column of the card are then entered into the related column of data input storage to replace the old setup.

Punch Station

The OK verified cards and the corrected cards are identified by punching in the left margin as they are fed into the punch station. See fig. 3-6.

The OK punching is in two positions, positions 0 and 1. A card receives this identifying punching after the entire card has been verified as correct through column 80, and the card is fed from the visible station by means of the FEED key in the manual mode or by the automatic feed in the automatic mode.



OK PUNCHED   CORRECTED PUNCHED

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Figure 3-6.—VP and VIP verified punches.

The CORRECTED punching is in but one position, position 1. A card receives this identifying punching after the original card has been completely verified through column 80 with correction made to the setup, and the card to be punched with the corrected data is fed from the auxiliary input.

An error card does not receive any identifying punching in its left margin. An error card is either the original card for which the setup was corrected or a card fed from the visible station by pressing the EJECT key.

Stackers

The OK and corrected cards are delivered to the output stacker. The error cards are segregated into the select stacker.

Function Control Switches

The function control switches control operations the same as was stated under keypunching except as noted in the following paragraphs.

PUNCH-VERIFY SWITCH.–Set the PUNCH-VERIFY switch at VERIFY. The VP or VIP will function as a verifier.

RIGHT JUSTIFY FILL SWITCH.–If one or more of the fields in the cards to be verified have been right justified during key punching,

make the same setting of this switch as was used during the key punching.

The setting of this switch determines whether a zero or a blank comparison will be made in the columns to the left of the first significant character in each field.

Operating Control Keys

Again, only those control keys that differ in verifying plus those unique to verifying are covered.

FEED–ROW 2, KEY 11.–The FEED key does not operate while a card is being verified. A card feeding cycle can only be taken when all 80 columns of the card have been verified by one or a combination of the four verifying operations (manual verifying, duplicate verifying, bypassing, and skipping).

For an OK card (no correction made) the FEED key becomes operative in the manual mode and is used. In the automatic mode, the automatic feed causes the card feeding cycle.

For a corrected card, no card feeding cycle can take place unless a blank card is inserted in the auxiliary input. This is to insure the punching of a new card with the corrected data. The FEED key is used at this time.

DUP (DUPLICATE)–ROW 1, KEY 7.–If a non-match mark is found when the DUP key is pressed or during the advance, the advance is stopped on that column and the non-match indicator is ON. After making any necessary correction, the advance is resumed by pressing the DUP key.

SKIP–ROW 3, KEY 11.–On each column skipped, a space code (blank) is generated for comparison with the contents of the storage column. If anything other than a blank storage column is met during the skip, the operation stops on that column with the non-match indicator lit.

After making any necessary correction, the skip is resumed by again pressing the SKIP key.

+RJ (RIGHT JUSTIFY, POSITIVE)–ROW 2, KEY 12; -RJ (RIGHT JUSTIFY, NEGATIVE)–ROW 1, KEY 12.–The only function of the RJ keys during verifying is to allow you to check for the presence or absence of punching in position 11 of the last column of a field right justified.

CORR (CORRECTION)–ROW 3, KEY 13.–This key can be used to correct a column or field of data storage. Pressing the CORR key on the first column of a field or any column within a field will permit storage entry from the keyboard with a character key or the space bar (punch function) into that column of data storage. This ability to enter storage will continue in effect through the last column of that field if field definition for the field is present in the program. After the last column of the field, the ability to enter storage ends. The machine changes back automatically to the verify function of comparing.

If there is no field definition for a column or field, the CORR key must be pressed before making a correction in any one column.

Pressing the CORR key turns on the red error indicator. This indicator will stay lit as long as the correction ability remains in effect.

Use of this key at any time when verifying a card will label that card as error and its image in storage as corrected. The new card punched from that image will be CORRECTED punched.

HOME–ROW 3, KEY 12.–If the yellow non-match indicator only is lit, the HOME key does not operate.

COL DUP (COLUMN DUPLICATE)–ROW 4, KEY 11.–If there is a non-match mark in a storage column on which this key is pressed, the advance will stop at that column and the non-match indicator will light.

CLEAR (CLEAR INTERLOCK)–ROW 3, KEY 1.–This key will be discussed in the error procedures.

Indicators

All five of the indicator lights function in the verifying use of a VP or VIP. The red INTERLOCK, the green ALPHA, and the green PROGRAM 2 indicators serve the same purpose and

function in the same manner when verifying as they do when keypunching.

NON-MATCH.–The yellow indicator to the left of row 2 of the keybank. This indicator turns on when a non-match is created on a card column during verifying or when a non-match mark is found. The keyboard will be interlocked at this time. The indicator will turn off and the interlock will release when the CLEAR key is pressed.

When only the non-match indicator is lit, the EJECT key can perform its function and also turn off this indicator.

ERROR.–The red indicator to the left of row 2 of the keybank. This indicator turns on with the non-match indicator during verifying when the second try at creating a match on a card column results in a non-match. It turns off automatically when the storage entry (correction) is made.

Pressing the CORR key turns on the error indicator. As long as the error indicator is lit, storage entry from a character key or the space bar can be made. An advance is obtained at this time only by pressing a character key or the space bar.

When both the non-match and error indicators are lit or only the error indicator is lit:

1. The EJECT key can perform its function and also turn off the indicators.
2. The backspace key can perform its function and also turn off the indicators.
3. The HOME key can perform its function, but the indicators will not turn off.

VP PROGRAM CODES

The VP program codes for verifying are shown in the unshaded part of the VP program code chart in figure 3-7.

The program codes for field definition, start duplicate, alphabetic and numeric shift are the same for verifying as for keypunching. The following codes discussed are specifically for verifying operations.

CODE 11 (5) START BYPASS.–Bypassing is used for those columns or fields not to be

CODES		WHERE PUNCHED IN A PROGRAM CARD FIELD	FUNCTION	
PROG 1	PROG 2		KEYPUNCHING	VERIFYING
12	4	EACH COLUMN EXCEPT FIRST	FIELD DEFINITION	FIELD DEFINITION
11	5	FIRST COLUMN ONLY	START SKIP	START BYPASS
0	6	FIRST COLUMN ONLY	START DUPLICATE	START DUPLICATE
1	7	EACH COLUMN REQUIRED	ALPHA SHIFT	ALPHA SHIFT
2	8	EACH COLUMN REQUIRED	NOT SIGNIFICANT	11/12 VERIFY ELIMINATION
11-1	5-7	FIRST COLUMN ONLY	NOT SIGNIFICANT	START RIGHT JUSTIFY
12-11-1	4-5-7	LAST COLUMN ONLY	STOP RIGHT JUSTIFY	STOP RIGHT JUSTIFY

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Figure 3-7.–VP verifying program codes.

verified. Bypassing can only be started automatically by this program code; it cannot be started by an operating control key. Once started, field definition continues the operation. In the columns bypassed, no comparisons are made and any non-match marks are disregarded.

The programmed operation of bypassing should not be confused with skipping. Skipping may be started in any field by pressing the SKIP key. During the advance of skipping, an automatic comparison is made for space codes (blank columns). If other than a space is found, the non-match indicator lights up.

CODE 2 (8)–11/12 VERIFY ELIMINATION.–This code functions in both the automatic and manual modes.

When a column contains code 2 (8) in its program, any punching in positions 11 or 12 or in both of these positions does not have to be verified. It is only necessary to verify the punching in positions 0-9 of the column. This would usually be a number.

Each column that may contain a position 11 or 12 punch that is not to be verified must contain code 2 (8) in the same column of the program.

If you verify position 11 or 12 in a column programmed with this code, a non-match will result if you try a different position (11 or 12) from that punched. If the attempt was an accident, all you have to do is press CLEAR and verify the code in positions 0-9 only.

CODE 11-1 (5-7)–START RIGHT JUSTIFY; CODE 12-11-1 (4-5-7)–STOP RIGHT JUSTIFY.–These codes perform their purpose only in the automatic mode. For the verifying of a right justified field, the columns of the program for that field should contain the following:

Code 11-1 (5-7).–Start Right Justify, in the first column to start the automatic zero or blank comparison.

Code 12 (4).–Field Definition, in all columns except the first to continue the zero or blank comparison once it has been started.

Code 12-11-1 (4-5-7).–Stop Right Justify, in the last column to stop the advance for the verification of position 11 with the +RJ or -RJ key. This code is not used if this verification is not required.

The stop right justify will not stop the advance at the units column of a field if the advance is obtained by the use of the SKIP, DUP, or COL DUP key.

With a full field, the manual verifying starts with the first column and continues through the last column. At that time if the stop right justify is programmed, the RJ keys are used to verify position 11.

SETUP PROCEDURES

The following eight steps will allow you to properly set up the VP or VIP for verifier operations:

1. Load the magazine with the supply of the cards to be verified.
2. Turn on the power by pressing in on the upper half of the power switch.
3. Set the PUNCH-VERIFY switch at VERIFY. Set the PRINT switch of a VIP at PRINT if the cards are to be printed.
4. Set the PROGRAM SELECTION switch at PROG 1 or PROG 2.
5. If the right justify is to be used, set the RIGHT JUSTIFY FILL switch at ZERO FILL or BLANK FILL.
6. To enter the program set the machine in the program mode, insert the program card in the auxiliary input and press the FEED key.
7. Enter any constant data to be duplicate verified. Constant data means those columns or fields where the punching is exactly the same in all cards for a batch. These are the columns or fields programmed to be duplicate verified automatically with program code 0 (6).

The procedure depends on the method to be used for entering the data, automatically from a master card or manually from the keyboard.

a. If you are provided with the prepunched cards (master cards) used to enter this data during keypunching, set the machine in the load data mode, insert the master card in the auxiliary input and press the FEED key.

b. For keyboard (manual) entry, set the PUNCH-VERIFY switch to PUNCH and set the machine in the manual mode. Next, press the SKIP key twice to clear the data input storage. Enter the data in the proper columns by means of the character keys and reset the PUNCH-VERIFY switch to VERIFY.

8. Set the mode of operation (automatic or manual) to be used for verifying. Press the FEED key to feed the first card to be verified from the magazine. Press the CLEAR key to release any keyboard interlock.

ERROR PROCEDURES

The VP and VIP offer two means of making corrections during the one-pass UNIVAC card verifying method; these can be called automatic and manual.

Automatic Correction

This is a correction made as the result of a non-match with the use of the CLEAR key. During the verifying of a card, you are checking the information as you read it from the original document against the way it was read by the operator who punched that card.

As long as you are in agreement, you will advance through the card image without interruption. When you do not agree at a column, the advance will stop with the yellow non-match indicator lit.

At this point the CLEAR key will be discussed, as it relates almost entirely to error conditions.

CLEAR (CLEAR INTERLOCK)–ROW 3, KEY 1.–When a non-match is created or a non-match mark is sensed, the non-match indicator lights and the keyboard interlocks. This procedure is then used:

1. The CLEAR key is pressed to turn off the non-match indicator and release the interlock. An attempt is then made to reach a match by pressing the proper character key or the space bar.
2. If a non-match results, the CLEAR key is again pressed to allow a second try. If a match results on either the first or second attempt, the storage indexing will advance.
3. If a non-match is again created on the second try, both the non-match indicator and the red error indicator to its right will light.
4. At this time, the VP or VIP is conditioned automatically to allow storage entry from the keyboard (punch function). The proper character key is pressed to correct the setup in that column of storage. Both indicators will turn off, the storage indexing will advance to the next column and the verifying function of comparing will resume.

If an error occurs in the last column of a negative right justified field when the stop right justify is used, the MULT PCH key is held depressed while the "11" key and the proper character key are pressed. The - RJ key is then used to advance to the next column.

NOTE: If a correction is made to the digit in the units column of a field right justified, the entry (if any) in position 11 of that column will be erased. At that time, the correct character key is pressed followed by a depression of the proper RJ (+ or -) key to complete the entry in the units column and to advance to the next column. That is, because position 11 is erased but is actually supposed to be there, the -RJ key must be depressed after the proper numeric character key has been depressed.

This stop action will happen only if the units position has been programmed with stop right justify; otherwise, once the character key has been depressed, the column indicator will advance out of the units position.

If you are not certain of what the proper entry should be, you can press the EJECT key to segregate the card so that the correct entry can be determined later. Press the FEED key so that the verifying can continue with the next card.

Manual Correction

This is a correction made by using the CORR (correction) key.

UNIVAC 1710 VIP

The important difference between the VP and the VIP is the ability of the VIP to print. As the keypunch and verify operations are accomplished by the VIP the same as previously described for the VP, only the print feature will be discussed.

Printing may occur during keypunch or verifier operations. It may also occur with a special operation called interpreting. Interpreting will be discussed at the end of this section on the VIP.

PRINT STATION (VIP)

The print station is just to the left of the visible station. As many as 80 characters can be printed in a row between the 12 position and the top edge of the card. Each chara is printed above a card column and is for the punched in that column.

The printing occurs as the card is fed from the visible station through the print and punch stations to the stackers. The characters printed are from the information in data output storage. The information in data input storage is transferred to data output storage at the time a card is fed from the visible station.

The printing is done by a constantly rotating type wheel located in front of the card. When the proper character is opposite the card, a hammer located back of the card is fired to cause the printing of that character.

An inking roll, mounted in front of the type wheel, keeps the rotating type wheel supplied with the ink necessary for the printing.

PRINT CONTROL SWITCH

The PRINT control switch is located at the top of the keyboard just to the left of the PUNCH VERIFY control switch. With the PRINT switch off, no printing will occur, regardless of your mode of operation.

With the PRINT switch on and in the manual mode, each character in storage that is punched is also printed. With the switch on and in the automatic mode, printing will occur as controlled by the program codes.

VIP KEYPUNCHING

The VIP keypunching operation differs from the VP mainly by the required use of additional program codes to control the printing feature. These codes will only control the operations involving printing if the VIP is in the automatic mode and the PRINT control switch is on.

VIP Program Codes for Keypunching

The VIP program codes for keypunching are shown in the unshaded part of the VIP program code chart (figure 3-8.) The basic codes: field definition, start skip, start duplicate, alphabetic shift, numeric shift and stop right justify do the same thing in a VIP program as they do with a VP program.

CODE 11 (5)–START SKIP AND NON-PRINT: CODE 11-2 (5-8)–START SKIP AND PRINT.–Although any column skipped would be blank anyway, the difference in the print editing part of these two codes allows for a two program (basic and alternate) application where the PROG ALT key is used to switch programs.

When the columns to be skipped in the basic program are to be punched in the alternate program, you would make a choice in the basic

CODES		WHERE PUNCHED IN A PROGRAM CARD FIELD	FUNCTION		
PROG 1	PROG 2		KEY PUNCHING	VERIFYING	INTERPRETING
12	4	EACH COLUMN EXCEPT FIRST	FIELD DEFINITION	FIELD DEFINITION	FIELD DEFINITION
11	5	FIRST COLUMN ONLY	START SKIP AND NON-PRINT	START BYPASS AND NON-PRINT	START NON-PRINT
0	6	FIRST COLUMN ONLY	START DUPLICATE	START DUPLICATE	START DUPLICATE
1	7	EACH COLUMN REQUIRED	ALPHA SHIFT	ALPHA SHIFT	NOT SIGNIFICANT
2	8	FIRST COLUMN ONLY	START SUPPRESS LEFT ZERO PRINT	START SUPPRESS LEFT ZERO PRINT	START SUPPRESS LEFT ZERO PRINT
2	8	EACH COLUMN REQUIRED EXCEPT FIRST	11/12 PRINT ELIMINATION	11/12 PRINT ELIMINATION	11/12 PRINT ELIMINATION
3	9	FIRST COLUMN FOLLOWING LAST COLUMN TO BE USED	START EARLY FEED NON-PRINT BALANCE OF CARD	START BYPASS AND NON-PRINT BALANCE OF CARD	START EARLY FEED NON-PRINT BALANCE OF CARD
11-2	5-8	FIRST COLUMN ONLY	START SKIP AND PRINT	START BYPASS AND PRINT	START PRINT
11-1	5-7	FIRST COLUMN ONLY	NOT SIGNIFICANT	START RIGHT JUSTIFY	NOT SIGNIFICANT
12-11-1	4-5-7	LAST COLUMN ONLY	STOP RIGHT JUSTIFY	STOP RIGHT JUSTIFY	FIELD DEFINITION

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Figure 3-8.–VIP keypunching program codes.

program between code 11 (5), non-print, and code 11-2 (5-8), print, according to whether those columns of the card for the alternate program are to be printed or not.

CODE 2 (8)–START SUPPRESS LEFT ZERO PRINT OR 11/12 PRINT ELIMINATION.–In the automatic mode, this code can serve either one of two purposes:

Start Suppress Left Zero Print.–In many cases, especially quantity and amount fields, zeros will be punched to the left of the most significant character in the field. This will happen automatically when right justify with zero fill is used. When printing, however, only the significant characters are to print, not the zeros to the left. Like this:

```
Punch ----- 0 0 0 1 2 8
Print -----       1 2 8
Code 2 (8)
```

To do this, the first column of the field has code 2 (8) in the program. When the first column is zero and for each zero column immediately following, there will be no zero printing. When a column does contain a code other than zero, printing resumes even for following zeros.

When code 2 (8) is used in a two program (basic and alternate) application where the PROG ALT key is used to switch programs, the code in the basic program controls print editing for both programs. That is when code 2 (8) is specified in the first column of a field in the basic program, it will act as start suppress left zero print when the basic program is in effect. It will act as start suppress left zero print if that same column of the alternate program is also specified as the first column of a field.

If that column of the alternate program is not the first column of a field but is punched with a zero in a card related to the alternate program, left zero print suppression will start and continue for all following columns punched with zeros in that field of that card.

If that column in a card related to either the basic program or the alternate program contains a code other than the zero only, code 2 (8) has no effect.

11/12 Print Elimination.–There are times when either position 11, position 12, or both positions 11 and 12 are punched in the same column as a numeric code (positions 0-9).

This happens automatically when the - RJ key is used to enter position 11 in the units column of a field right justified. When printing, however, only the character for the code punched in positions 0-9 is to be printed.

When code 2 (8) is specified in the basic program in any column of a field EXCEPT the first, it will perform 11/12 print elimination in that column of the cards related to both the basic and alternate programs.

```
                      11
Punch ----- 0 0 0 1 2 0
Print ----- 0 0 0 1 2 0
Code 2 (8)
```

Code 2 (8) can be used for both of its purposes in one field. Again, right justify can be used as the example.

```
                      11
Punch ----- 0 0 0 1 2 0
Print -----       1 2 0
Code 2 (8)
```

If an alphabetical or special character using the 11 or 12 position is punched in this column of the card related to the alternate program, the true character will not be printed.

Code 2 (8) serves no function in the manual mode.

CODE 3 (9)–START EARLY FEED AND NON-PRINT.–There are many applications when you will have entered all of the data necessary for the card punching at a column well before column 80 is reached.

In these cases, early feed should be programmed for the column immediately after the column where the data entry ends. Then, just as soon as the last column of entry is made, a card feeding cycle will start. This saves a skipping operation through column 80 to get the automatic feed or pressing the FEED key.

The early feed operation should be kept in mind when planning a two program (basic and alternate) application where the PROG ALT key is to be used to switch programs and early feed is to be used.

When you are preparing a program, there are times when more than one operation is to be performed on one column. The following charts in figure 3-9 show the program codes that may be combined for the VP and for the VIP.

The combination of code 0 (6)–start duplicate and code 1 (7)–alphabetic shift in one column is not valid for both the VP and VIP. If this 0 & 1 (6 & 7) combination is used, it will act as stop right justify.

The combination of code 1 (7)–alphabetic shift and code 2 (8)–start suppress left zero print is not valid for a VIP. If this 1 & 2 (7 & 8) combination is used, it will act as early feed.

A useful application of combining codes is illustrated in figure 3-10 and explained as follows for the basic program:

Code 2 in column 56 starts left zero print suppression.

Code 12 in columns 57-61 continues this operation as well as the right justify.

Code 12-11-1 in column 62–stop right justify.

Code 2 in column 62 performs 11/12 print elimination for negative amounts to allow the code punched in positions 0-9 to print a numerical character.

VP - Verifying Punch

12 4	11 5	0 6	1 7	2 8	3 9	Program 1 Program 2
X			X			Field Def. & ALPHA
X				X		Field Def. & 11/12 VE
X			X	X		Field Def. & ALPHA & 11/12 VE
			X	X		ALPHA & 11/12 VE
	X		X	X		Start RJ & 11/12 VE
X	X		X	X		Stop RJ & 11/12 VE

VIP - Verifying Interpreting Punch

12 4	11 5	0 6	1 7	2 8	3 9	Program 1 Program 2
	X		X	X		Start RJ & Supp. LZP
X	X		X	X		Stop RJ & 11/12 PE
X			X			Field Def. & ALPHA
X				X		Field Def. & 11/12 PE
X			X	X		Field Def. & ALPHA & 11/12 PE
		X		X		Start Dup. & Supp. LZP

49.381

Figure 3-9.–VP and VIP program code combinations.

Program Selection Switch

On the VIP, the setting of this switch determines the program that will govern the printing (print edition), regardless of any use of the PROG ALT key. This has been previously explained under the specific VIP program control codes.

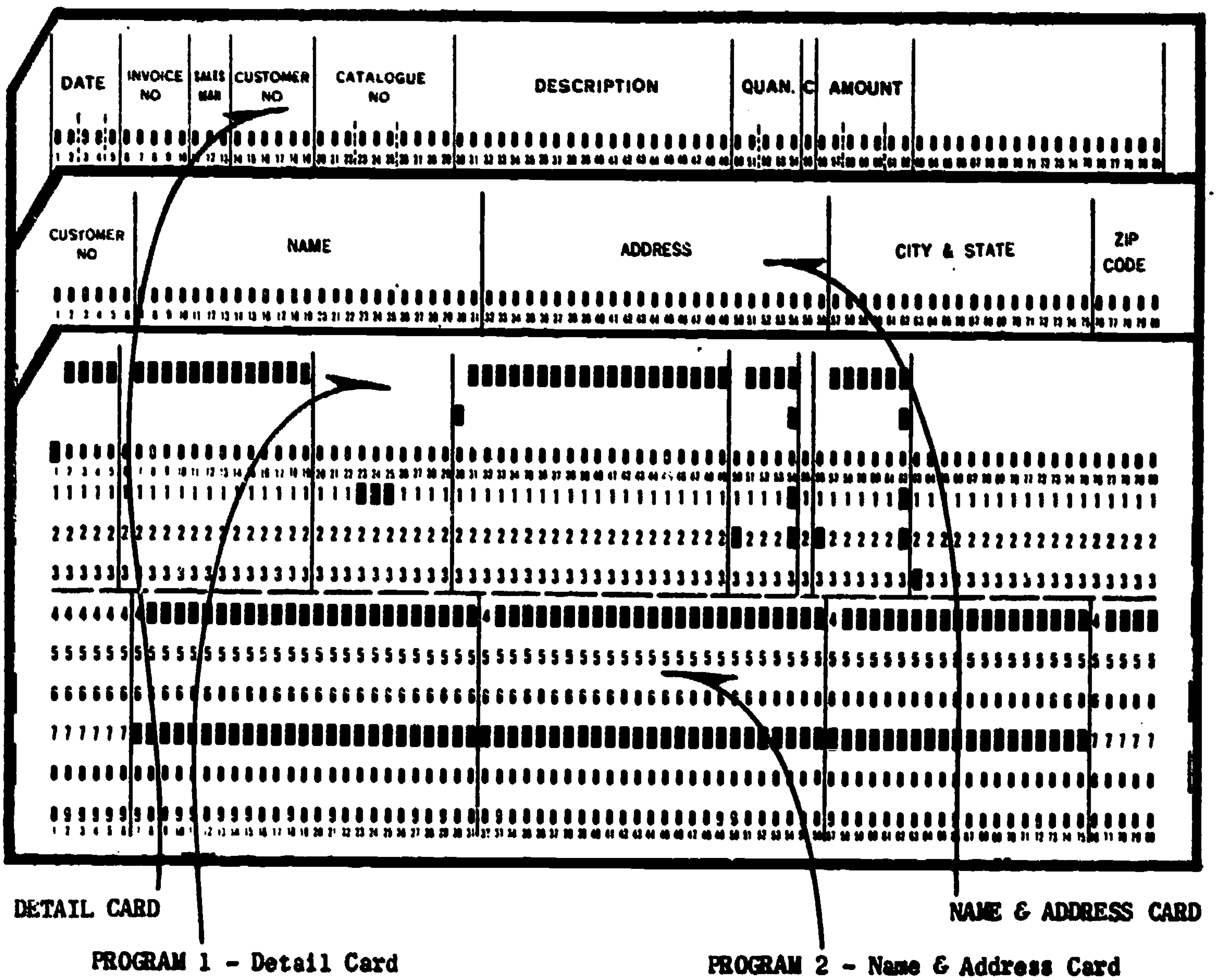
VIP VERIFYING

The VIP differs from the VP in its operation only in its ability to print on corrected cards. Program codes for controlling the print are the same for verifying as they are for keypunching except the word BYPASS replaces the word SKIP in the definition of the codes' functions. Figure 3-11 shows this more clearly.

Print Station

When the PRINT switch on the keyboard is set at PRINT, OK verified cards and blank cards punched with a corrected setup are printed as they pass through the print station.

If a VIP was used for the original card punching, the printing would probably have been done at that time also. In this case, the



49.382

Figure 3-10.—VIP combination programming.

PRINT switch should be set off during verifying except when a corrected card must be punched.

VIP INTERPRETING

One of the uses of a UNIVAC verifying interpreting punch (VIP) is the interpreting of punched cards. Interpreting is the continuous automatic feeding of punched cards so that the characters related to the codes punched in those cards will be printed along the top of the cards just above the 12 positions. The character printed above a card column is for the code entered into storage for that column.

Interpreting is a very simple operation. After placing the punched cards to be interpreted in the input magazine, you press the INTERPRET-START switch on the keyboard to start the automatic card feeding. As each card is fed, all of the punching in that card is read for entry into data output storage as the card feeds through the read station to the visible station. The card is printed with the information in data output storage as it passes through the print station on its way from the visible station to the output stacker.

Interpreting may be performed in either the automatic or manual mode.

CODES		WHERE PUNCHED IN A PROGRAM CARD FIELD	FUNCTION		
PROG 1	PROG 2		KEY PUNCHING	VERIFYING	INTERPRETING
12	4	EACH COLUMN EXCEPT FIRST	FIELD DEFINITION	FIELD DEFINITION	FIELD DEFINITION
11	5	FIRST COLUMN ONLY	START SKIP AND NON-PRINT	START BYPASS AND NON-PRINT	START NON-PRINT
0	6	FIRST COLUMN ONLY	START DUPLICATE	START DUPLICATE	START DUPLICATE
1	7	EACH COLUMN REQUIRED	ALPHA SHIFT	ALPHA SHIFT	NOT SIGNIFICANT
2	8	FIRST COLUMN ONLY	START SUPPRESS LEFT ZERO PRINT	START SUPPRESS LEFT ZERO PRINT	START SUPPRESS LEFT ZERO PRINT
2	8	EACH COLUMN REQUIRED EXCEPT FIRST	11/12 PRINT ELIMINATION	11/12 PRINT ELIMINATION	11/12 PRINT ELIMINATION
3	9	FIRST COLUMN FOLLOWING LAST COLUMN TO BE USED	START EARLY FEED NON-PRINT BALANCE OF CARD	START BYPASS AND NON-PRINT BALANCE OF CARD	START EARLY FEED NON-PRINT BALANCE OF CARD
11-2	5-8	FIRST COLUMN ONLY	START SKIP AND PRINT	START BYPASS AND PRINT	START PRINT
11-1	5-7	FIRST COLUMN ONLY	NOT SIGNIFICANT	START RIGHT JUSTIFY	NOT SIGNIFICANT
12-11-1	4-5-7	LAST COLUMN ONLY	STOP RIGHT JUSTIFY	STOP RIGHT JUSTIFY	FIELD DEFINITION

49.383

Figure 3-11.—VIP program code chart for verifying.

In the automatic mode, the printing can be edited with such programmed operations as non-print, duplicate in interpreting, left zero print suppression, and 11/12 print elimination. The early feed can also be obtained.

In the manual mode, the operation is not under program control. All information punched in a card will be printed without any editing.

Duplicate Interpreting

Duplicate interpreting is a new term to you. With this operation, constant data can be entered into one or more fields of storage before starting an interpreting run. This data will then be printed on all of the cards instead of the data that may be punched in these fields of the individual cards.

Duplicate interpreting prevents storage entry from the individual cards as they are read during interpreting. Any entry made into storage before starting interpreting in the columns programmed for duplicate interpreting will be printed on all of the cards fed. The punching in the individual cards in those columns is disregarded.

The columns or fields not programmed for duplicate interpreting are interpreted in their own right and subject to other means of programming.

The data to be duplicate interpreted may be entered manually from the keyboard or automatically from a master card.

IMPORTANT: If the entry is made manually from the keyboard, either the FEED or EJECT key must be pressed after making the entry to transfer the data to data output storage.

If the constant data is to be printed in columns that are blank (unpunched) in the cards, it is still necessary to use duplicate interpreting. If it is not, the constant data

entered before starting interpreting will be erased by the space codes in those columns of the first card fed.

Auxiliary Input

The auxiliary input is used to enter a program or to enter constant data for duplicate interpreting before starting an interpreting operation. It has no use while the operation is in progress.

The duplicate interpreting operation prevents the data from the fields programmed for this operation from entering the data output storage.

Visible Station

At the start of an interpreting operation if there is no card in the visible station, the operation stops after the first card is fed from the magazine with the red keyboard interlock indicator lit.

After pressing the CLEAR key, the operation is resumed by again pressing the INTERPRET-START switch.

Print Station

The PRINT switch on the keyboard must be set at PRINT for the print station to function during the interpreting. The characters printed are from the codes in data input storage.

Punch Station

The punch station does not function during interpreting.

Function Control Switches

PUNCH-VERIFY.–This switch is set at PUNCH.

PRINT.–This switch is set at PRINT.

INTERPRET-START.–This switch is pressed to start interpreting. If the operation is stopped for any reason during a run, the interpreting can only be resumed by pressing this START switch.

It is to be noted that the FEED key becomes inoperative when the INTERPRET-START is pressed. The FEED key becomes active again when the last card feeds from the input magazine or when the card feeding is stopped with the INTERPRET-STOP.

INTERPRET-STOP.–While interpreting is going on, you can stop the operation at any time by pressing this STOP switch. The operation is resumed by pressing the INTERPRET-START switch.

INDICATORS

Only the red interlock indicator functions when interpreting to indicate a keyboard interlock caused by card feeding.

After correcting the reason for the keyboard interlock, the interpreting is resumed with two steps:

1. Press the CLEAR to release the keyboard interlock and to turn off the indicator.
2. Press the INTERPRET-START to resume the operation.

PROGRAM CODES

The VIP program codes for interpreting are shown in the unshaded part of the VIP program code chart, (figure 3-12).

CODE 12 (4).–FIELD DEFINITION.–This code serves the same purpose during interpreting as it does when keypunching and verifying to continue an operation once it has been started by a program code. Code 12-11-1 (4-5-7) also serves for field definition.

CODE 11 (5)–START NON-PRINT.–No printing will occur when the storage is advanced into a column containing this code in the program. This non-printing is continued automatically for following columns by using field definition.

CODE 11-2 (5-8)–START PRINT.–The printing of the characters related to the codes in storage happens automatically. This code serves no purpose when interpreting.

CODE 0 (6)–START DUPLICATE.–Duplicate interpreting is used for those columns

CODES		WHERE PUNCHED IN A PROGRAM CARD FIELD	FUNCTION		
PROG 1	PROG 2		KEY PUNCHING	VERIFYING	INTERPRETING
12	4	EACH COLUMN EXCEPT FIRST	FIELD DEFINITION	FIELD DEFINITION	FIELD DEFINITION
11	5	FIRST COLUMN ONLY	START SKIP AND NON-PRINT	START BYPASS AND NON-PRINT	START NON-PRINT
0	6	FIRST COLUMN ONLY	START DUPLICATE	START DUPLICATE	START DUPLICATE
1	7	EACH COLUMN REQUIRED	ALPHA SHIFT	ALPHA SHIFT	NOT SIGNIFICANT
2	8	FIRST COLUMN ONLY	START SUPPRESS LEFT ZERO PRINT	START SUPPRESS LEFT ZERO PRINT	START SUPPRESS LEFT ZERO PRINT
2	8	EACH COLUMN REQUIRED EXCEPT FIRST	11/12 PRINT ELIMINATION	11/12 PRINT ELIMINATION	11/12 PRINT ELIMINATION
3	9	FIRST COLUMN FOLLOWING LAST COLUMN TO BE USED	START EARLY FEED NON-PRINT BALANCE OF CARD	START BYPASS AND NON-PRINT BALANCE OF CARD	START EARLY FEED NON-PRINT BALANCE OF CARD
11-2	5-8	FIRST COLUMN ONLY	START SKIP AND PRINT	START BYPASS AND PRINT	START PRINT
11-1	5-7	FIRST COLUMN ONLY	NOT SIGNIFICANT	START RIGHT JUSTIFY	NOT SIGNIFICANT
12-11-1	4-5-7	LAST COLUMN ONLY	STOP RIGHT JUSTIFY	STOP RIGHT JUSTIFY	FIELD DEFINITION

49.384

Figure 3-12.—VIP program code chart for interpreting.

or fields where the punching in the cards is to be DISREGARDED. Information entered into storage prior to the start of the run is to be printed in place of what is actually in the card.

A duplicate interpreting operation starts automatically when the storage is advanced into a column containing code 0 (6) in the program. Once started, field definition continues the operation.

For those columns or fields of duplicate interpreting, the constant information is entered before starting interpreting. This can be done manually in the manual mode from the keyboard or automatically in the load data mode from a master card.

Once the constant data has been entered, the function of the duplicate interpreting is to prevent any data punched in those columns or fields from entering the data output storage.

CODE 2 (8)—START SUPPRESS LEFT ZERO PRINT OR 11/12 PRINT ELIMINATION.—This code serves either one of its two purposes during interpreting as it does when keypunching and verifying. The purposes of this code were indicated when the VIP program codes for keypunching were explained.

CODE 3 (9)—START EARLY FEED.—When the last character to be printed for an interpreting application is in a column to the left of column 80, the early feed should be programmed for the column immediately after the column where the printing is to end.

Use of the early feed speeds the interpreting operation by ending reading and printing and starting feeding and ejecting at that point.

VIP INTERPRETER SETUP

The interpreting operation is the simple procedure of continuous feeding and printing of punched cards. The suggested procedure for performing this operation is as follows:

1. Turn on the power by pressing in on the upper half of the POWER switch.
2. Enter the program. If the interpreting is to be done in the automatic mode, set the machine in the program mode and insert the program card in the auxiliary input. Press the FEED key, remove the program card from the select stacker and set the program switch at PROG 1 or PROG 2.
3. Enter all constant data to be duplicate interpreted. Constant data means those columns of fields where the printing is to be the same for all cards and the punching in those columns or fields is disregarded. These are the columns or fields programmed to be duplicate interpreted with program code 0 (6).

The procedure depends on the method to be used for entering this data. This can be done automatically from a master card or manually from the keyboard.

a. Master Card Entry–Set in the load data mode, insert the master card in the auxiliary input, and press the FEED key. Remove the master card from the select stacker.
b. Keyboard (Manual) Entry–Set the PUNCH-VERIFY switch at PUNCH. Set the PRINT switch at PRINT. Set in the manual mode.

Press the SKIP key twice to clear the data storage.
Enter the data in the proper columns by means of the character keys.
To check the entry and to transfer the data to data output storage, insert a blank card in the auxiliary input; press the FEED key to print and punch the card with constant data entry; and remove the card from the select stacker and be certain the entry is correct.

4. Load the magazine with the supply of the cards to be interpreted.
5. Set the FUNCTION CONTROL switches for the interpreting operation.

The PRINT switch is set at PRINT.
The PUNCH-VERIFY switch is set at PUNCH.
The LOAD MODE switch is set at OFF.
The OPERATING MODE switch is set at either AUTO or MANUAL. If a program has been entered, the AUTO setting would be made.
The PROGRAM SELECTION switch is set at either PROG 1 or PROG 2 if the automatic mode is to be used. If the manual mode is being used, this switch setting is not important.

6. To start the operation, press the INTERPRET-START switch. If the visible station is empty at the start of operation, press the CLEAR key to remove the keyboard interlock which occurs when the first card is fed. Next, press the INTERPRET-START switch again to resume the operation.
7. If you wish to stop the operation at any time during the run, press the INTERPRET-STOP switch.
8. If the operation stops automatically during the run, determine and correct the reason for the stoppage.

Press the CLEAR key if a keyboard interlock is in effect.
Press the INTERPRET-START switch to resume the operation.

9. At the end of the run, the last card from the magazine will have been printed and delivered to the output stacker.

MAINTENANCE

Except for VIP inking roll replacement and any future development of MRC, it is not recommended you do the maintenance. Normally, your supervisor will designate a man for the maintenance and repair of the VP and VIP.

Inking Roll Replacement

Once installed, an inking roll is used until its supply of ink is exhausted. The used roll is then discarded and a new roll installed.
When the inking roll needs to be replaced, you can do it quickly and easily. Refer to foldout 3-5C while following these steps:

1. To remove the old roll, lift the roll and shaft from the mounting, remove the nut, drop the roll into a wastebasket or onto a piece of paper.

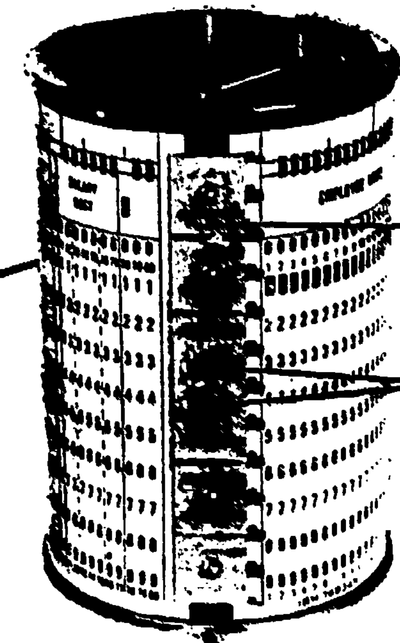
2. To install the new roll, place the roll on the empty shaft, return and tighten the nut on the shaft. With the nut side to the right, merely drop the roll and shaft into the mounting slots. Check to see that the shaft is fully seated in the mounting slots.

For your protection, when the access cover is raised, the electrical current to the motors in the machine is shut off. No internal movement can take place. When the access cover is fully closed, this current is turned back on automatically.

Always be sure to close the access cover tightly. If you do not, the machine will not operate.

The grille in the top of the access cover allows free air circulation inside the machine. NEVER put anything on this cover. If you do, you will block the air circulation and cause the machine to overheat.

NORMAL CODE	FUNCTION	ALTERNATE CODE
12	FIELD DEFINITION	4
11	START AUTO SKIP	5
0	START AUTO DUP-LICATION	6
1	ALPHABETIC SHIFT	7
2	LEFT ZERO PRINT	8
3	PRINT SUPPRESS-ION	9



B. PROGRAM CARD WRAPPED A
A PROGRAM DRUM

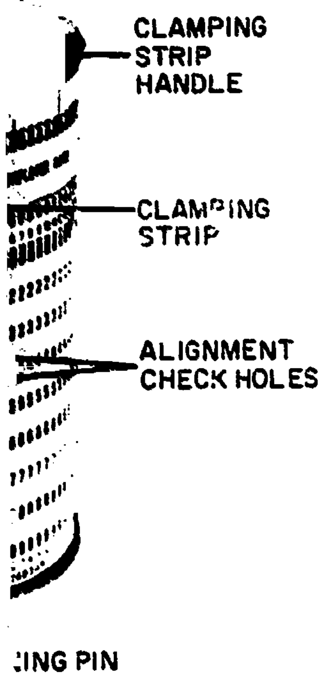
A. RELATIONSHIP BETWEEN THE PROGRAM CARD, PROGRAM DRUM, STAR WHEELS, AND PROGRAM CONTROL LEVER

E. CAF

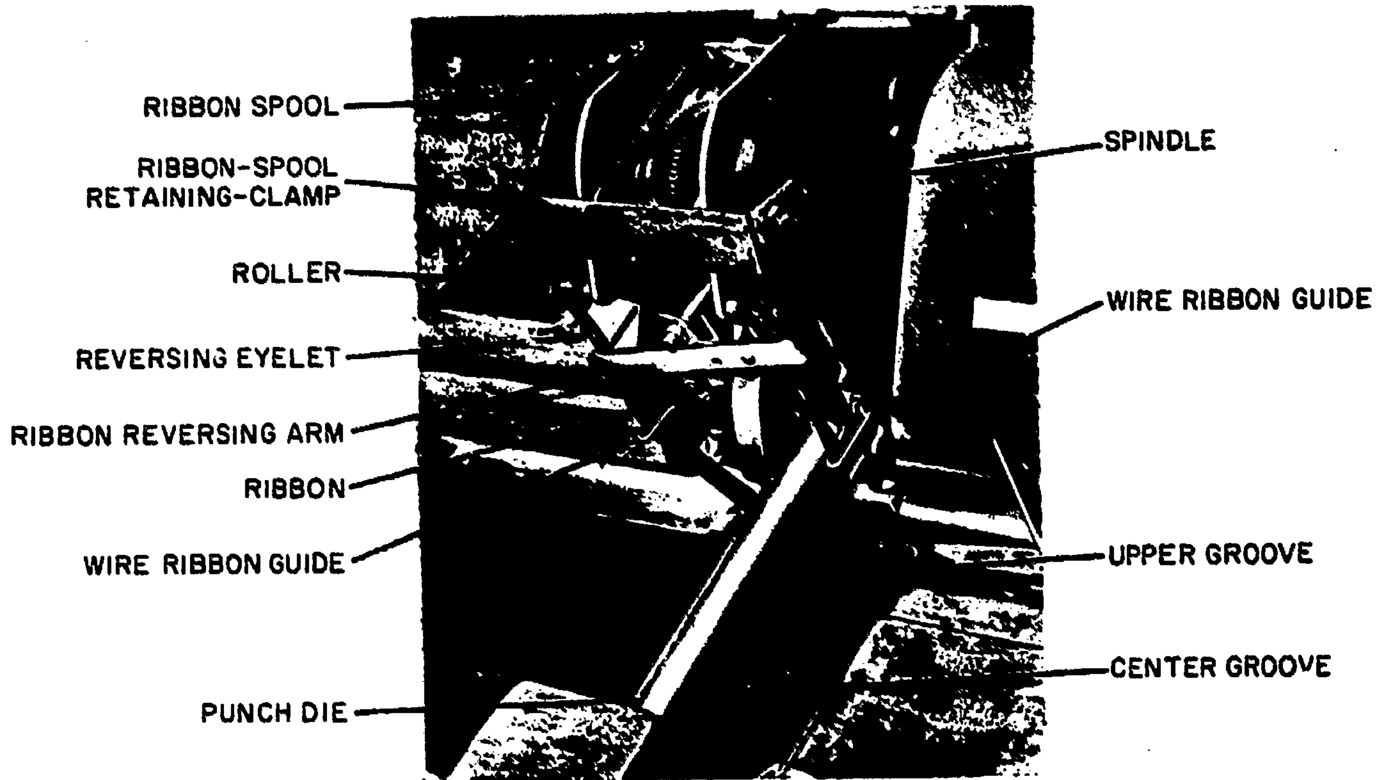
OPERATION	NORMAL CODE		ALTERNATE CODE	
	FIRST COLUMN	REST OF FIELD	FIRST COLUMN	REST OF FIELD
PUNCH NUMERIC	SPACE	12	SPACE	4
PUNCH ALPHABETIC	1	A	7	7+4
DUPLICATE NUMERIC	0	12	6	4
DUPLICATE ALPHABETIC	0+1	A	6+7	7+4
SKIP AUTOMATICALLY	X	12	5	4
LEFT ZERO PRINT	2	B	8	8+4
SUPPRESS PRINTING	3	C	9	9+4

PROGRAM CARD CONTROL CODES

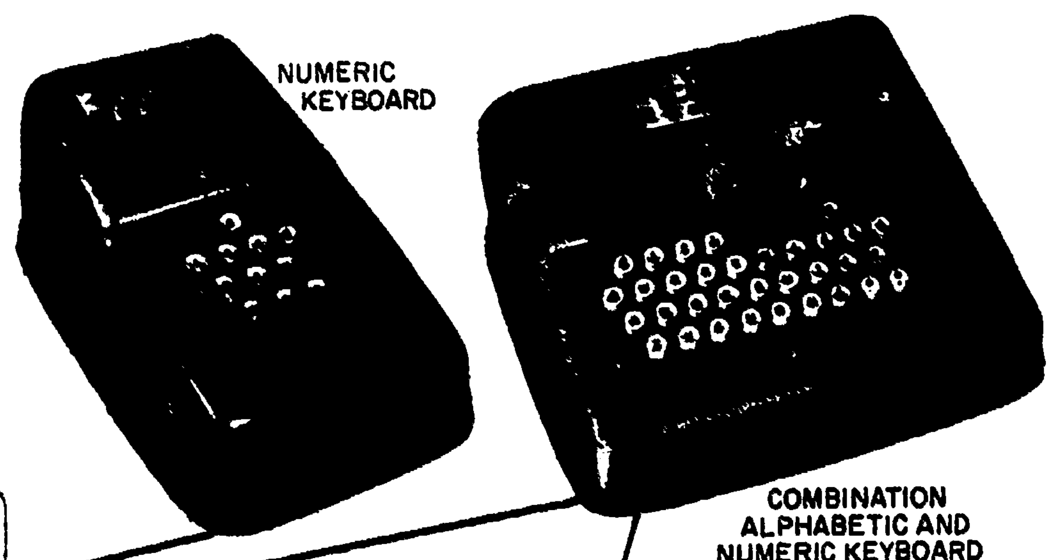
Foldout 3-1.—IBM 26 Printing Card Pun

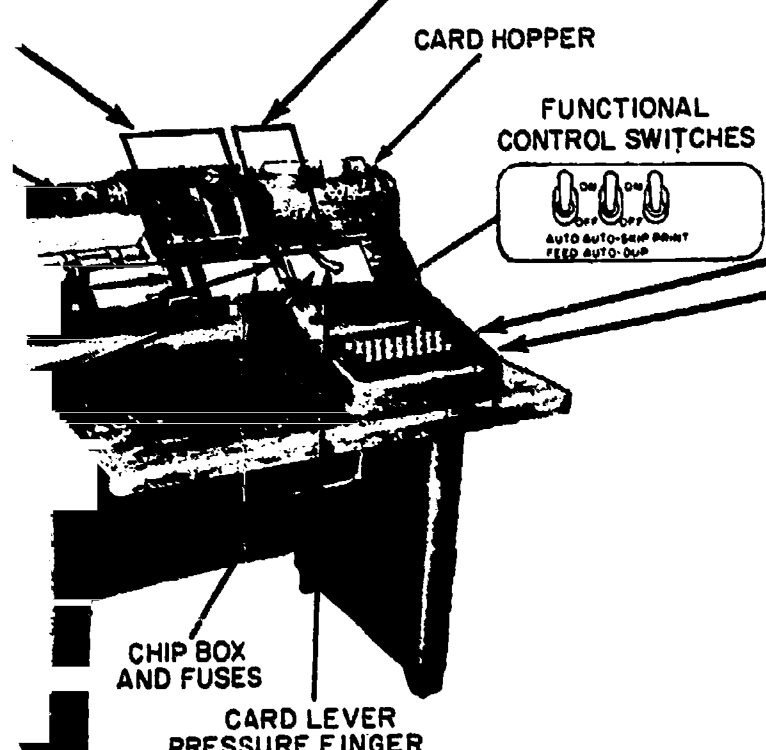


WRAPPED AROUND
AM DRUM

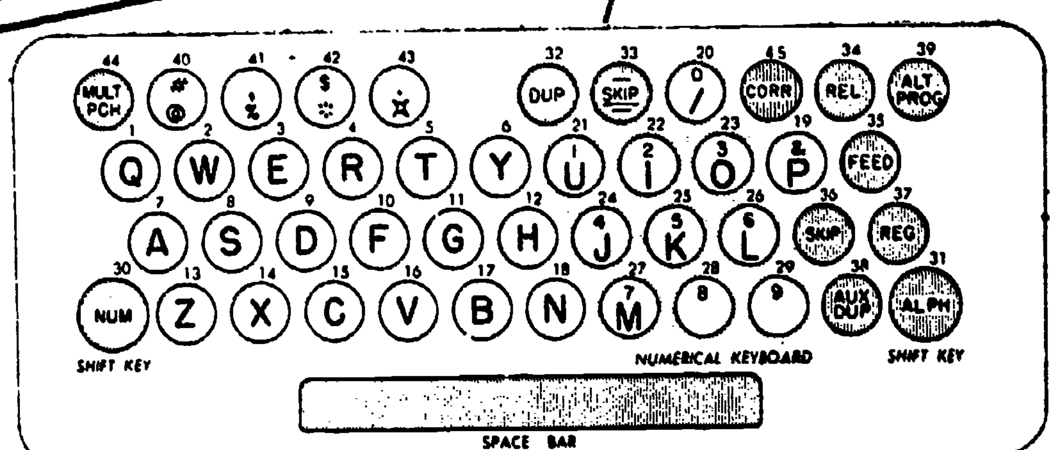


C. PRINTING UNIT





E. CARD PUNCH OR KEY PUNCH



D. COMBINATION KEYBOARD CHART

R49.5.1

ntina Card Punch.

BEST COPY AVAILABLE

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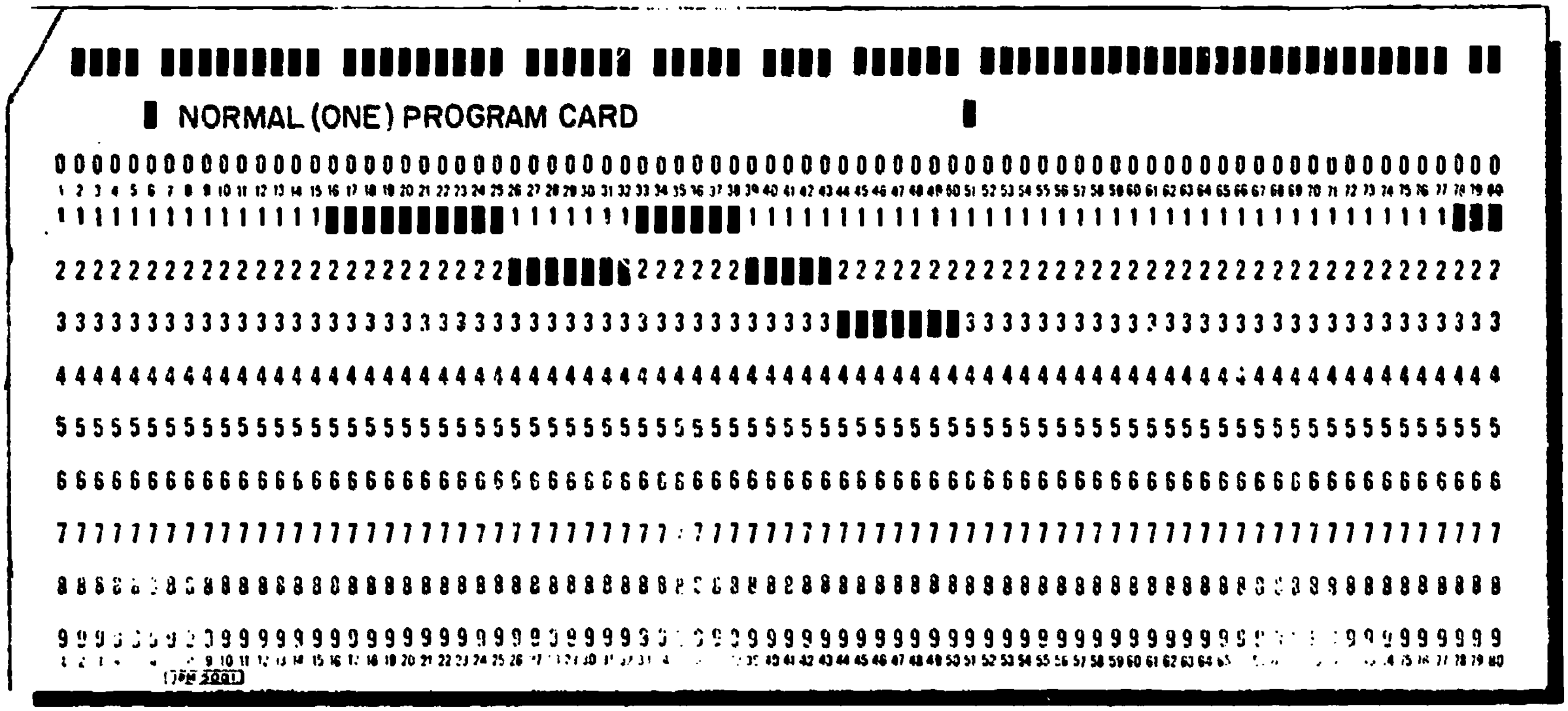

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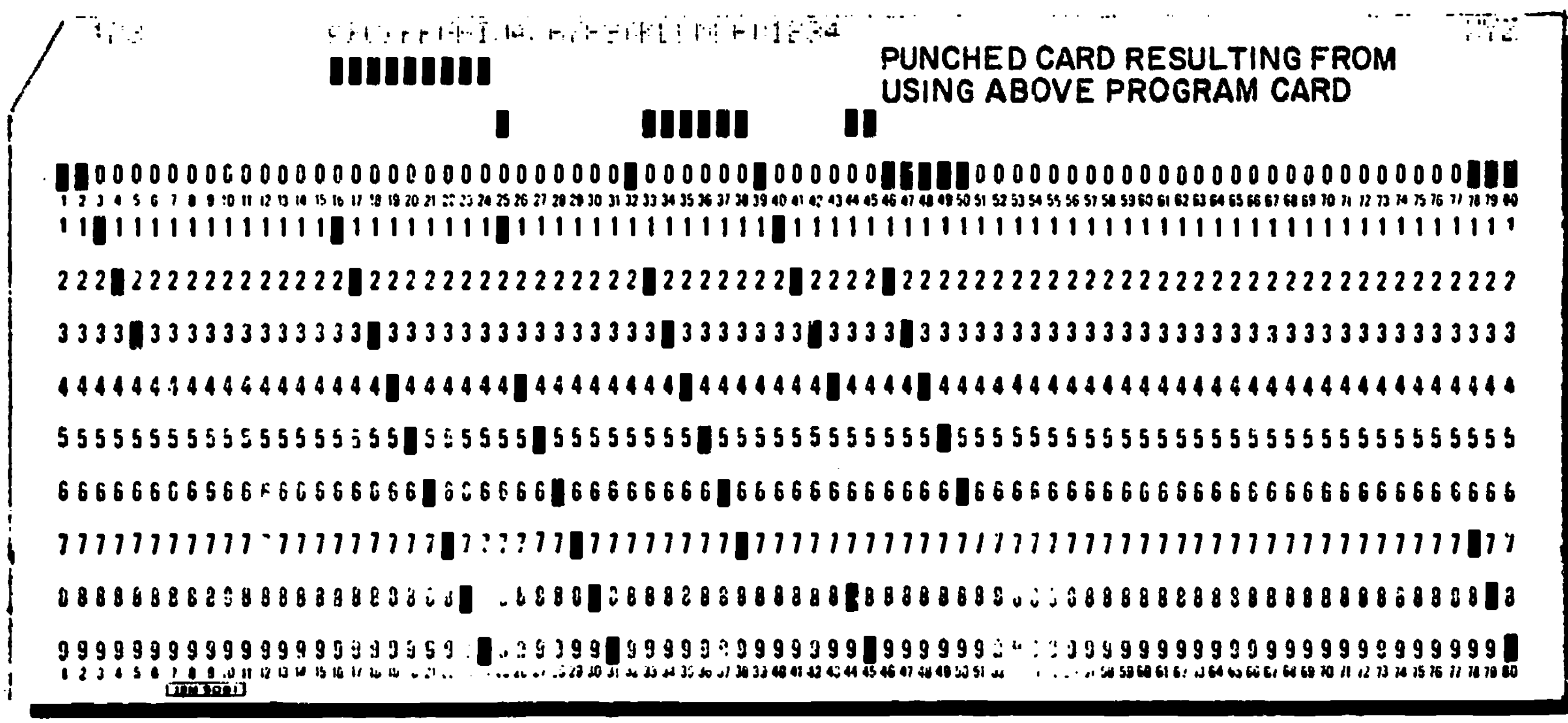

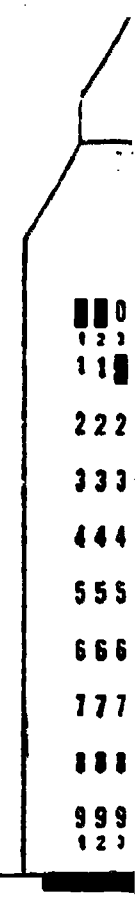

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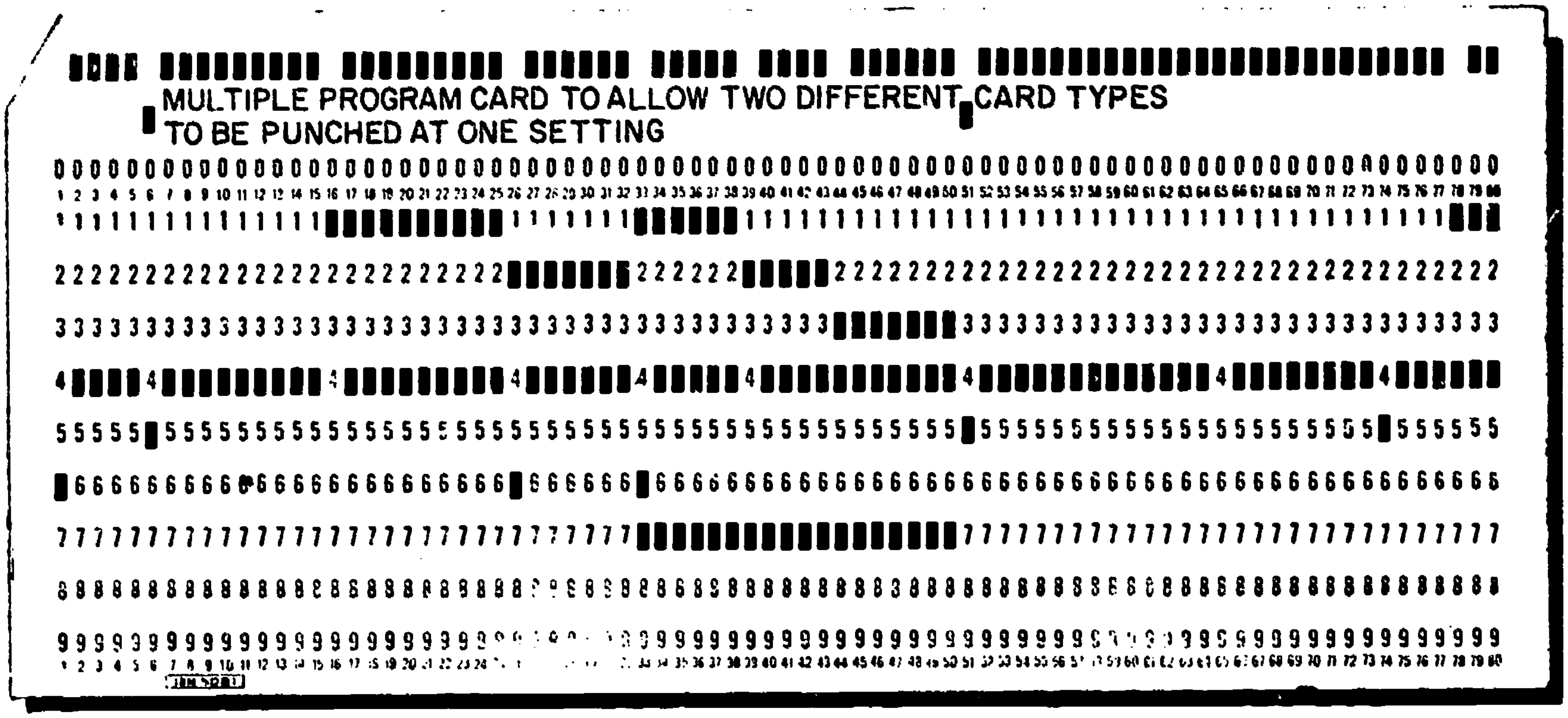

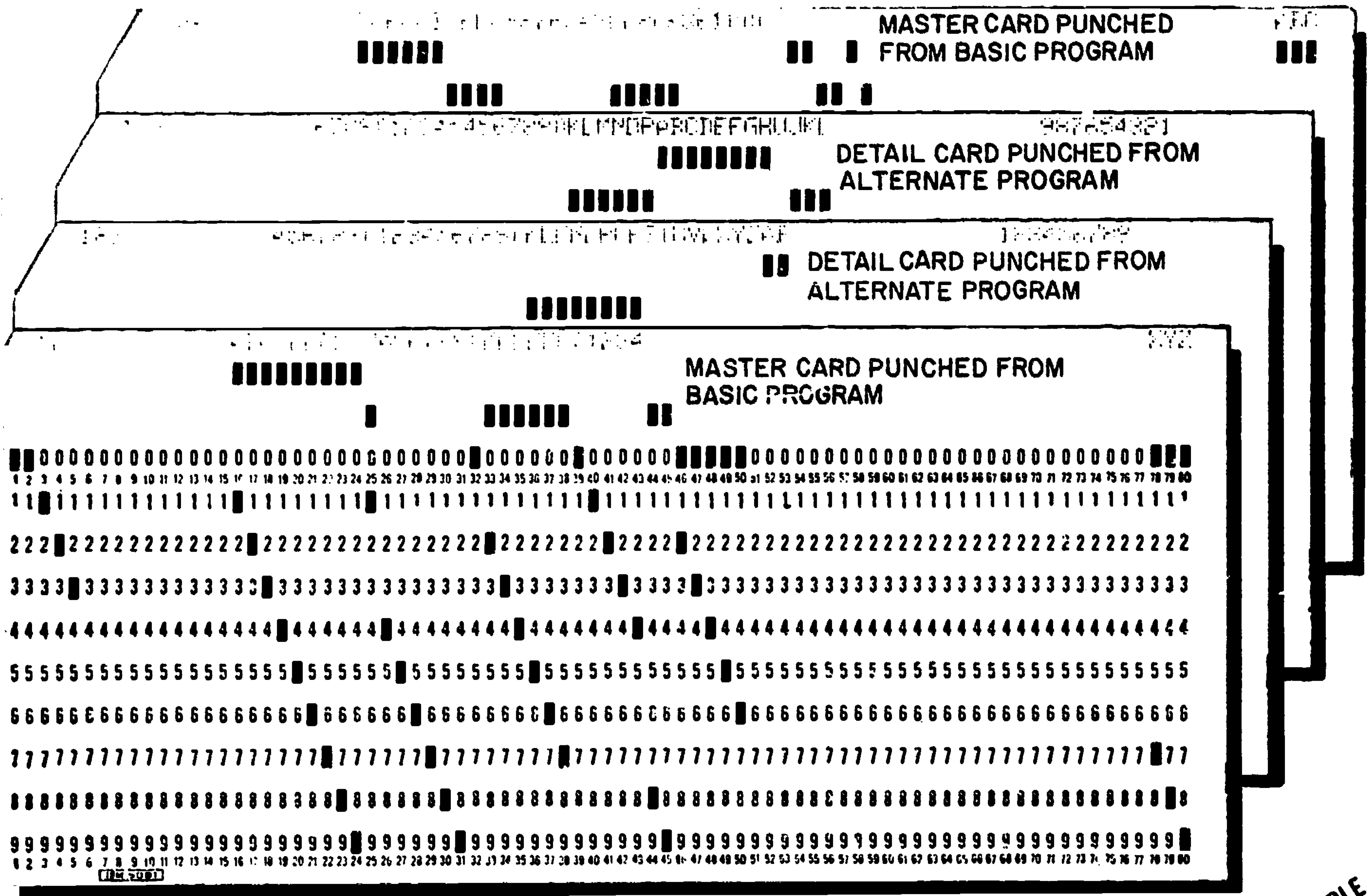

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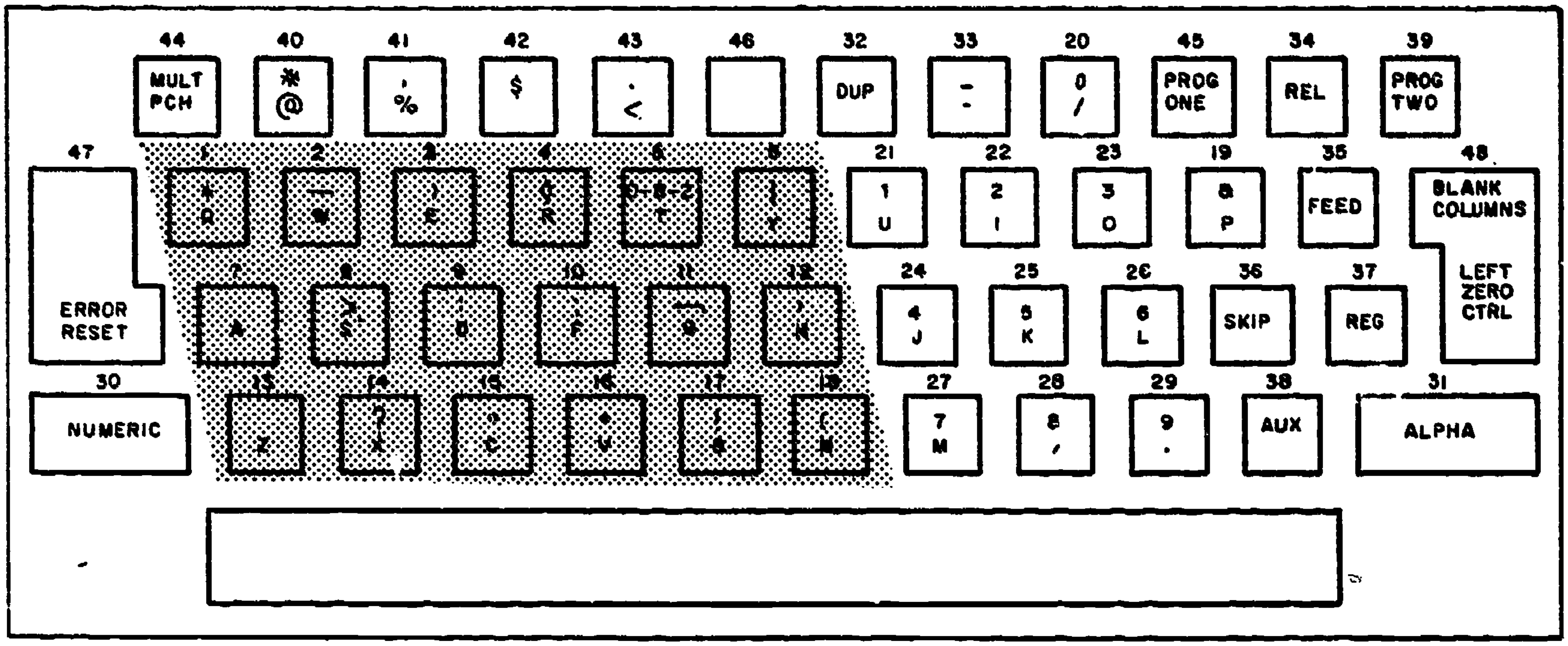
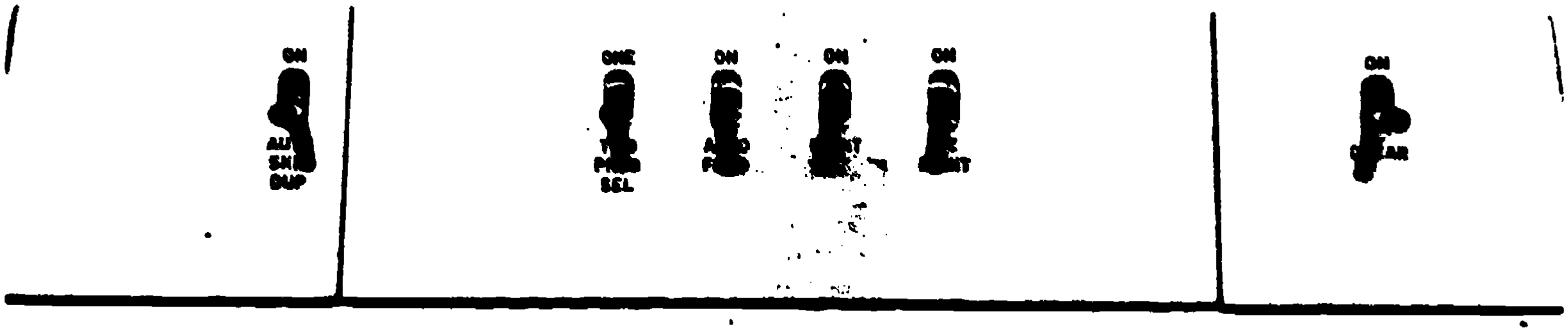


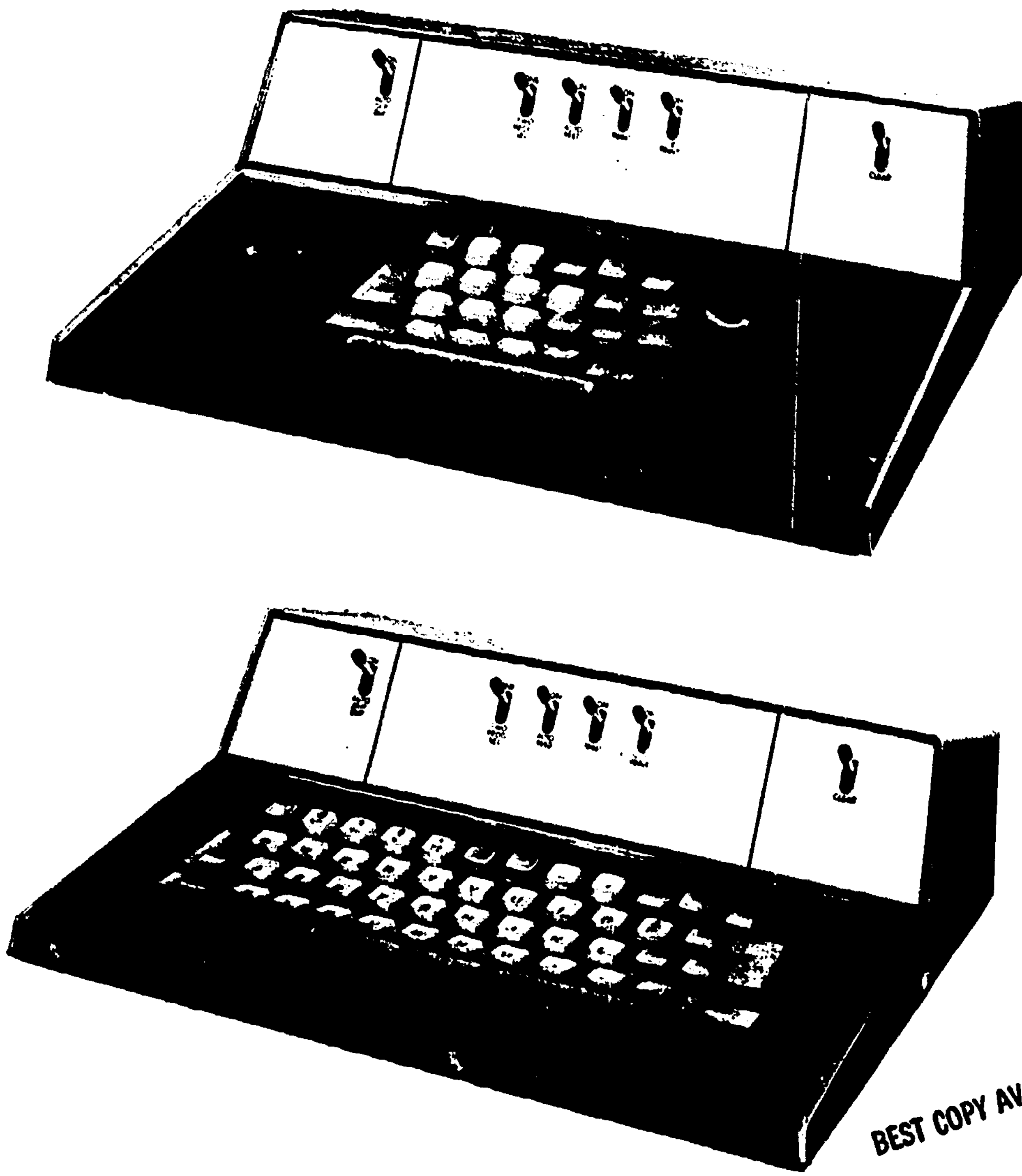
A. COMBINATION KEYBOARD CHART

Foldout 3-3.—IBM 29 Card Punch.

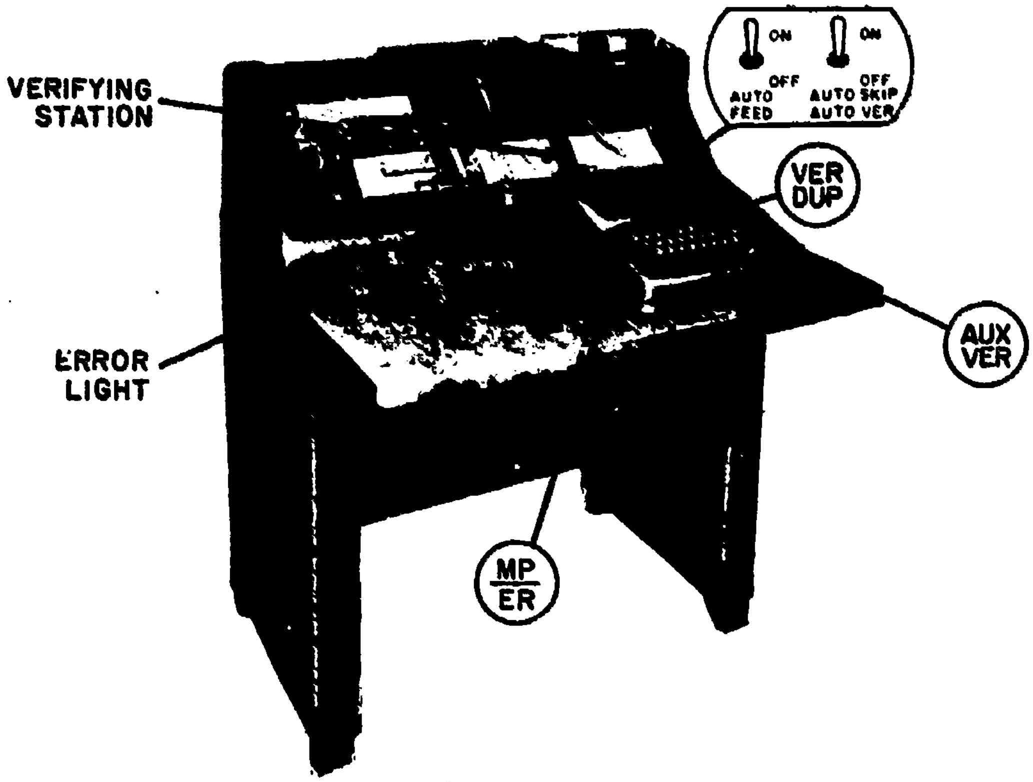
F



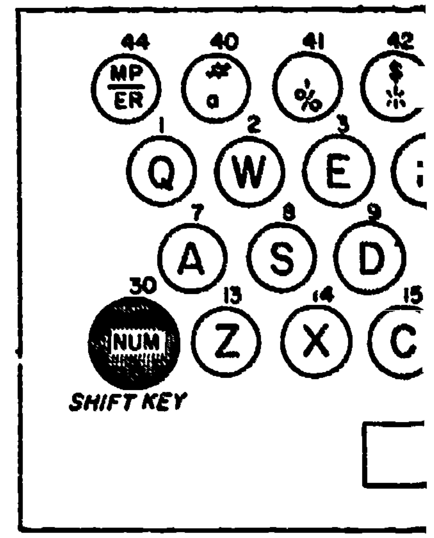
B. KEYBOARD SWITCH PANEL

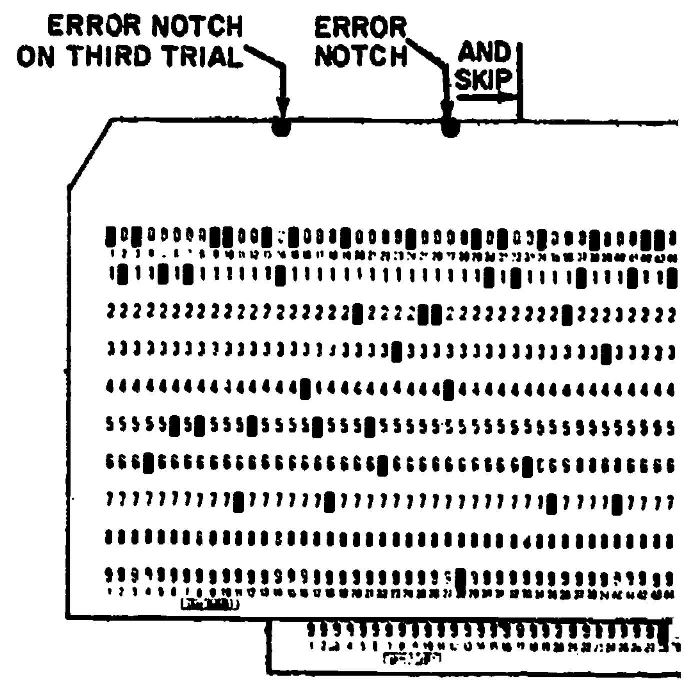


R49.5.2 C. NUMERIC AND COMBINATION KEYBOARDS

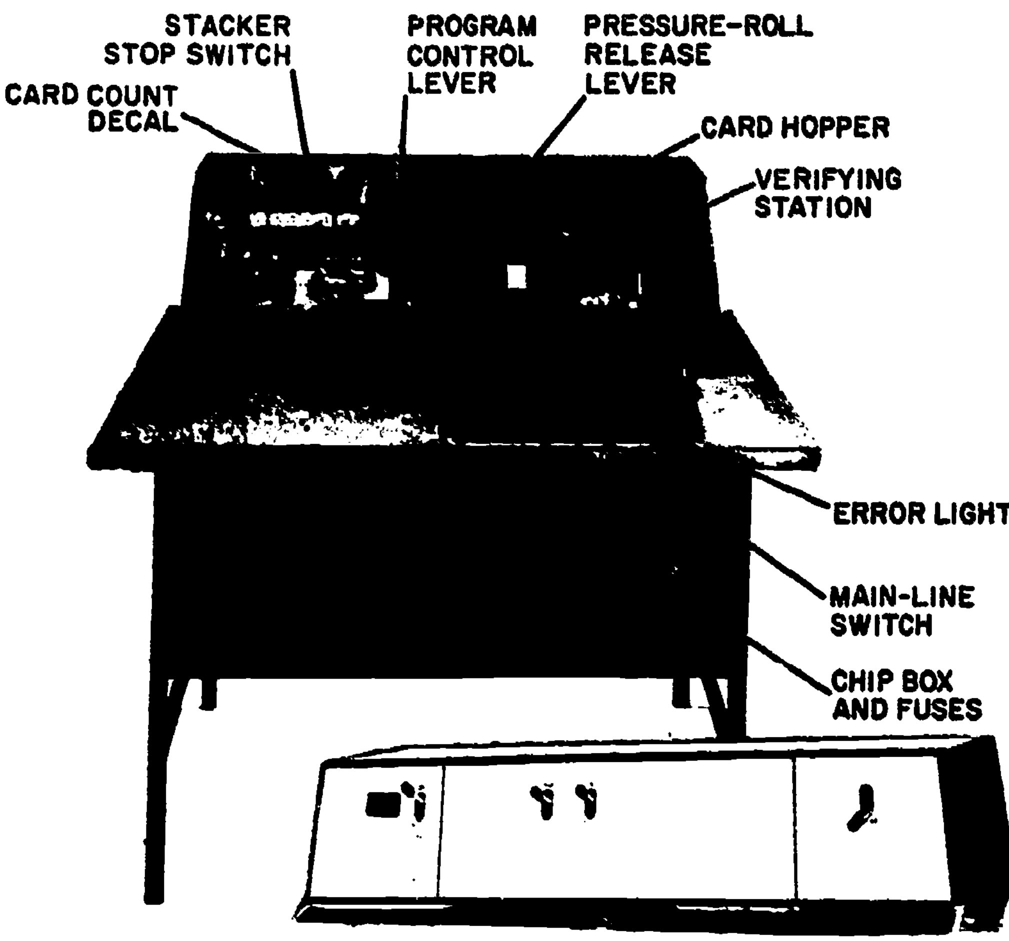


A. IBM TYPE 56 VERIFIER

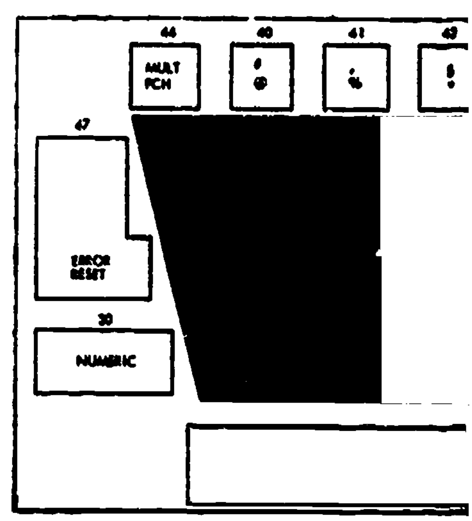




D. VERIFICAT



B. IBM TYPE 59 VERIFIER



C. COMBIN

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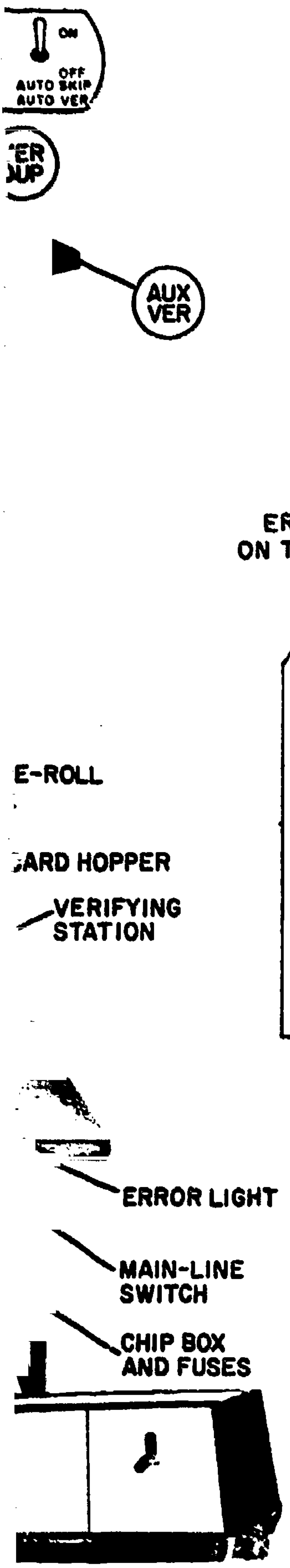
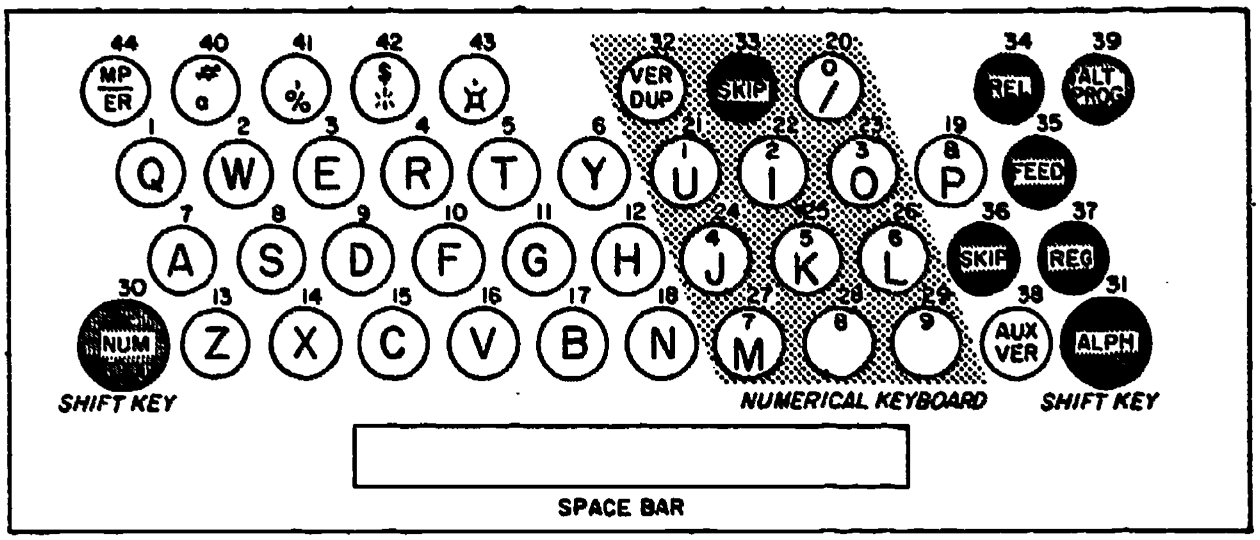
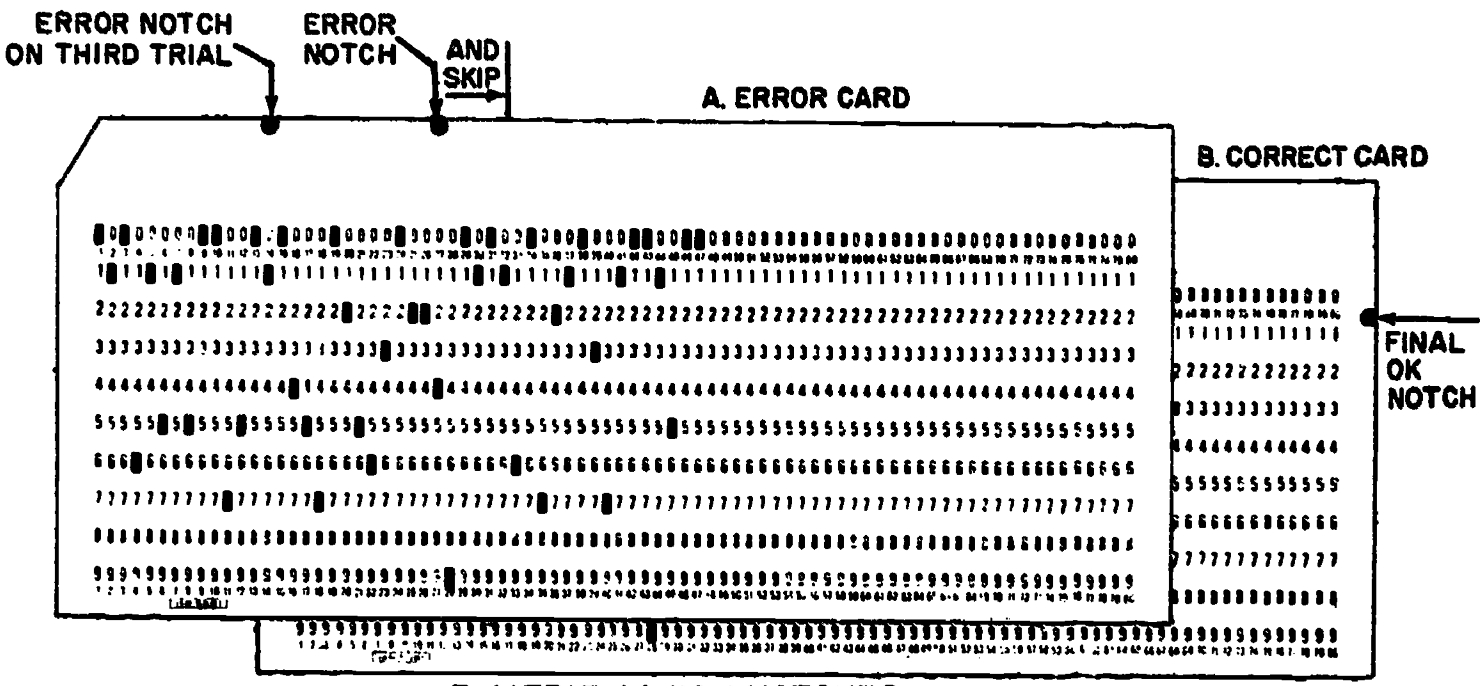
Foldout 3-4.—IBM 56 and 59 Key Verifiers.

H

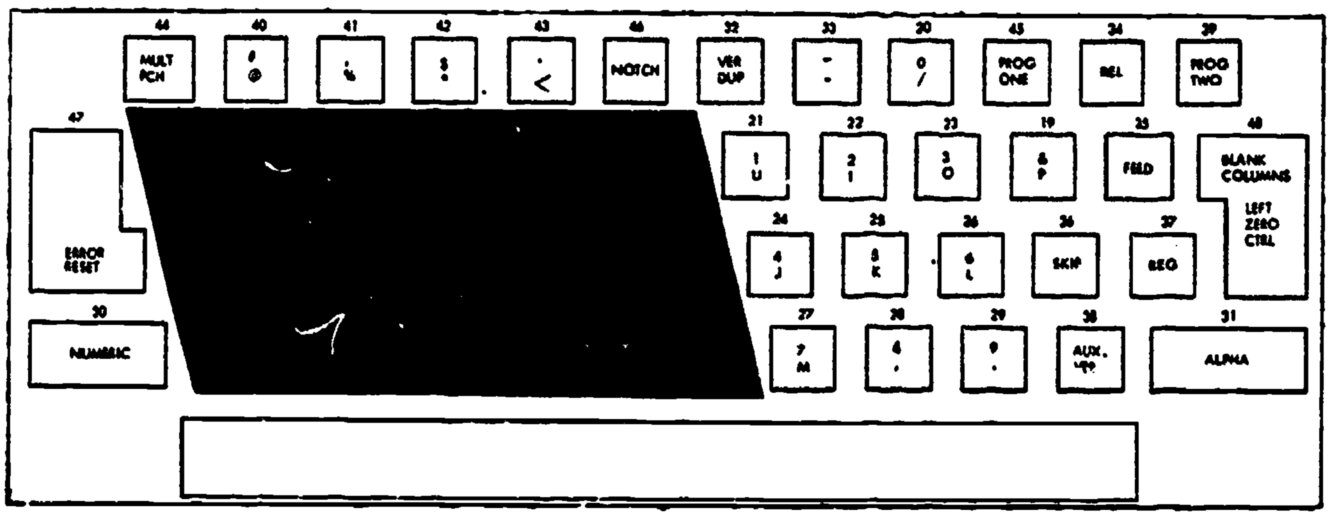




E. IBM 56 KEYBOARD



D. VERIFICATION NOTCHES



C. COMBINATION KEYBOARD CHART, IBM 59

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Foldout 3-4.—IBM 56 and 59 Key Verifiers.

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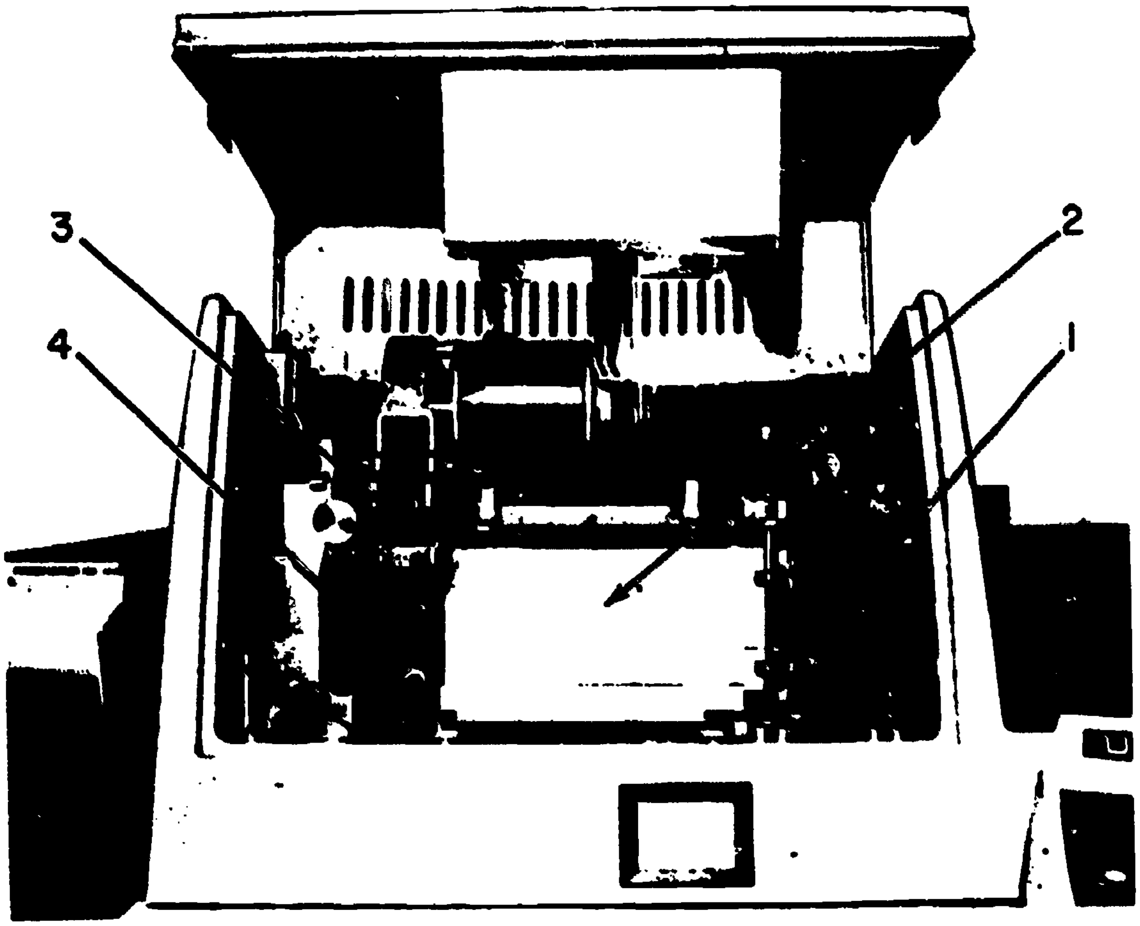
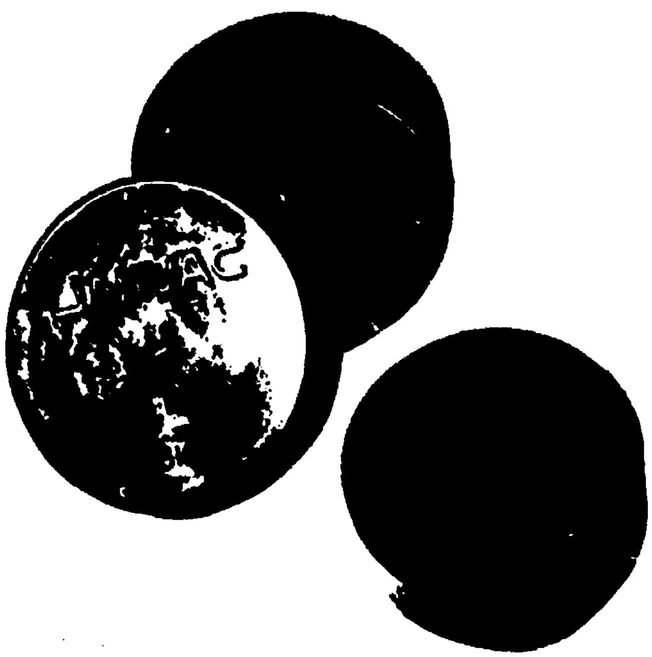
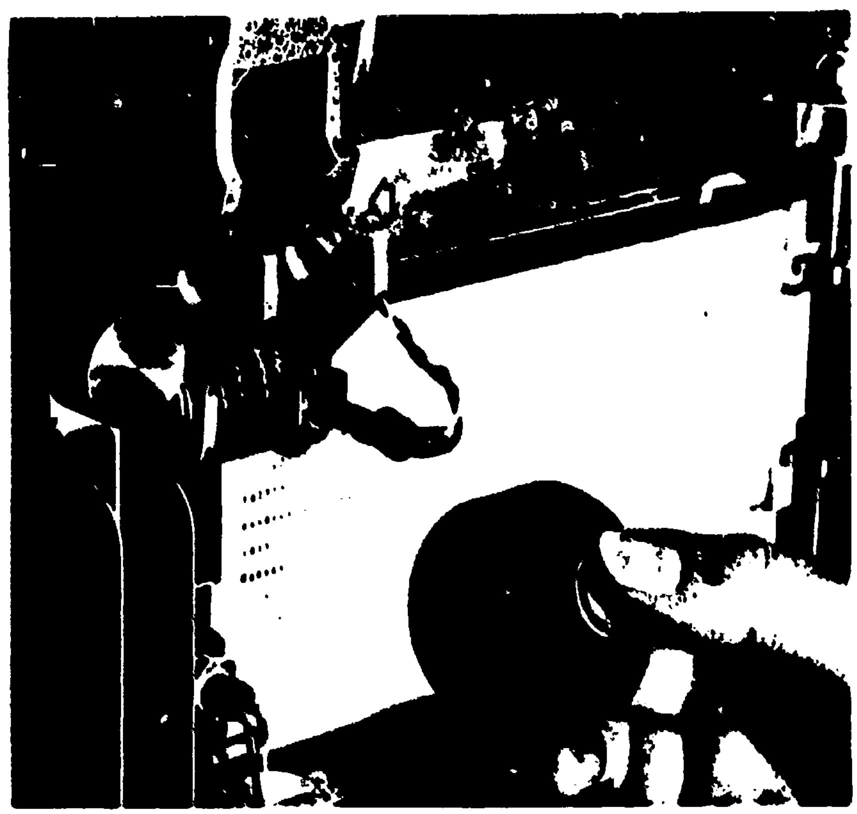
I



1. READ STATION
2. VISIBLE STATION
3. PRINT STATION (VIP)
4. PUNCH STATION

A



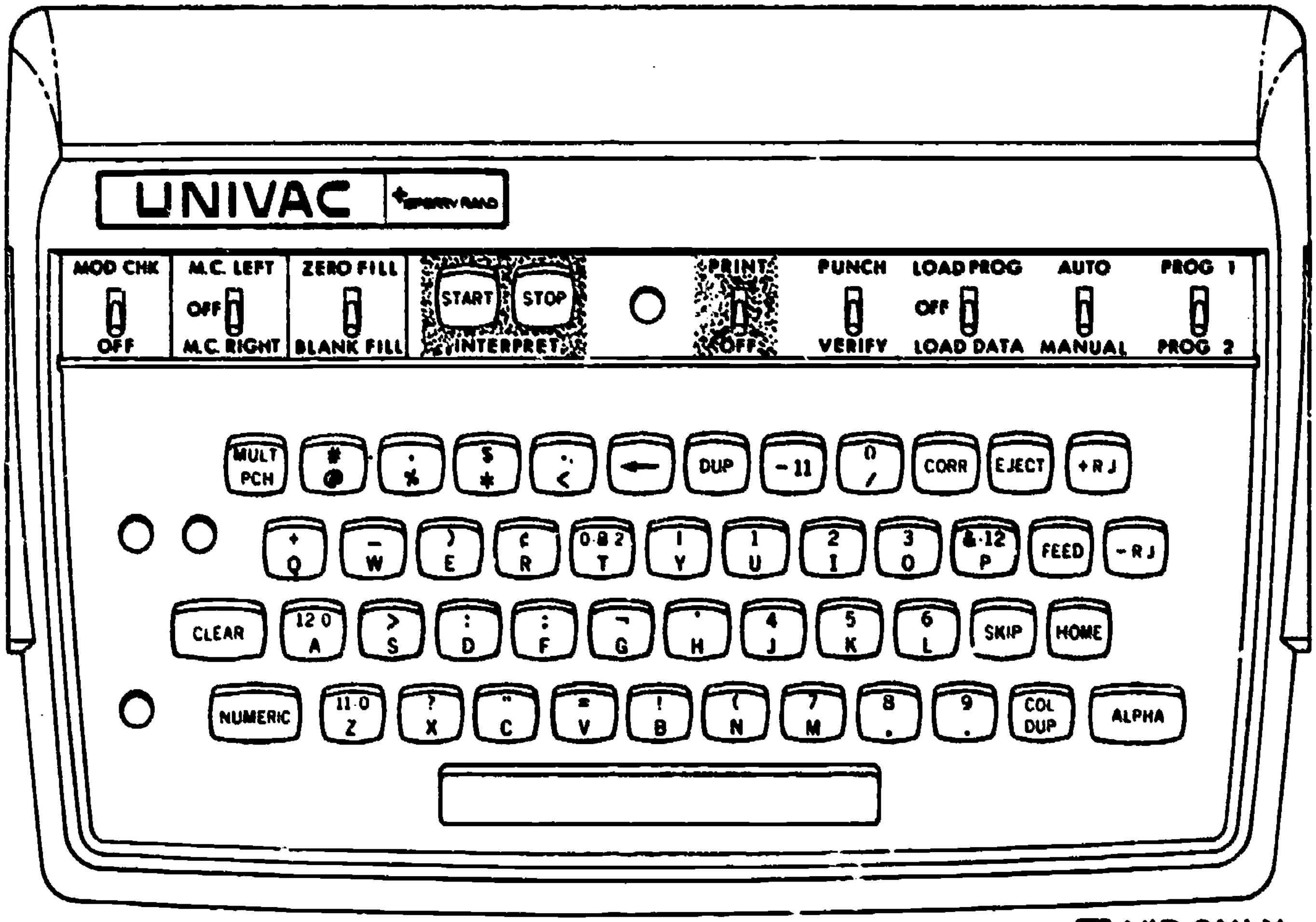


THE INKING ROLL IS INSTALLED IN THE SLOTS INDICATED BY ARROW

C

J

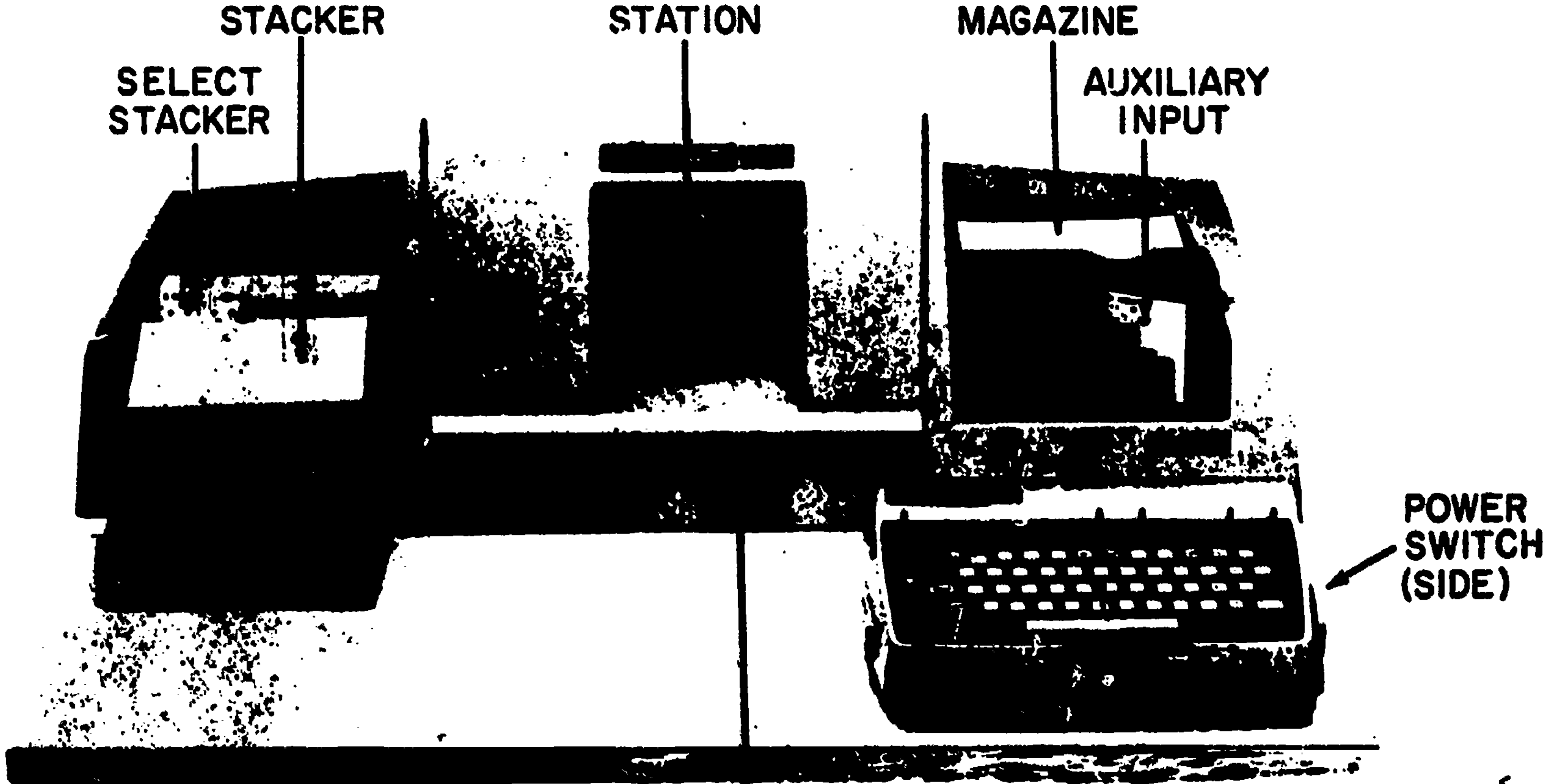
Foldout 3-5.—UNIVAC 1710 Verifier Inte



EXTERNAL FEATURES

VIP ONLY

B



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1 ... er Interpreter Punch.

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CHAPTER 4

CARD SORTERS

INTRODUCTION

One of the basic requirements for preparing any type of report is that the documents to be used in the report must be in some sort of sequence. This may require rearranging the documents into a sequence other than that in which they are ordinarily maintained. For instance, they may be arranged alphabetically by name field but need to be sorted into numerical sequence by social security number or vice versa. Or they may be filed in numerical sequence by one numeric field, but may be needed in a sequence determined by another field.

They may have to be arranged in ascending sequence; that is, starting with the lowest control numbers or letters and proceeding to the highest. Or, they may have to be arranged in descending sequence, which means that the control numbers or letters must go from high to low.

Such arranging is called SORTING. Manual sorting or arranging documents into numerical or alphabetic sequence is a tedious and time consuming operation. However, where punched card data processing systems are employed, the sorting of punched cards into any desired sequence can be performed easily and rapidly by high speed card sorting machines like the one shown in foldout 4-1A.

Card sorting is a simple operation, but it is important for you to know just what your sorter is capable of doing, and the proper sorting procedures to be followed, in order to make the most effective use of your sorting time. Skill can be attained only through practice and application of the best techniques to be used for a particular sorting operation.

A brief description of the operations which may be performed on card sorters is presented in the following paragraphs.

1. NUMERICAL SORTING. Cards may be arranged in numerical sequence by sorting each column in the control field. A control field can be any field common to all cards used in an operation to control the particular job being performed, such as social security number, job order number, or stock number.

2. ALPHABETIC SORTING. Cards may be arranged in alphabetic sequence by multiple sorts per column.

3. CONTROL SORTING. This is the operation in which the sorting sequence is dependent upon two or more control fields, "within" simply means before. For example, consider a report arranged by name within an activity. Each field is referred to as a control group. In sorting for this report, you would first sort to name sequence and then to activity sequence.

4. BLOCK SORTING. When the volume of cards is so large that it would be too slow and impractical to complete all sorting before the cards are forwarded to the next processing step, considerable overall time can be saved by separating the cards into blocks. Each block can then be sorted separately, and used for other job steps before all sorting has been completed. Because each block can be sorted separately, more than one sorter may be utilized to accomplish large file sorting.

5. SELECTIVE SORTING. Not all the cards in a file need to be sorted, if only those cards with particular digits are to be used. Selection switches provide a means for selecting only those cards required without disturbing the sequence of the remainder of cards in the file.

Learning Hint

You may be required to operate sorters of different types. Since each type in common use has characteristics which differ from the others,

each will be discussed separately in this chapter. However, you will find that certain principles pertaining to one type will apply equally to the others. For example, a thorough understanding of the IBM type 83 sorting operations will help you to understand the operation of the IBM type 84.

CARD SORTER, TYPE 83

The IBM type 83 Card Sorter, illustrated in foldout 4-1 operates at a speed of 1000 cards per minute. Sorting is accomplished by placing a group of cards in the feed hopper, setting the sort brush on the desired column, and depressing the start key. Thirteen pockets receive the sorted cards; one pocket for each punching position and a reject pocket for cards that are not punched or are rejected for other error conditions during a sorting operation.

Cards are placed in the card feed hopper face down, with the 9 edge toward the throat (entry to the feed mechanism) of the hopper. The 83 is a continual feeding machine, therefore, additional cards may be placed in the hopper while the machine is operating, provided necessary care is exercised in doing so.

FILE FEED

A FILE FEED with a capacity of 3600 cards is an optional item but usually found on the 83 sorter. This is an extension of the normal card hopper and reduces card handling time by allowing more cards to be readied at one time. The file feed is equipped with an automatic card joggler (foldout 4-1E). This device gives the cards a final joggling just before dropping the cards into the regular hopper.

A card weight must be placed on top of the cards in the file feed. When there are only enough cards to fill the hopper, the card weight provides the necessary weight for proper card feeding. Without this weight a card jam may occur.

CARD READING

Cards leave the hopper, pass through the throat of the machine and move through the read station. This station consists of a movable reading brush (foldout 4-1C) and a contact roller. Electrical contact is made between the brush and the roller whenever there is a punch present in the column being sorted.

The column desired for sorting can be selected by use of the COLUMN SELECTOR KNOB. A clockwise rotation will raise the brush and advance the brush (column 5 to 6, etc.) one column. The COLUMN INDICATOR on the sort brush assembly indicates the column the brush is positioned on for reading.

A counter clockwise movement of the column selector knob will raise and retreat the column indicator and brush one column.

The brush can be moved more than one column at a time. Turn the column selector knob either way until the brush is at its most raised position. Push down and back on the FINGER LEVER of tne column indicator. Slide the brush to whatever column you desire. Release the finger lever and lower the brush with the selection knob.

CHUTE BLADES

Once read by the brush, a SELECTOR PIN (foldout 4-1D) is activated to separate parallel metal strands. These metal strands are called CHUTE BLADES.

The chute blades are controlled by 12 selector pins, with each pin centered above the exposed portion of its corresponding chute blade tab. When a punched hole is sensed, a magnetic armature is attracted, which in turn pushes down the appropriate selector pin and separates the chute blades. The card is then transported by the carrier rollers between opened chute blades to the appropriate pocket. If an unpunched card is fed into the machine, the card acts as an insulator preventing the brush from making contact with the roller. The card then passes under all chute blades and falls into the reject pocket.

POCKETS

There are 13 pockets to which the cards may be directed. They are usually labeled from left to right with one pocket for each digit (9-12). The extreme right hand pocket is called the REJECT pocket.

The 1 through 9 pockets will receive cards according to the numeric punch in a column. The 0, 11, 12 and reject pockets receive cards according to the setting of the SORT SELECTION SWITCH and the EDIT or EDIT STOP SWITCHES.

SORT SELECTION SWITCH

The sort selection switch (foldout 4-1B) is provided to alter the punch detection during reading. This switch may be rotated to any one of five positions to control the particular sorting operation involved. The function of each switch setting is illustrated in figure 4-1 and described in the following paragraphs.

N. (Numerical.) Cards are sorted on the first punch read, and blanks are rejected. Double-punched cards are rejected as errors if either the edit switch or edit stop switch is ON.

Z. (ZONE.) Cards are sorted on zone punches only. Cards without a zone punch are rejected. Any card with more than one zone punch is rejected as an error if either the edit switch or edit stop switch is ON.

A-1. (Alphabetic Sort 1.) Cards punched with a digit and a 12 zone (A through I) are sorted on the digits 1 through 9. Cards punched with an 11 zone sort into the 11 pocket, and zero zones sort into the zero pocket. Blank cards, and cards punched with only a digit or a single 12-punch are rejected. Cards with multiple digit or zone punches are rejected as errors if either the edit switch or edit stop switch is ON.

A-2. (Alphabetic Sort 2.) Cards punched with a zero or 11 zone are sorted on the digits. Blanks, cards with a zero or 11 zone only, cards with digits only, and cards with letters A through I are rejected. Multiple digit or zone punches are rejected as errors if the edit or edit stop switch is ON.

A-N. (Alpha-Numerical.) Cards containing digits 0 through 9, but no zcne, are sorted into their respective pockets. Zone and blank cards are rejected. Cards with 11 zones are sorted into the 11 pocket, and the 12 zones are sorted into the 12 pocket. Multiple digit or zone punches are rejected as errors if the edit or edit stop switch is ON.

By correctly setting this selection switch most any type sorting may be accomplished. The main advantage is a reduction of time when sorting alphabetic information. This will be discussed under sorting operations.

SORT SELECTION SWITCH SETTING	POCKETS												REJECTS REGARDLESS OF EDIT	ERRORS (When Edit or Edit-Stop is ON)
	9	8	7	6	5	4	3	2	1	0	11	12		
Numerical (N)	9	8	7	6	5	4	3	2	1	0	11	12	Blanks	Multiple-punched cards (incl. letters)
Zone (Z)										0	11	12	Any card without a zone punch	Any card with more than one zone punch
Alpha-1 (A–1)	I	H	G	F	E	D	C	B	A	0 S-Z	11 J-R		Blanks and cards with a 12-zone punch but no digit punch. Digits 1 to 9.	Any card with more than one zone punch or with more than one digit punch
Alpha-2 (A–2)	R,Z	Q,Y	P,X	O,W	N,V	M,U	L,T	K,S	J 0-1				Cards with 0 or 11-zone only. Blanks. Letters A to I, and 12-zone spec. char. Digits 1 to 9.	Same as A-1
Alpha-Numerical (A–N)	9	8	7	6	5	4	3	2	1	0 (digit)	11 J-R	12 A-I	Blanks, 0-zone (S-Z)	Same as A-1

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Figure 4-1.–Sorting pattern for standard 83 sorter.

DIGIT-SUPPRESSION KEYS

There are twelve DIGIT-SUPPRESSION KEYS. These keys correspond to the twelve punching positions. By depressing one of these keys the corresponding timed impulse is not allowed to reach the contact roller. If no electrical contact is made, the selector pin is not activated and no chute blade is opened. This means that if the 5 key were depressed (during numeric sorting), a card punched with a 5 would be treated as a blank.

When pressed, the keys automatically latch down. To unlatch the keys, run a fingertip along the bottom edge of the keys.

These keys are used to select out certain punched cards of a file without disturbing the sequence of the rest of the file. They are also used to select certain punched cards of a file during sorting. These operations will be discussed later.

SWITCHES, LIGHTS, KEYS

Main-Line Switch

The main-line switch is located on the right end of the sorter. This supplies the power to the sorter.

Start Key

Press this key to start the cards feeding from the hopper. The cards then feed automatically until the hopper is empty, until a pocket (stacker) is full, until the edit-stop is activated because of an error, or until the stop key is pressed.

Power-On-Light

This light glows approximately one minute after the main-line switch is turned ON and indicates that the machine is ready to operate.

Stop-Reset Key

Press this key to stop card-feeding or to reset the error circuits when the sorter has stopped with the error light ON.

Edit Switch

With this switch ON, errors fall into the reject pocket without stopping card-feeding.

Edit-Stop Switch

With this switch ON, errors fall into the reject pocket, the error light comes on, and card-feeding stops. To reset the error circuits when the machine has stopped and the error light is ON, press the stop-reset key.

Sort-Test Switch

To check machine timing, the machine serviceman sets this switch to TEST. Set the switch to SORT for sorting operations.

Edit Light

When the edit-stop switch is ON and the machine senses an error, this light comes on. It also comes on when the test-sort switch is set at TEST and the brush is reading a punch in the card.

SORTING OPERATIONS

Before any sorting operation is begun, you should check all switches to ensure they are set in accordance with the job you are about to do. Improper switch settings may result in getting a file of cards out of order, thus requiring a repeat sort. It is also important to have a thorough understanding of the sequence in which the cards are to be sorted. Many valuable hours have been wasted in report preparation because the sorter operator misunderstood the sorting sequence required, or neglected to ensure that the sorting was performed in the correct sequence.

Numerical Sorting

In order to arrange cards in numerical sequence, each column in the control field requires one sort. Sorting begins with the units or low order position and progresses from right to left through the high order position. The sort brush is set to read the first column to be sorted. The sort selection switch is set at N.

In figure 4-2, the left panel illustrates the sequence of events for the first sort of a 2-column sorting operation

1. Part (A) indicates the original sequence of the cards before sorting is begun.
2. Part (B) indicates the cards in the stacker after the completion of the first sort, on the units position. The cards are removed from the stacker pockets in ascending sequence, so that the zeros will be stacked on the bottom followed by the 1s, 2s, and so on through 9.
3. Part (C) indicates the sequence of the cards after the completion of the first sort.

OBSERVE THE NUMERICAL SEQUENCE OF THE UNITS POSITION.

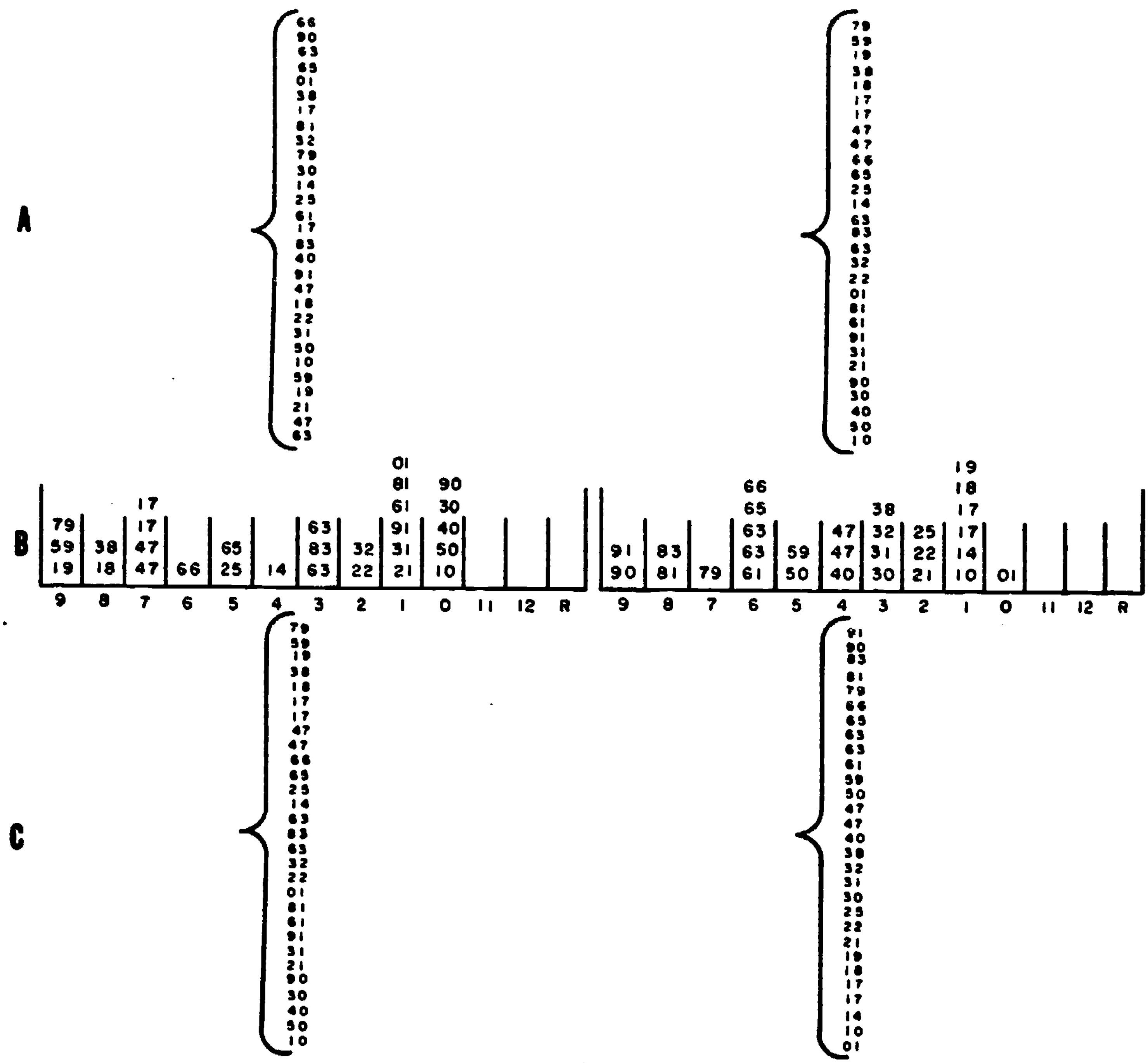

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Figure 4-2.—Numerical sorting.

Upon completion of the first sort, the column selector knob must be rotated counter-clockwise to move the brush back one column. (Remember, low order to high order.)

The right panel in figure 4-2 illustrates the sequence of events for the 2nd (and last) sort of a 2-column sorting operation.

1. Part (A) indicates the sequence of cards after the first sort has been completed.
2. Part (B) indicates the cards in the stacker after the completion of the second sort, or the tens position. Cards must be removed in the same sequence as the first sort.
3. Part (C) indicates the sequence of the cards after the completion of the second sort.

OBSERVE THE NUMERICAL SEQUENCE OF THE HIGH ORDER POSITION AND ALSO THE ASCENDING SEQUENCE OF BOTH COLUMNS.

Control Sorting

In certain sorting operations, the desired sequence may involve more than one field. For instance, assume you have been given the job of sorting a file of personnel status cards to social security number, rate code, and activity code sequence. First, you must determine the sequence of these fields in relation to one another. If the cards are to be sorted to social security number within rate code within activity code sequence, social security number would be your minor field, and must be sorted first. The intermediate field would be rate code, and must be sorted next. Since activity code would be your major field, it must be sorted last. An apt rule to remember, is that the major field is determined by its degree of importance in relationship to other fields to be sorted. Consequently, the minor control field would always be the lowest subdivision of the major, with the intermediate control field falling between the two.

If two or more reports are to be prepared from the same file of cards, but the cards are to be sorted differently for each report, considerable sorting time can be saved by first analyzing the control fields required for each report and then sorting for these reports so that duplicate sorting of one or more control fields is avoided. For example, assume you must sort one file of cards for three reports (figure 4-3). The first report is to be prepared in rate code sequence within activity, the second in name sequence within rate code, and the third in name sequence only. Further assume that these reports do not have to be prepared in the order shown. If you sorted for each report in the order shown, you would sort rate code twice and name twice.

Now take a closer look at the sorting requirements (figure 4-4). The third report is to be prepared in name sequence only, so it should be sorted first. Then, the cards can be sorted for the second report simply by keeping the cards in name sequence and sorting to rate code. Sorting

1

ACTIVITY	RATE	NAME
0131	DPC	ABELL, B.
0131	DPC	MONROE, C.
0131	TD3	KING, J.
0141	DPC	ADAMS, T.
0440	PN1	CONNORS, W.
0440	TDAN	FOX, A.V.
7090	SN	MEANS, C.

2

RATE	NAME	
DPC	ABELL, B.	0131
DPC	ADAMS, T.	0141
DPC	MONROE, C.	0131
PN1	CONNORS, W.	0440
SN	MEANS, C.	7090
TD3	KING, J.	0131
TDAN	FOX, A.V.	0440

3

NAME		
ABELL, B.	DPC	0131
ADAMS, T.	DPC	0141
CONNORS, W.	PN1	0440
FOX, A.V.	TDAN	0440
KING, J.	TD3	0131
MEANS, C.	SH	7090
MONROE	DPC	0131

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Figure 4-3.—Reports sequence before analyzing.

1

NAME		
ABELL, B.	DPC	0131
ADAMS, T.	DPC	0141
CONNORS, W.	PN1	0440
FOX, A.V.	TDAN	0440
KING, J.	TD3	0131
MEANS, C.	SN	7090
MONROE, C.	DPC	0131

2

RATE	NAME	
DPC	ABELL, B.	0131
DPC	ADAMS, T.	0141
DPC	MONROE, C.	0131
PN1	CONNORS, W.	0440
SN	MEANS C.	7090
TD3	KING, J.	0131
TDAN	FOX, A.V.	0440

3

ACTIVITY	RATE	NAME
0131	DPC	ABELL, B.
0131	DPC	MONROE, C.
0131	TD3	KING, J.
0141	DPC	ADAMS, T.
0440	PN1	CONNORS, W.
0440	TDAN	FOX, A.V.
7090	SN	MEANS, C.

49.251X

Figure 4-4.–Reports sequence after analyzing.

for the first report can be accomplished last by keeping the cards in rate code sequence and sorting activity.

Alphabetic Sorting

Since alphabetic characters consist of two punches, sorting of alphabetic fields requires multiple sorts per column. Sorting proceeds from the low order to the high order as in numerical sorting.

The following procedures are used when sorting alphabetic columns:

1. Set the sort selection switch to A-1, and turn on the edit stop switch. Letters A through I sort into pockets 1 through 9 respectively. Eleven zones sort into the 11 pocket, and zero zones sort into the zero pocket. Cards that are blank, or punched with a 12 zone or digit only, sort into the reject pocket. Multiple zone or digit punches reject and stop the sorter. (See figure 4-1.)

2. After sorting the column on A-1 remove the cards from the pockets in order from the 1 through the 9. A sorter rack (foldout 4-1F) is usually provided with a stacking slot for each sorter pocket. If a pocket fills before the sort is completed, the sorter will stop. Remove the cards from that pocket, place in the respective slot in the sorter rack and depress the start key.

The cards in pockets 1 through 9 represent A through I, and do not have to be sorted again on that column. Stack the cards from the 11 and zero pockets separately. Rejects may be left in the reject pocket, or you may check them for valid punching and hold for the next column to be sorted. By getting the A through I cards out in one pass, the file volume has been greatly reduced for the second sort on the same column.

3. Change the sort selection switch to A-2, but do not change the column setting. Do not sort the rejects or A through I cards.

4. Sort the 11 zone cards, which will fall into pockets 1 through 9. These represent J through R, and are stacked behind the A through I cards.

5. Sort the zero zone cards, which will fall into pockets 2 through 9. They represent S through Z, and are stacked behind the J through R cards.

6. Place valid rejects in front of the file and proceed to the next column.

Alpha-Numerical Sorting

Sorting of card columns that may contain either letters or numbers is controlled by setting the sort selection switch to A-N. This setting separates the alphabetic from the numerical cards. The digits 0 through 9 sort into the 0-9 pockets. The 12 zones sort into the 12 pocket, 11 zones into the 11 pocket, and zero zones into the reject pocket. Any digit under a zone punch is ignored. Cards not punched in the column being sorted will sort into the reject pocket.

The digit cards are now in sequence, and the alphabetic cards are separated into three groups. The 12 zones are then sorted on A-1, and the 11 and zero zones on A-2.

You may wonder how zeros sort into the zero pocket one time and into the reject pocket another time. The editing device provides for checking a column to see if there are two punches in it. For example, if only a zero is punched, it is recognized as a numerical zero, and the card sorts into the zero pocket. It any letter S through Z is punched, the numbers 2 through 9 are sensed but not sorted, and the card sorts into the reject pocket.

Block Sorting

Cards are usually sorted by beginning with the low order position of a field and continuing to the high order position. Sorting in this manner means that only one sorter can be used, and all sorting must be completed before the cards can be used for another job. When a large volume of cards must be sorted, it may be advisable to break the cards down into small groups. To do this, set the sort selection switch to N then sort on the high order position of the field. This will result in a maximum of ten blocks of cards (12 if single 11's and 12's are present). Each block can then be sorted individually in the usual manner. See figure 4-5.

Block sorting reduces the overall time required to prepare a report by permitting the processing of completed blocks through other machines while the remaining blocks are being sorted. Block sorting also permits the use of more than one sorter to get the job done (fig. 4-6).

In operations involving more than one field, block sorting is accomplished by first sorting the high order position of the major fields. Each major block of cards can then be treated as a separate group and sorted individually.

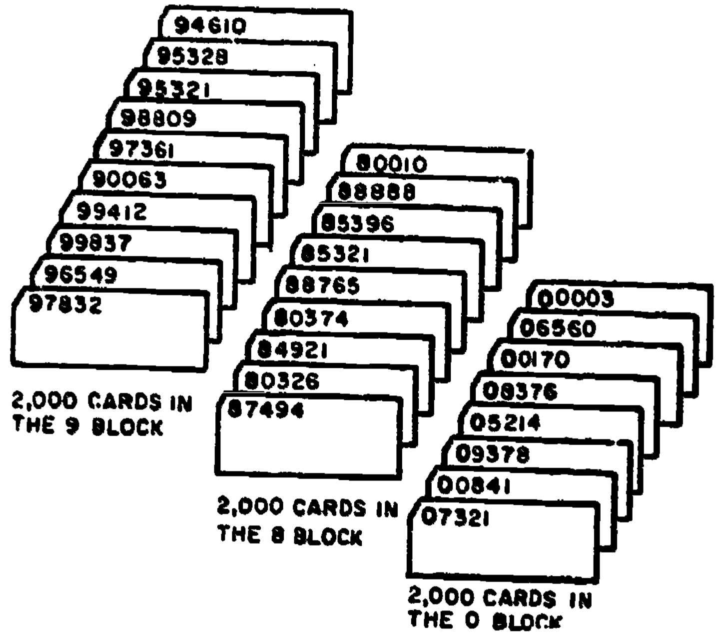

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Figure 4-5.—Block sorting.

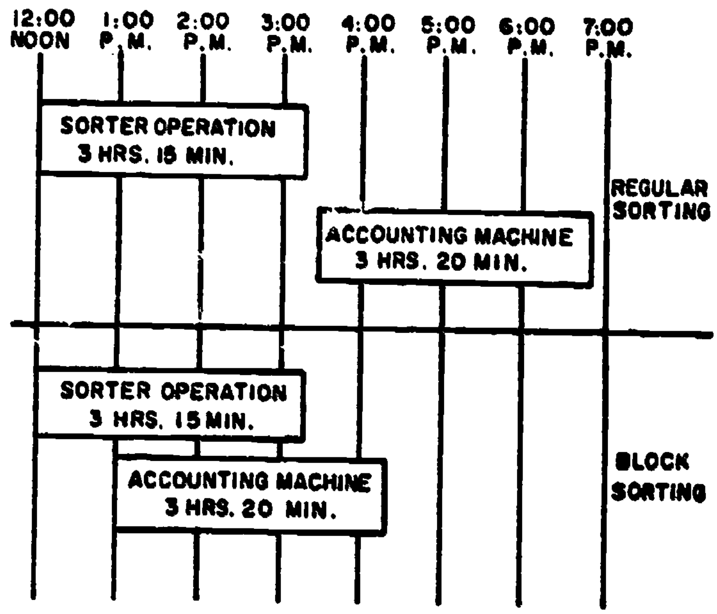

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Figure 4-6.—Reducing the overall elapsed time through the earlier use of other equipment.

Selective Sorting

In some instances it may be desirable to select cards containing specific digits without disturbing the sequence of the selected cards. In this case, the suppression keys representing digits to be selected are depressed. This causes selected cards to sort into the reject pocket and unselected cards to sort into their respective pockets. This method can be used only when all cards are punched in the column being selected. If any cards are unpunched, they will sort into the reject pocket with the selected cards.

Cards punched with certain digits can be selected from a file without disturbing the

original sequences of the remainder. All suppression keys representing digits not to be selected are depressed. This causes unselected cards to sort into the reject pocket and all selected cards to sort into their respective pockets. Examples of this are as follows:

If you wish to select all cards in a file containing the letter A in column 79 (without disturbing the rest of the file), set the sort selection switch to A-1. Set the column indicator on column 79. Depress all of the digit supression keys EXCEPT the 1 and 12. This will cause any 12-zoned character except the A to go to the reject pocket (figure 4-1) along with blanks, 0-zone, 11-zone and special characters. The A's will sort out to pocket 1.

For selection of an 11-zone character let us use the letter M. Set the sort selection switch to A-2. Depress all of the digit suppression keys except the 4, 11, and 12. The 12-zone characters automatically reject on the A-2 setting. The 0 has to be depressed; otherwise, the letter U would also sort out. So now the single letter M goes to pocket 4 and all others to reject.

For selection of a 0-zone character let us use a T. Set the sort selection switch to A-2. Depress all suppression keys except the 3, 0 and 12. This will put the T in pocket 3 and all others to reject.

For a numeric (0-9) selection set the sort selection switch to A-N. Depress all but the digit you wish. Your code will sort to its respective pocket and all others to reject.

For selection of all of a specific zone set the sort selection switch to Z and depress the two suppression keys for the zones you do not want.

OPERATING SUGGESTIONS

The operating efficiency of card sorters depends upon their condition, and the care with which cards are handled. The following operating suggestions are listed to assist you in attaining the best results during a sorting operation.

Handling Cards

Most of the difficulty that occurs in a sorting operation is a result of improper card handling. Edges of the cards are sometimes damaged while they are being joggled or placed in the feed hopper. Damaged cards may cause a jam or missort as they pass through the machine. They may wrinkle or fold at the throat, under the brush, or between the chute blades and rollers.

Edges of cards should be checked to see that they are not bent, nicked, or torn. The feed hopper should be checked to make sure it does not contain any dirt, card dust, pieces of cards, or any foreign matter which might hinder proper card feeding.

Cards should be fanned (by grasping one end of a group of cards, drawing the other end back, and allowing a few cards at a time to "fan" to the normal position), in order to remove static electricity before they are placed in the feed hopper. Static electricity causes cards to stick together, especially in dry weather. Fanning also allows any foreign matter between the cards to fall out. Keep the hopper well supplied with cards to assure continuous machine operation.

Pocket Stops

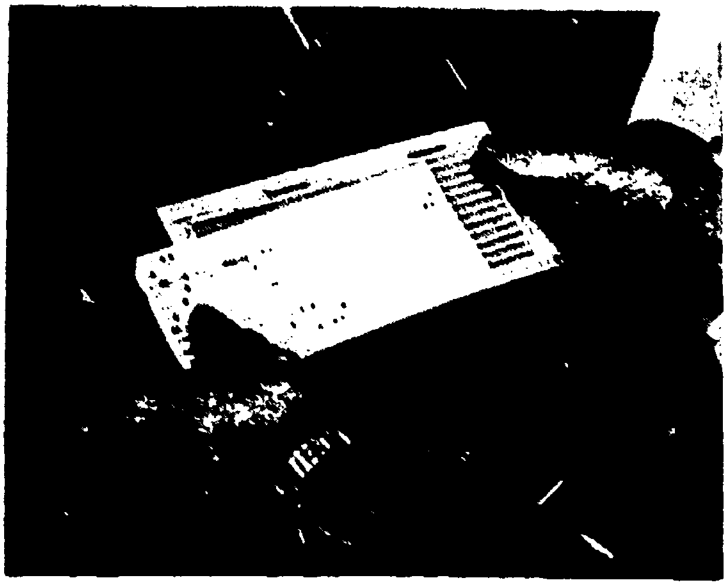
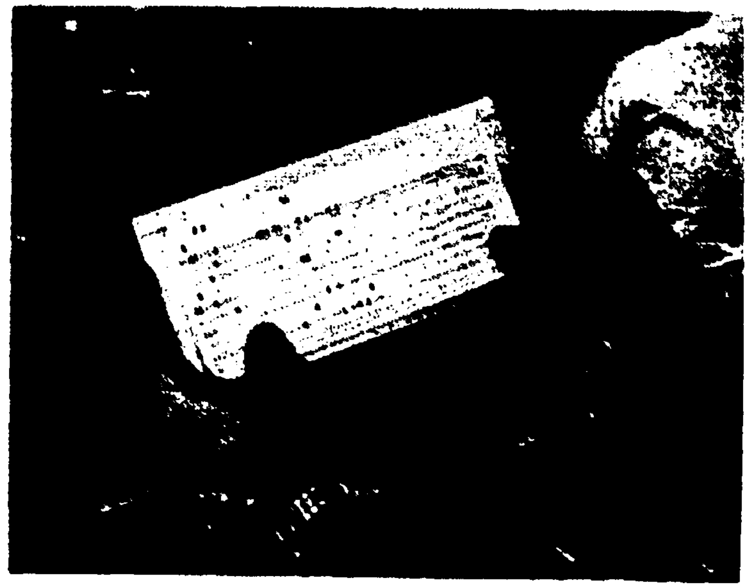
Each of the 13 pockets has a pocket-stop lever. To adjust the capacity of the pockets, adjust the control lever on the rear of the sorter. It can be set for approximately 400, 565, 735, or 800 cards per pocket. Foldout 4-1G shows the pocket-stop control lever as seen from the front of the machine. From this position, you may move the lever until it clicks into one of the four positions.

Checking and Stacking Cards

Off-punched or damaged cards may result in missorting. If cards appear to be off-punched, check several of them with a card gage. Figure 4-7 shows a card gage. It may be necessary to duplicate off-punched or damaged cards in order to assure proper card feeding and sorting.

Sight Checking

After removing cards from each pocket, check the accuracy of the sorting. Joggle the cards so that they are in perfect alignment. Hold them in front of a source of light and look through the hole corresponding to the pocket from which they were removed. If the cards have been sorted properly, you can see light through the hole. If you cannot see light, remove the

49.237
Figure 4-7.—Using a card gage.

missorted cards and file them in their correct sequence.

Sort Needle

Missorted cards can be quickly detected by using a sorting needle (fig. 4-8). Simply place the needle in the hole you are checking and push it gently through the cards. The needle will stop when it reaches the missorted card. Remove the missorted card and continue pushing the needle until it has passed completely through all the cards.

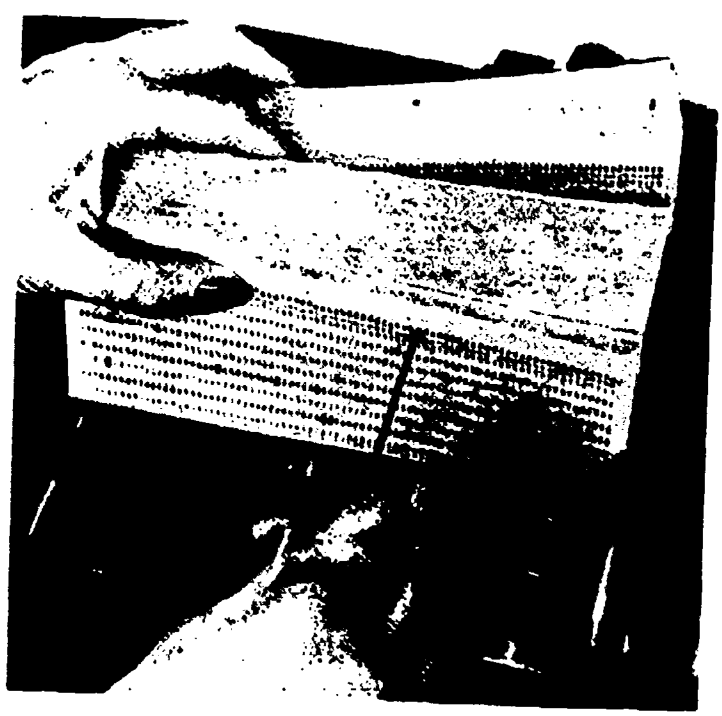
The sorting needle can also be used for manually sorting a large volume of cards when the punching in any given column to be sorted will almost always be the same. For example, if you are sorting an amount field and the high order position of all but a few cards contains a zero, this position can be needle sorted by passing the needle through the zero punching position and manually selecting all cards punched with other than zero.

After checking the sorting accuracy of each group of cards, place them face down in sorter racks. These racks are usually attached to the back of the sorter. If the volume of cards being sorted is small, the top of the sorter may be used for temporary stacking of cards.

Card Jams

Even with proper card handling, jams will sometimes occur. If the sort bursh is not timed properly, the chute blades may tear the leading edge of the card and cause it to jam. If the machine fails to stop when a pocket becomes full, a jam will occur.

In the event of a card jam, depress the stop key immediately, and turn off the main line switch. If the jam has occurred at the throat, remove the cards from the hopper, turn the column selection handle to the raised position,



R49.339X
Figure 4-8.—Using a sorting needle

and remove the brush holder. Care should be exercised in removing the brush to avoid damaging it. The brush should be replaced if it is bent, or if the wire strands are spread. Remove the damaged cards and replace the brush holder.

If the jam has occurred in the chute blades above the stacker pockets, raise the glass cover over the pockets. Remove the damaged cards by a steady pull, being cardful not to damage the chute blades. An interlock switch prevents machine operation when either the glass cover over the pockets is raised or the cover of the brush is raised.

The process of making damaged cards over will be made easier if you make every effort not to tear them any more than necessary when removing them from the sorter. Slightly damaged cards can be reproduced or duplicated, while badly torn cards must be manually re-punched. All damaged cards must be made over to avoid card jams or misfeeding in later machine operations.

Always have a supervisor instruct you the first couple of times.

IBM 84 SORTER

The IBM 84 Sorter (see figure 4-9) has evolved from the IBM 83 to provide an even faster, more accurate and convenient machine

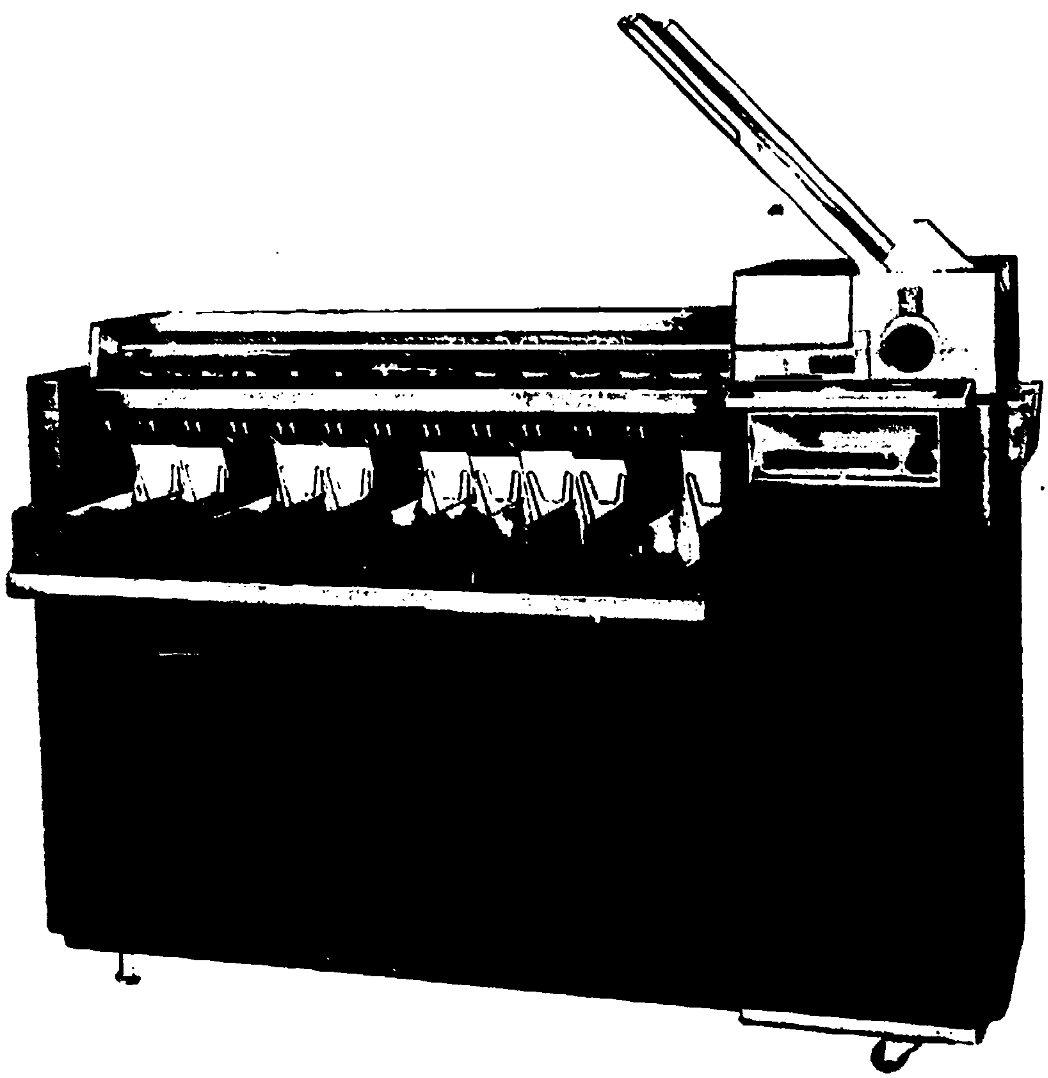


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Figure 4-9.—IBM type 84 sorter.

for sorting. For this reason the 84 is similar to the 83 in many ways. With the exception of the differences mentioned in this section of the manua', the IBM 84 operates the same as the 83, but at the rate of the 2,000 cards per minute, double the rate of the 83.

The IBM 84 is designed for large volumes of cards. Sorting small groups of cards on the 84 is less economical with reference to card handling time, total sorting time and operator attendance at the machine. The 84 has brushless card-sensing, radial stackers, a vacuum-assist feed, and solid-state circuitry, all of which provide an increase in speed, accuracy and convenience of sorting. Solid-state circuitry makes a warm-up period unnecessary.

Brushless Card Feeding

The sensing of holes in a particular column is accomplished by a movable one-watt light bulb shining from beneath the card, through a hole in the card, and onto a light sensitive diode (fig. 4-10). Turning the column-selector knob moves the bulb and diode assembly from column to

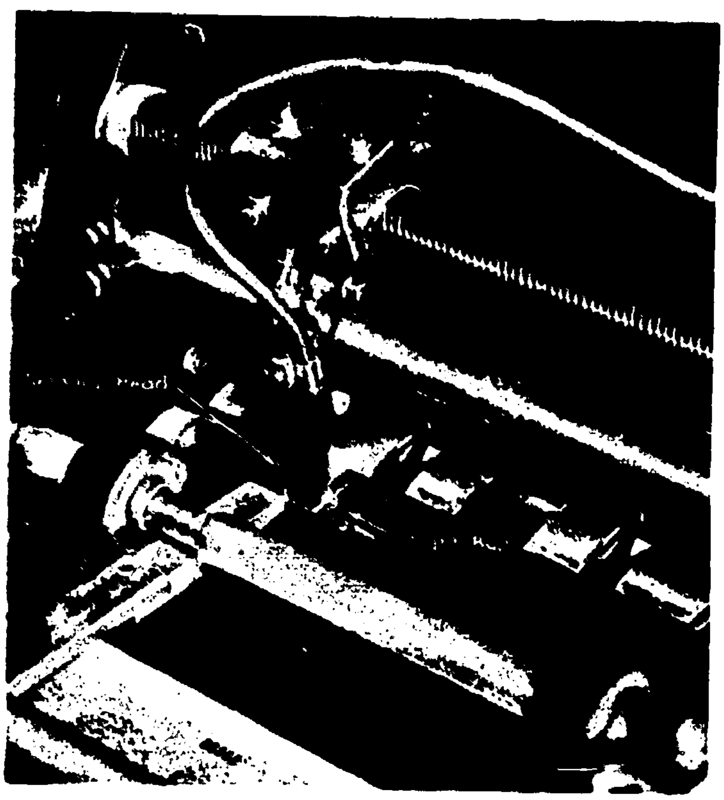

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Figure 4-10.—Sensing mechanism, type 84.

column. The column indicator is directly above the column selector knob (fig. 4-11). The light source should be cleaned daily with a dust cloth to minimize rejects. More frequent cleaning may be required if the sorter is running for extended periods. Any adjustments to the sensing mechanism should be made by a machine serviceman. If a jam occurs which requires removal of the sensing mechanism, call a machine serviceman. Do not attempt removal of the mechanism yourself.

Radial Stackers

Cards are sorted into 13 radial stackers, as illustrated in figure 4-12, each with a capacity of approximately 1650 cards. Instead of cards being stacked face down, as in other types of sorters, they are stacked on the column 80 end, with the face of the cards toward the front of the machine. Card retaining levers prevent the cards from falling backward into the stacker. As the stacker fills, the card deck is pushed forward until it activates the stacker-stop switch which stops the machine and turns on the full-pocket light. Cards may be easily removed from the stackers without stopping the machine.

Full Stacker Light

The full stacker light (fig. 4-11) signals that a stacker is approaching its maximum holding capacity of approximately 1,650 cards. When this capacity is reached, card feeding is automatically stopped.

Vacuum Light

The type 84 sorter is equipped with a vacuum-assist feed. When the vacuum level has fallen to low to assure proper card feeding, the vacuum light (fig. 4-11) comes on and card feeding stops. When this happens, the condition should be corrected only by a machine serviceman.

File Feed

A file feed with a capacity of 3,600 cards is provided as standard equipment. The file feed automatically joggles the cards as they are fed into the hopper, thus reducing the amount of

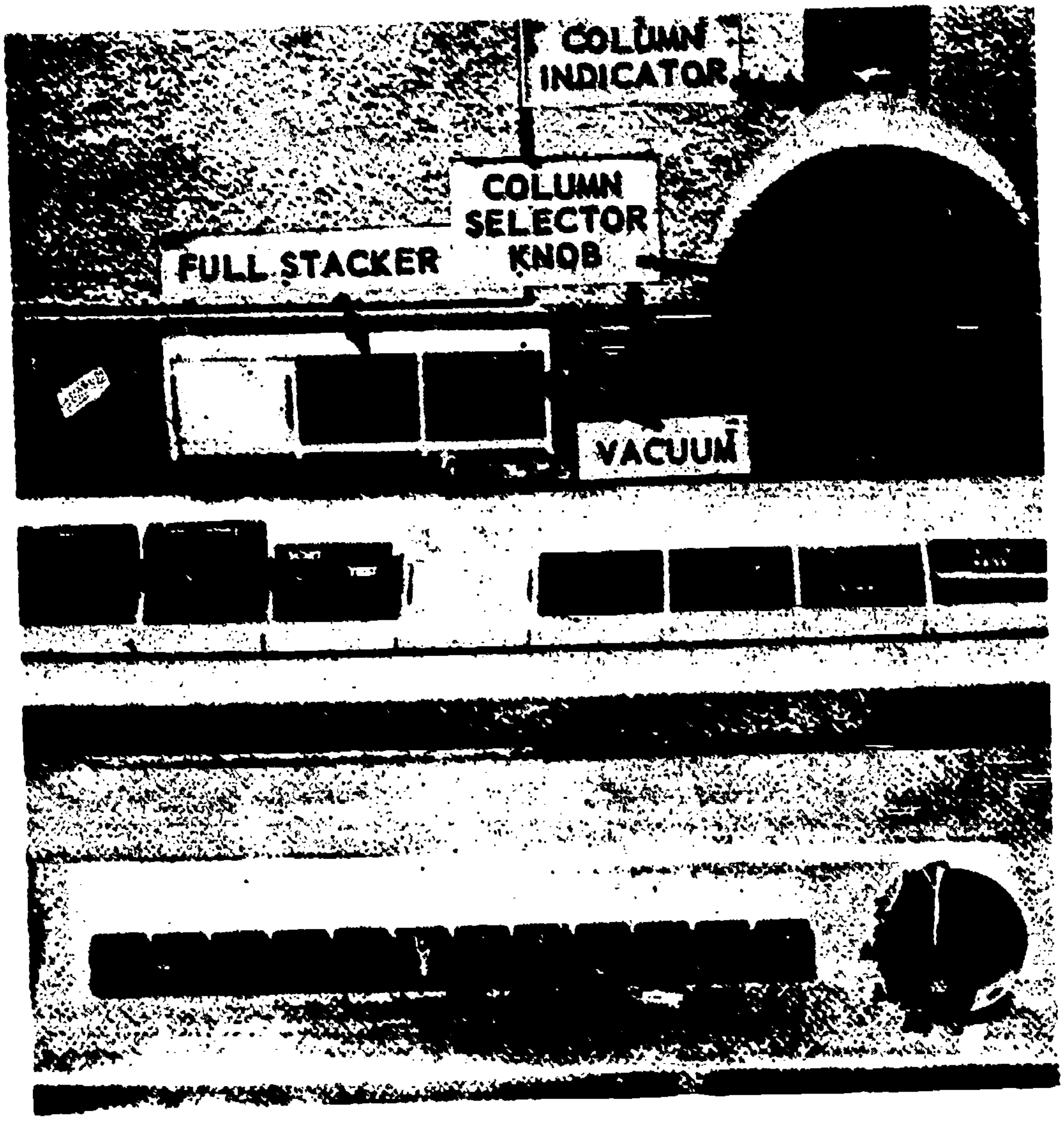

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Figure 4-11.—Machine controls, type 84.

manual joggling to a minimum. Cards are fed by the high-speed vacuum-assisted feed mechanism surely and accurately without a card weight.

OPERATING SUGGESTIONS

The photoelectric sensing mechanism may read staple holes and heavy erasures. Oil spots on cards should be avoided also, since they make the card translucent and cause the machine to read the spots.

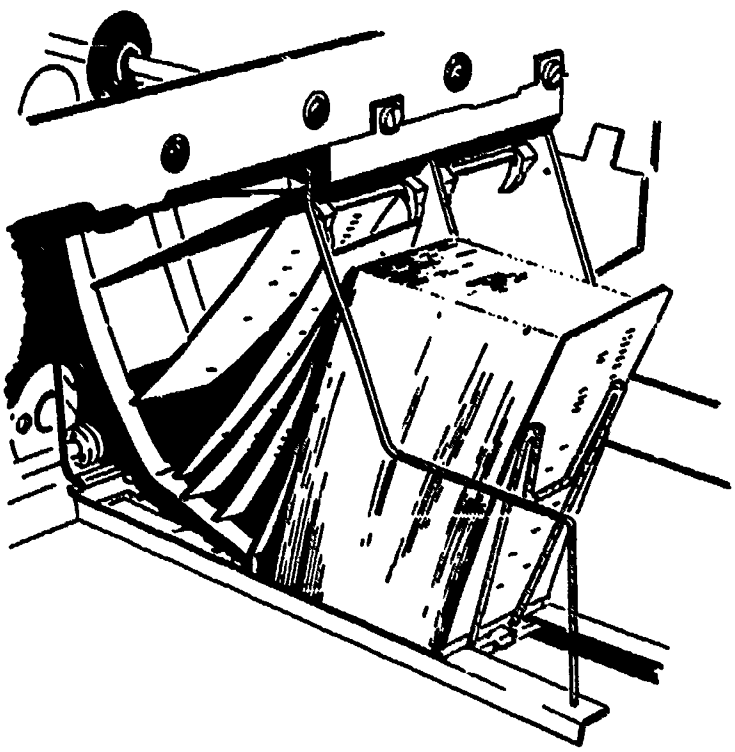
The main-line switch should be turned off when the sorter is not in use, to conserve the light source and vacuum pump. The 84 can be used immediately after the main-line switch is turned on.

SPECIAL FEATURES

There are several special features which may be added to card sorters to extend the application possibilities of the machines. While you are not expected to be an expert on all these features, there are certain ones with which you should be familiar.

AUXILIARY CARD COUNTER

An electrically operated card counter can be mounted to the left of the feed hopper to count the number of cards that pass the sort brush or sensing mechanism. The sorting speed and the method of operation are not affected when the



49.386
Figure 4-12.–Side view of radial stacker.

card counter is used. The maximum capacity of the counter is 999,999 for types 83 and 84.

While the card counter is normally used for counting the total number of cards that pass through the machine, it may also be used to count by pockets. On the first sort, a total of all cards is accumulated. On the second sort, each pocket is sorted and counted separately. The sum of the pockets is then crossfooted to the overall total to assure that card counting has been performed correctly.

SORT SUPPRESSION

If cards with different punches are to be selected from a file, it is customary for the selected cards to sort into their respective pockets while all other cards are rejected, or vice versa, depending upon the method of selection employed. For example, if the type 83 sorter is used to select all cards punched with a 1, 3, or 5, and the digit suppression keys for all other digits are depressed, any cards punched with a 1, 3, or 5 will sort into their respective pockets while all other cards sort into the reject pocket.

With the sort suppression device installed, the selected and unselected cards are placed in two groups without distrubing the sequence of either. In the example stated above, the selected cards punched with a 1, 3, or 5 will sort into the 12 pocket, and all other cards sort into the reject pocket.

Cards may be edited on the types 83 and 84 sorters during a selection operation without disturbing their sequence. With the sort selection switch set to N and the edit stop switch and sort suppression switch ON, cards are separated and errors fall into the reject pocket in sequence with other rejected cards. The edit stop switch will stop the machine when an error card falls into the reject pocket.

Still another use for the sort suppression device on the types 83 and 84 sorters is checking a single column for blanks or double punches without disturbing the sequence of the cards. Set the sort selection switch to N, and turn the edit switch and sort suppression switch ON. Cards punched with only one digit will sort into the 12 pocket, while double punched cards or cards not punched will sort into the reject pocket. Setting the edit stop switch to the OFF position allows continuous card feeding without causing the machine to stop each time an error is detected.

ALPHABETIC SORTING FEATURE

An alphabetic sorting feature can be installed on the types 83 and 84 sorters to speed the operation of alphabetic sorting. When this device is installed, the sorting patterns normally established when the sort selection switch is set to A-1, A-2, and A-N are changed permanently. The sorting pattern established by this device is shown in figure 4-13. This pattern is based on the frequency that certain letters appear in proper names.

ALPHABETIC SORTING.–To sort a column alphabetically, all cards are fed through the sorter once and a part of the cards a second time. On the first sort, 10 letters, including all vowels, are sorted and may remain in their respective pockets while the balance of cards are sorted a second time.

On the first sort, set the sort selection switch to A-1. This causes all cards punched A, C, E, G, I, L, O, R, U, and X to sort into pockets zero through 9 respectively. Cards punched with B,

SORT SELECTION SWITCH SETTING	POCKETS												REJECTS REGARDLESS OF EDIT	ERRORS (When edit or edit-stop is on)
	9	8	7	6	5	4	3	2	1	0	11	12		
Alpha-1	X	U	R	O	L	I	G	E	C	A	KN QT WZ	BD FH JM PS VY	Cards punched with digits only, zones only, 0-1 combination, or blank	Any card with more than one zone punch or more than one digit punch
Alpha-2	Z Y X	W V U	T S R	Q P O	N M L	K J I	H G	F E	D C	B A			Same as A-1	Same as A-1
A-N	9	8	7	6	5	4	3	2	1	0	KN QT WZ 11	BD FH JM PS VY 12	Blanks. A,C,E,G,I, L,O,R,U,X and the combination 0-1.	Same as A-1

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Figure 4-13.—Sorting pattern for alphabetic sorting device.

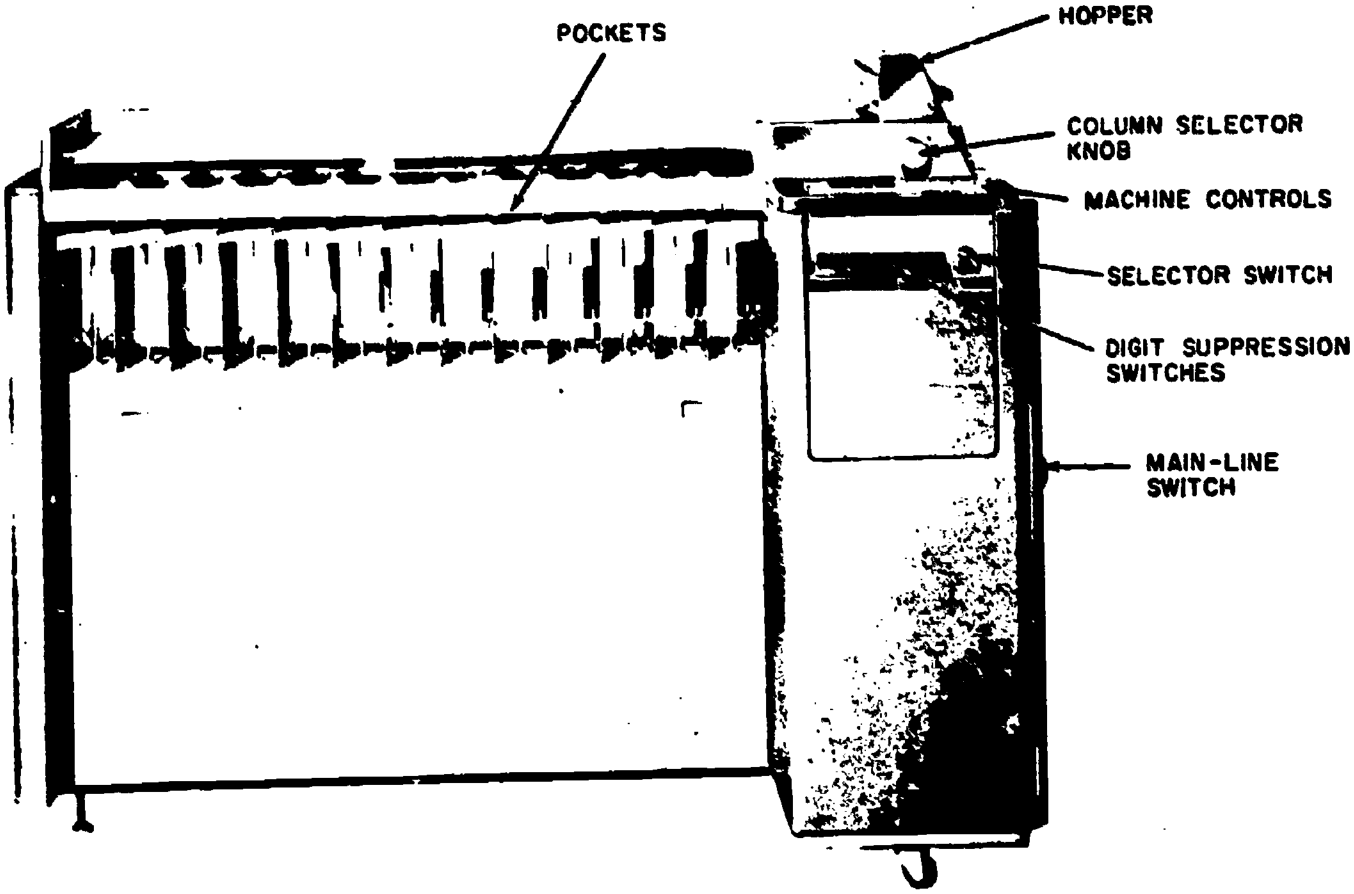
D, F, H, J, M, P, S, V, and Y sort into pocket 12, while those punched with K, N, Q, T, W, and Z sort into pocket 11. Blanks, and cards not punched with an alphabetic letter, sort into the reject pocket.

On the second sort, change the sort selection switch to A-2, but leave the sorted cards in pockets zero through 9. Place the cards from pocket 12 in the hopper, followed by those from pocket 11. Upon completion of the second sort, all cards in pockets zero through 9 will be in sequence from A through Z. Remove them in ascending sequence from pockets zero through 9.

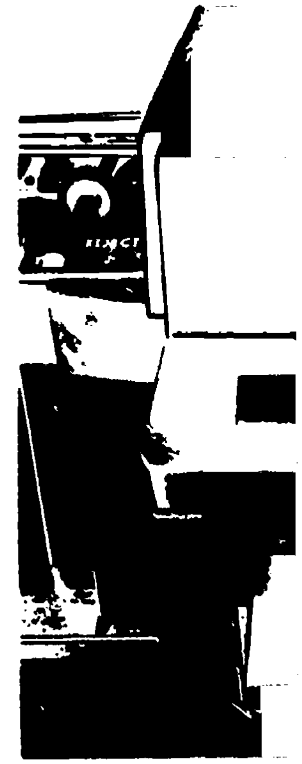
ALPHA-NUMERICAL SORTING.–Cards which may contain either letters or numbers can be sorted by first setting the sort selection switch to A-N. The digits 0-9 sort into pockets 0-9 respectively, and all other cards sort into pockets 11, 12, and the reject pocket.

After the digit cards have been removed from pockets 0 through 9, the reaminder can be sorted alphabetically in the following manner. Set the sort selection switch to A-1 and sort the cards from the reject pocket.

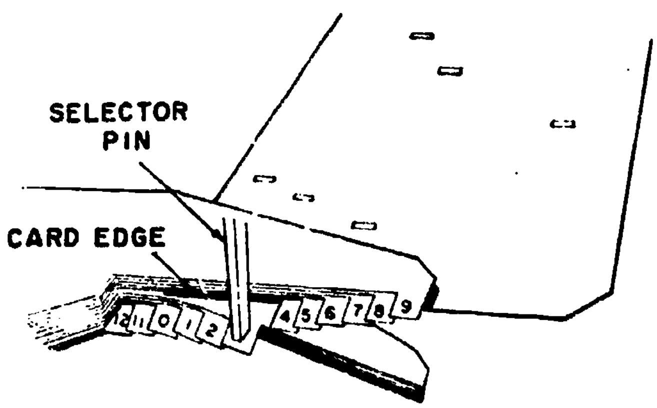
Without removing these cards, set the sort selection switch to A-2 and place the cards from pocket 12 to the hopper, followed by those from pocket 11. Upon completion of this sort, all cards in pockets 0 through 9 will be in sequence from A through Z.



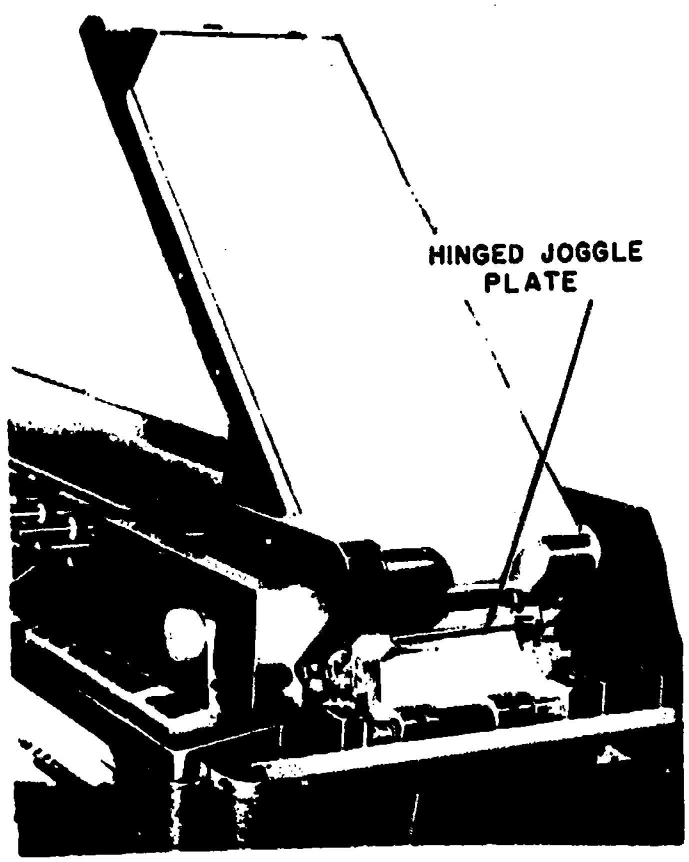
A. BASIC 83 SORTER



B



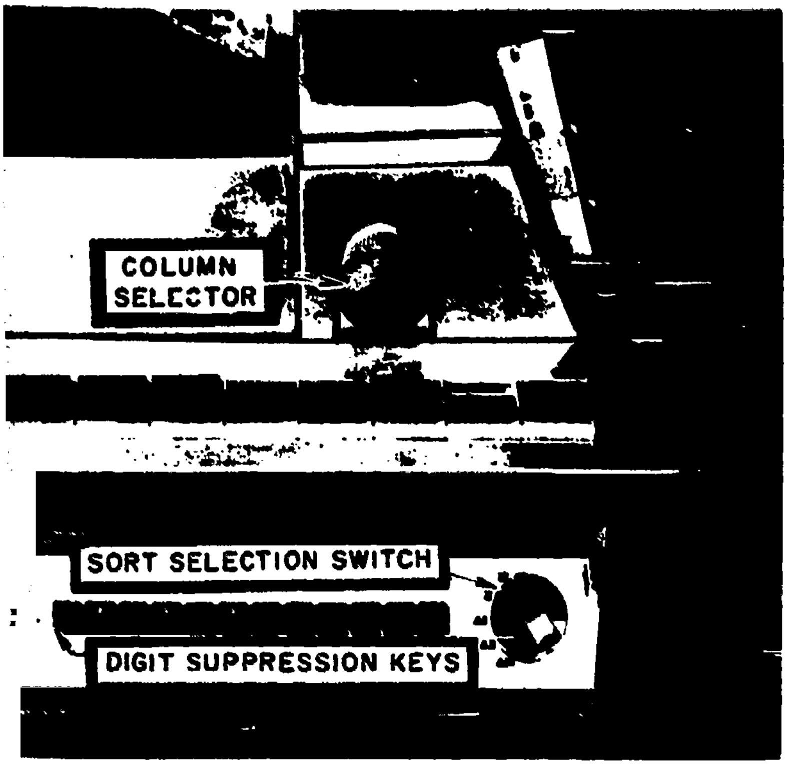
D. CHUTE BLADES, TYPE 83



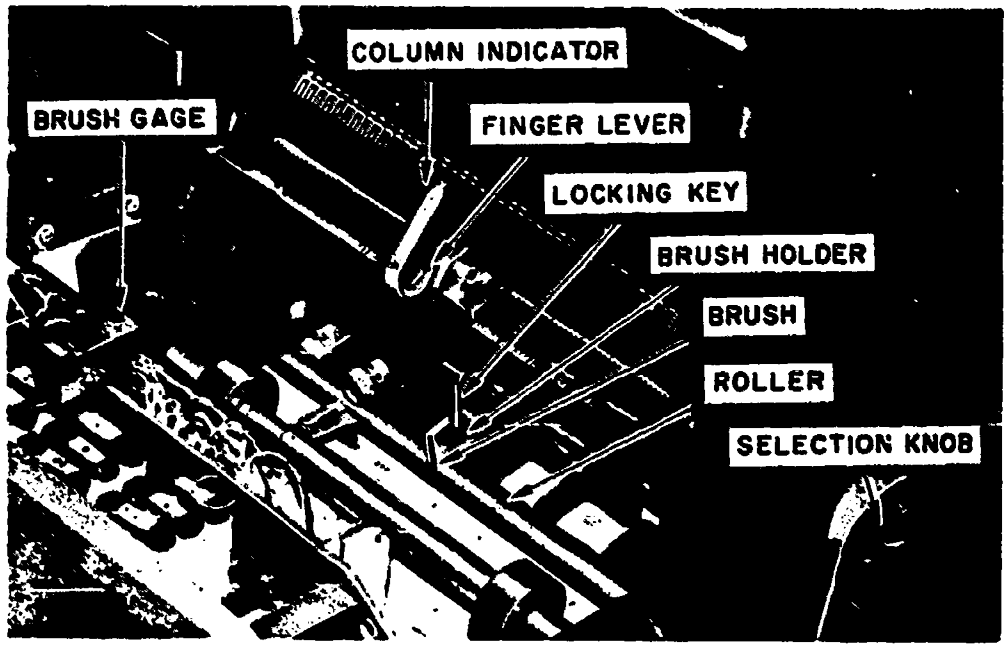
E. AUTOMATIC CARD JOGGLER

Foldout 4-1.—IBM type 83 sorter.

A



B. MACHINE CONTROL (83)



C. SORT-BRUSH ASSEMBLY (83)

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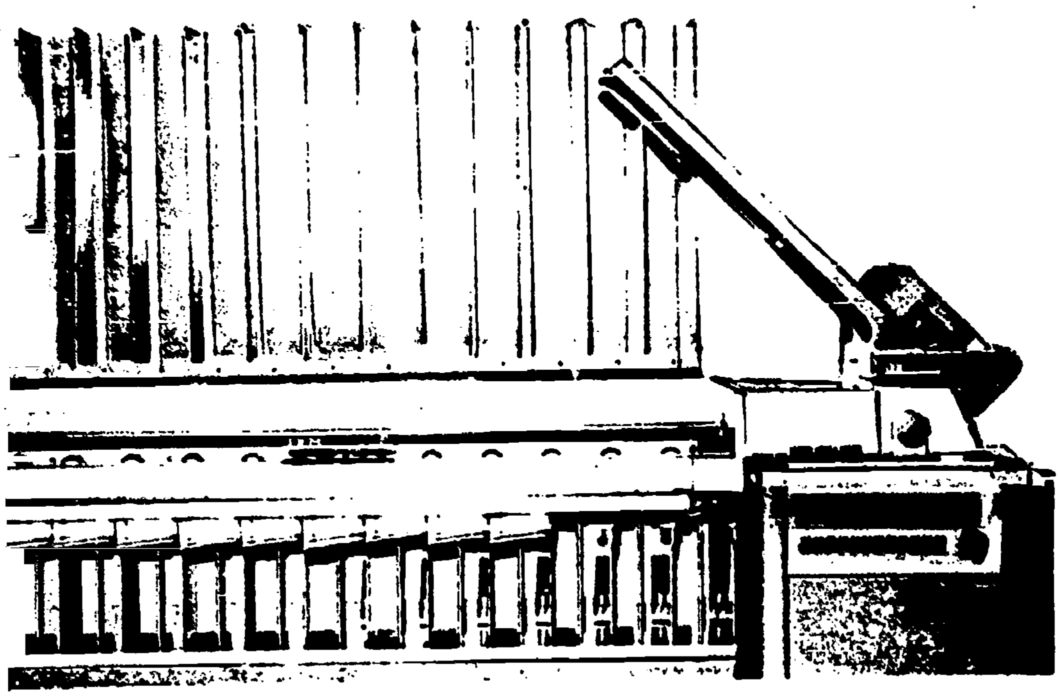
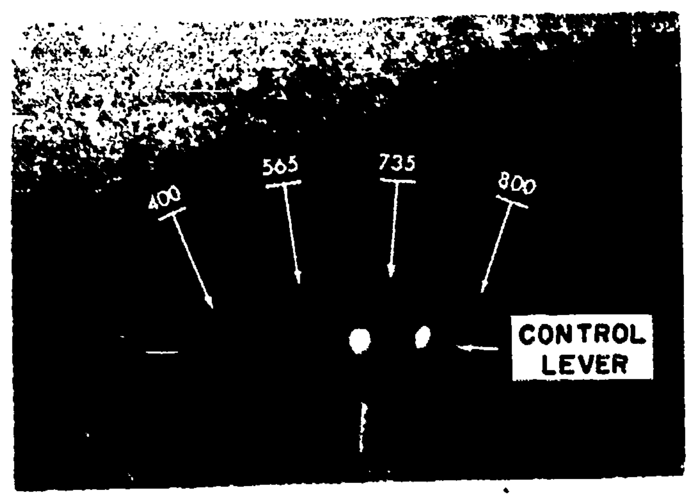


F. IBM 83 SORTER WITH FILE FEED AND SORTER RACK



G. CONTROL LEVER FOR ADJUSTING POCKET STOP (83)

CHAPTER 5

FUNCTIONAL WIRING PRINCIPLES

Before you are introduced to individual unit record machines for specific wiring and operations, you should know about some operational and wiring principles that are common to them all. Each unit record machine requiring control panel wiring has certain stations, control panel areas and machine functions that provide exactly the same thing. These similarities may not be labeled exactly the same on all machines and some of the components may be switched around, but they operate or are wired almost identically.

This chapter introduces you to these similarities to aid your understanding the specific unit record machines described later and to reduce the otherwise detailed repetition in the chapter for the individual machine.

It is extremely important that you understand these functional wiring principles. The knowledge that you will gain from studying this chapter will help you in thoroughly understanding the wiring and operations of the unit record machines in the following chapters.

It is not important that you try to understand specific machines or their operations in this chapter even though specific machine control panel diagrams may be used as examples. Direct your attention to the PRINCIPLES being explained rather than the machines referenced.

CARD READING

In order for unit record equipment to work for you, it must be able to read and manipulate your data. The reading is accomplished by detection of the punched holes in cards by electrically timed impulses. The manipulation of data is accomplished by your further directing these impulses and utilizing other machine impulses for control purposes through control panel wiring.

It is, therefore, important that you understand, first of all, the methods used for reading the data.

READING STATIONS

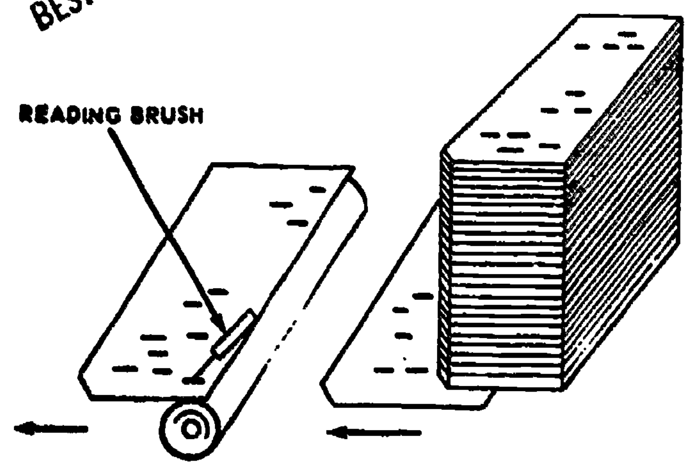
Each machine has one or more reading stations consisting of a reading brush or brushes and a source of electrical impulses (usually a contact roller). A station consisting of a single brush and contact roller is the easiest to explain and understand. So, let's start the discussion of card reading with the sorter, for in this machine only one column of the card is read at a time, by one brush.

As the card passes through the machine, it passes over an electric-contact roller. While the card is passing over the contact roller (figure 5-1), it passes under a brush. The brush is positioned by the operator to read one of the 80 vertical columns in the card. The illustration shows the contact roller, the card, and the brush.

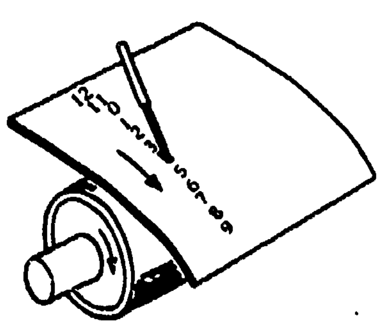
As the card passes through the machine, bottom (9-edge) first, the brush is kept from touching the contact roller by the card, which acts as an insulator. However, when a punched hole reaches the brush (a 4-hole in the illustration), the brush drops into the hole and touches the contact roller.

This completes an electric circuit, just as you do when you switch on your electric lights at home. When the brush makes contact with the roller, electric current flows from the roller to the brush. This flow of current, or impulse, continues until the contact between the brush and the roller is broken by an unpunched portion of the card moving between the brush and the roller.

The timing of the brush impulse, or flow of current, is the means by which the machines



1. CARDS BEING READ AS THEY PASS BETWEEN A BRUSH AND AN ELECTRIC CONTACT ROLLER.



2. ELECTRICAL CONTACT IS MADE ONLY WHERE PUNCHED HOLES ARE LOCATED.

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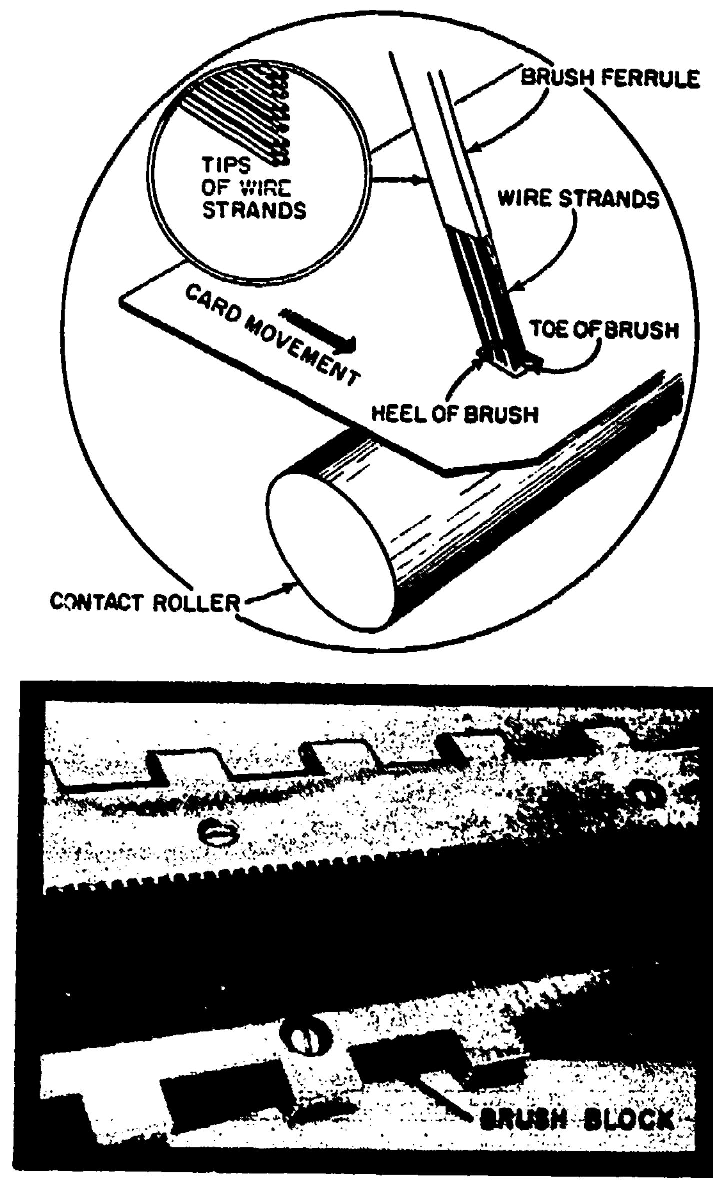
Figure 5-1.—Single brush read station.

recognize whether the punch is a 9, 8, 7, 6, 5, 4, 3, 2, 1, 0, 11, or 12. If the impulse is available just after the 9-edge of the card has passed between the contact roller and the brush, the machine recognizes that a hole is punched in the 9-position of the card. If the impulse is available a little later, the machine recognizes that a hole is punched in the 8-position of the card. This is true of all positions that can be punched. In fact, the machines recognize which digit has been punched by the amount of time that elapses from the moment the leading edge of the card passes under the brush to the moment when the brush drops into a punched hole and the impulse becomes available.

Multiple-Column Reading

In discussing the sorter, we have considered one brush, set to read one column at a time. In most machines, however, we have a set of 80 brushes; each brush reads one of the 80 card columns. Therefore, the entire card is read as it passes between the set of 80 brushes and the contact roller (figure 5-2).

This does not mean that all of the possible 960 punching positions are read at one time. Remember that the card travels forward row by row. When we say all 80 columns are read, we really mean that there is a reading brush positioned for each column and that the 9 row is being read for all 80 columns at once, then the 8 row, etc., until the entire card has passed the read station.



49.229

Figure 5-2.—An 80 column brush assembly.

Multiple Read Stations

Some machines not only perform multiple-column reading but do so with two or more reading stations. This allows for the reading of two or more cards at the same time. A multiple read station machine that performs reading in a somewhat different manner is the accounting machine.

IBM 407, 408, and 409 Accounting Machines are equipped with two reading stations. Each reading station has 960 stationary reading brushes, and 960 metal segments instead of a contact roller. All possible punches in all card columns can be read (12 positions multiplied by 80 card columns). Each reading station also contains 80 commutators that rotate from the 9-position to the 12-position (figure 5-3).

If a hole is punched in a card, a contact is made between the reading brush for that specific column and row, and the metal segment for that specific column and row. Each column has one commutator. When the commutator has rotated to the specific position fo the punched hole, an electric circuit is completed through the brush. An impulse is available in the control panel at the corresponding position in FIRST READING or SECOND READING hubs.

In the 407, 408, and 409, the card can be held at either the first or second reading station and read several times.

Card Movement

The explanations that have been given so far for reading have dealt with cards moving 9-edge first. Different machines require different card insertion. Some machines require the LEADING EDGE (first to enter the machine) to be the 12 row rather than the 9. Some machines require the cards be face up, while others (the majority) require face down placement.

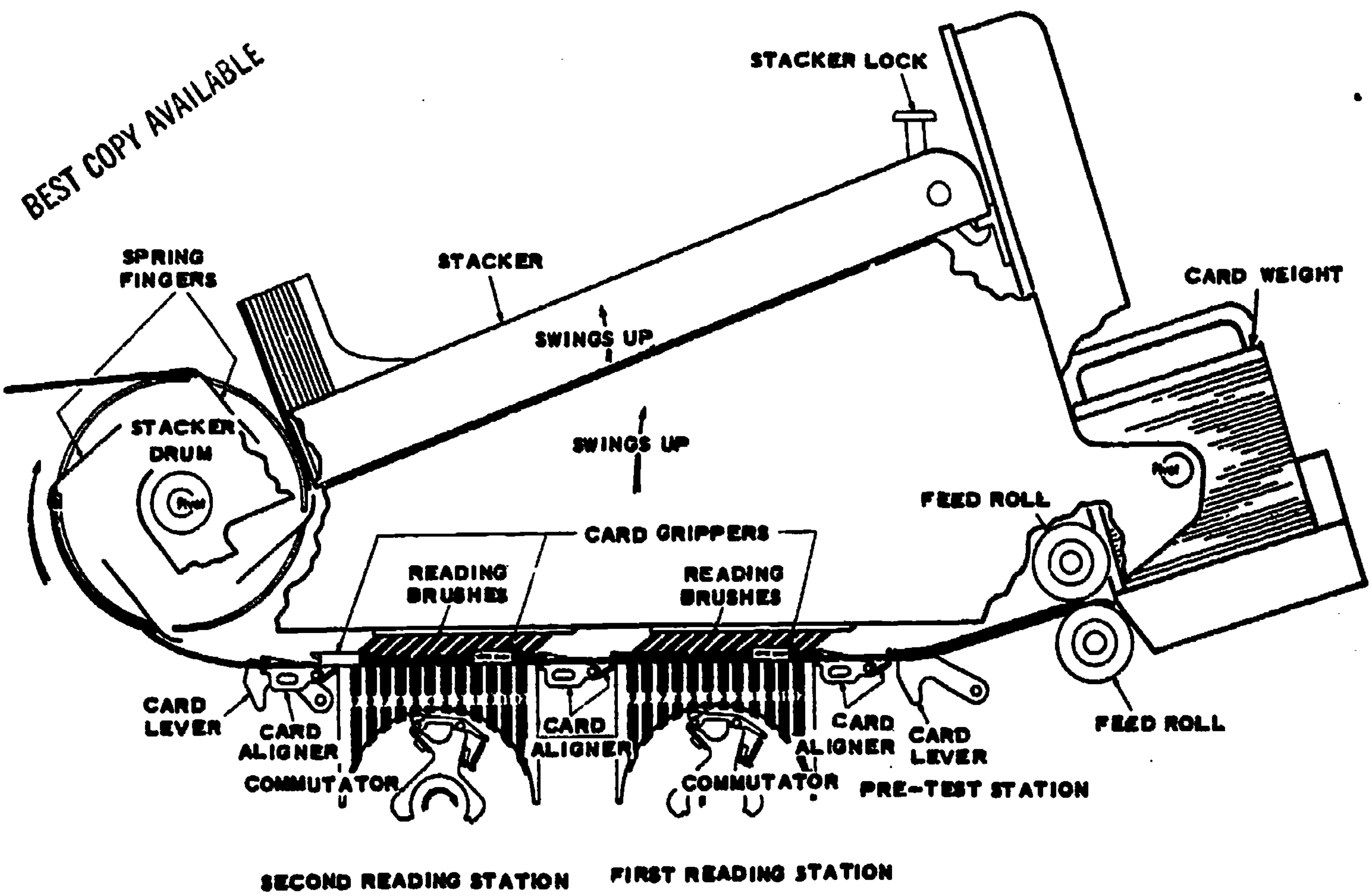


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Figure 5-3.—Accounting machine feed schematic.

The important factor for correct reading is the required leading edge. Face up or face down requirements are, for the most part, to ensure proper sequence during card handling.

The leading edge requirement is based on the internal digit timing. In other words, is the machine designed so that the first digit encountered will be recognized as a 9, or a 12? Timing charts for individual machines will tell you this. More information on timing charts will be presented throughout this chapter and following chapters on the individual equipment.

CONTROL PANELS

At the time the card is being read, the impulses are delivered to and made available at EXITS on the control panel.

You will then, by external plug-in wires, direct the impulse to an ENTRY point on the control panel for some type of performance (printing, punching, etc.).

Basically, the control panel is similar, in principle, to a telephone switchboard. An incoming call on a switchboard lights a signal light that tells the operator which line the incoming call is on. After she answers the call, she plugs the cord into a hub on the board that is internally connected to the desired extension. Actually, the operator has completed an electric circuit to give the correct result.

A control panel does exactly the same thing; it completes electric circuits through wires you insert. The internal circuits (figure 5-4) to be controlled by external wiring are connected to rows of metal prongs (contacts) that are the ends of these internal circuits.

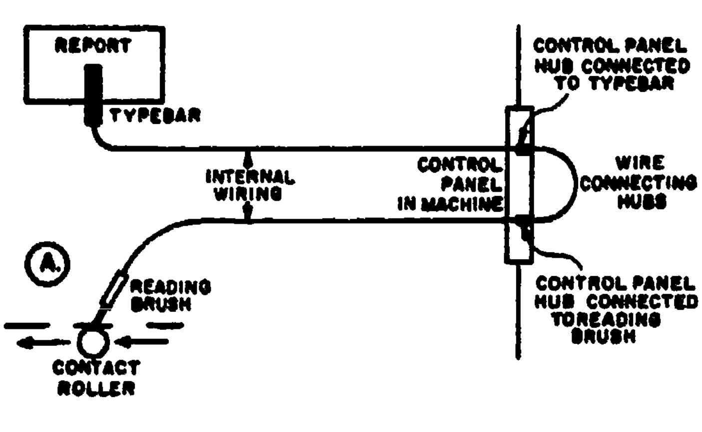

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Figure 5-4.—Internal and external wiring to cause printing.

When the control panel is fitted into place, a jack on the control panel touches each one of the machine's metal contacts. In this way the external wiring (control-panel wiring) completes the desired circuits (figure 5-5).

Types of Control Panels

There are two general types of control panels. Control-panel wires with special tips are used with each of the two types of panels.

One type of panel has metal prongs, or contacts, that press against the stationary internal contacts. The external wires (figure 5-5A) plug into these metal prongs to complete the internal circuits.

The second type of panel consists only of hubs into which the external wires are inserted. The wires themselves have longer and larger tips (figure 5-5B) that pass through the control panel and press directly against the stationary prongs. These wires are known as self-contacting control-panel wires. Each of the two general types of wires is available, color-coded in various lengths.

Control Panel Hubs

HUBS are those visible, labeled holes in a control panel that allow wires to be inserted. The hubs which represent circuits that accept electric impulses are called ENTRIES; those which represent circuits that emit impulses are called EXITS. This method of labeling may be seen on the left side of figure 5-6.

COMMON HUBS.—Control-panel hubs may be single, or two or more may be internally connected to each other. If they are internally connected, they are called COMMON. Common hubs are identified on the face of the control panel by lines connecting them (fig. 5-6).

If these hubs are exit hubs, the exit impulse is available out of all the hubs connected by a line. If these common hubs are entry hubs, an impulse wired externally into any one of the connected hubs is directed into the machine and is available out of the other hubs common to it.

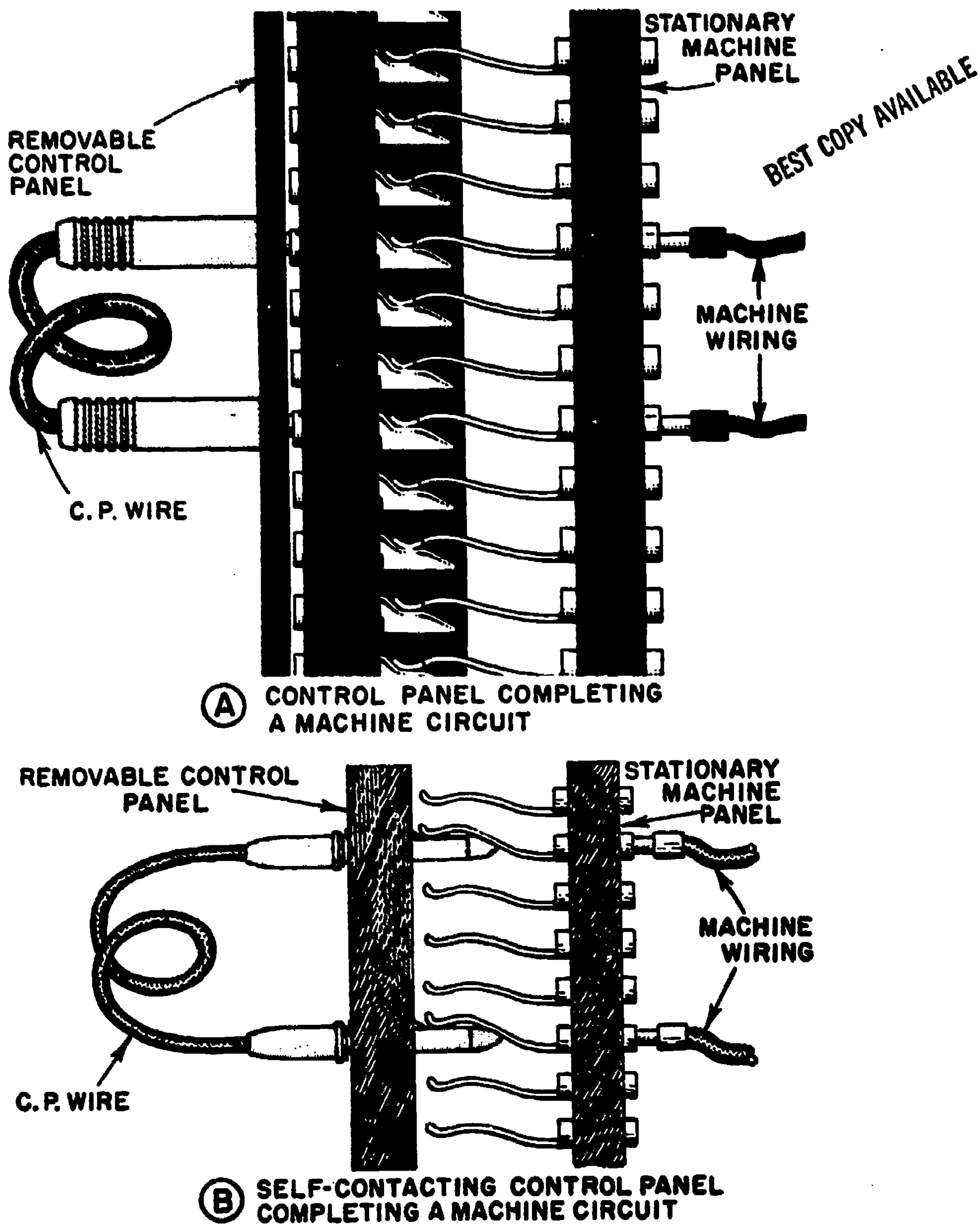

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Figure 5-5.—Types of control panels.

BUS HUBS.—Bus hubs (figure 5-6) are several hubs internally connected to each other; they are neither exit nor entry hubs, for, although they are connected to each other, they are not connected to an internal machine circuit. If an impulse is wired from an exit hub on the control

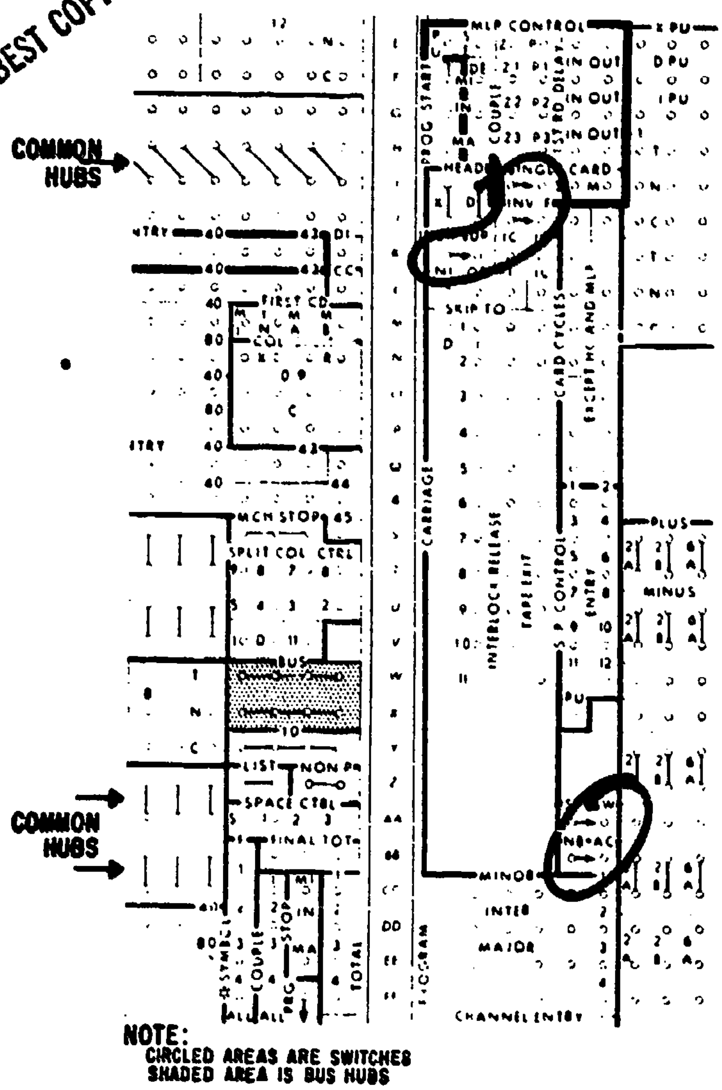

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Figure 5-6.—Control panel hubs.

panel to a bus hub, this same impulse is available out of all the other hubs of that connected group.

SWITCHES.–Switches (figure 5-6) are simply sets of hubs to be wired together to allow or disallow certain functions during machine operations. Switches may contain two or three hubs. Generally, if there are only two and they are NOT wired, the function does not happen. In some cases there is a center hub exiting an impulse that must be directed to the corresponding ON or OFF hub.

Hub Labeling

All hubs have descriptive labeling to help the wirer. The labels refer to the machine station that the impulses are coming from or going to, the function they are associated with or the impulse they will send or receive.

CONTROL-PANEL DIAGRAMS

Paper diagrams (drawings) of the hub layouts on each type of control panel are available. These are used to keep a permanent record of a control-panel setup. To make the diagram as legible as possible, there are a few simple rules to follow when drawing a diagram (fig. 5-7).

1. Use different colored pencils to diagram wiring that makes the machine perform different functions. For instance, wiring for printing might be a different color than wiring for addition.
2. Pencil-in the hubs of a FIELD and connect these hubs with a horizontal line.
3. Connect the exit and entry fields by one line. Actually, this line may represent any number of individual wires in the control panel. However, in order to make the diagram easy to read, we use this abbreviation, understanding that, although only one line is shown on the

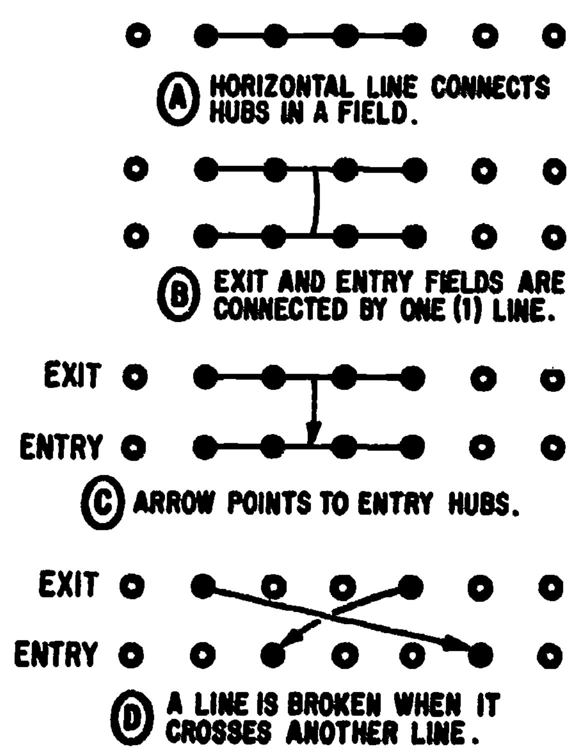

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Figure 5-7.—Diagramming techniques.

diagram, a four-position field requires four wires in the actual control panel.

4. Indicate exit and entry hubs by drawing an arrow pointing to the entry hubs.

5. When it is necessary to cross lines on a diagram, break one line. This prevents the possibility of following the wrong line to the entry hubs.

TIMING CHARTS

Before proceeding to the function and wiring of specific hubs, you need to know about the use of timing charts. The use, at this point, will be limited to hub location, hub use (exit or entry) and notation of cycles.

Timing is an important concept to understand. For example, as a result of timing, an 8-hole read causes an "8" to be printed, or causes an 8-hole to be punched. You hear people speaking of impluses being available and things happening in a machine at 9-time, 8-time, etc. All they mean is that the impulse is available, or things are happening, at the time the card is in position for a 9, 8, etc., to be read. When the term 9-time is used, it really means at 9-time in the cycle.

HUB LOCATION

If a hub name is known but cannot be easily found on a congested panel, refer to a timing chart (figure 5-8).

Down the left side of the chart is the hub name. Following the name is a code for its location on the respective machine's control panel. The alphabetic characters refer to the horizontal (row) line on the panel. Most rows on panels are lettered from the top down starting with the letter A. This will continue through Z and then start over with double letters (AA, BB, etc.).

The number following the letter refers to the vertical position. Numbering the columns of hubs usually starts at the left and increases by one for each position to the right.

By referring to the location code on the chart, the hub can be easily located. Find the alphabetic letter of the code on the panel and follow it across the panel until the code number is intersected.

If two letters appear (C-H), it means that the set of hubs occupies two or more (inclusive) rows of the panel. Two numbers (21-22) would mean the inclusive vertical locations.

Use Indication

To determine whether a hub is an exit or an entry is simple with a timing chart. The "use" codes are indicated on a timing chart (across the top of figure 5-8) by various shadings. These colors appear in the degree duration section of the chart for the approximate duration of time that the hubs emit or accept impulses.

If the particular hub is other than a complete exit or entry, it will have a note code that may be referenced in the manufacturer's technical manual for that piece of equipment.

You will notice several things about figure 5-8. The degree durations for the hubs named Interpret Read are shaded to indicate that these are exit hubs (as are all read hubs). Also, the first digit impulse available is the 12 timed impulse. This means that the cards are fed 12-edge first.

A hub that is active continuously such as the Asterisk Control (left) is available for what is called a MACHINE CYCLE.

THE CYCLE CONCEPT

The term cycle is one we have not discussed yet, and there are others, such as cycle points, card cycle, print cycle, and degrees. The word cycle itself is a familiar term. A cycle is the period (or time interval) required to complete a round of events or operations that occur in sequence on a regular basis. We have weather cycles, economic cycles, business cycles, and many others. A cycle can, therefore, be thought of as a circle. You can think of second hand on a clock as the pointer, and in one revolution it has completed a cycle.

Machine Cycles

Each IBM machine is made to perform its functions within a given time, called a machine cycle. A machine, when running, operates at so many machine cycles per minute.

Normal Exit — Other Exit — Normal Entries — Other Entries

HUBS	LOCATION	TIMING FROM	TIMING TO	NOTES
Asterisk Control (Left)	AH-AI 21-22	192°	192°	1,2
CC Switch (Left)	AG-21-22	22°°	240°	2
Column Splits	C-H 21,22			
Interpret 11-12		189°	24°	
0-9		24°	189°	
Proof 11-12		188°	48°	
0-9		48°	188°	
Comparing	A-B 27-31			
ALTN	A-B 31	112°	152°	3
ISUP	A-B 29	20°°	232°	4
STOP	A-B 27	112° 207°	169° 23_°	
SUP	A-B 28	112° 20_°	159° 23_°	
UNEQ	A-B 30	144°	159°	
Compare Entry	T 1-20	5°	159°	
Control X Read	C, 1-20	198°	210°	
Digit Selector Pickup	A-B 11-18			5
Interpret Emitter	W-X, 1-22 Y-Z 21-22	5°	169°	6
Interpret Read	D-L 1-20	358°	273°	7
Plug to Print	U 1-20	358°	2_0°	
Posting	AB-AC 23-35, AE-AF 23-34	96°	248°	
Print Entry 1 and 2	M-S 1-20			8
Print Entry Zero Selector	Y-AA 23-34			9
Print Line	AD 23-35 AG 23-34	96°	248°	
Proof Entry 1 and 2	M-S 23-42	30.5°	181.5°	
Proof Emitter	W-X, 23-44 Y-Z, 43-44			
Proof Reading	D-L 23-42	358°	273°	10
Repeat Print	J-K, 21-22 L-M -21			11
Control X		198°	210°	
Proof X		42.5°	46.5°	
X Switch (upper)		0°	360°	12
Selectors	Y-AD, 1-20			
T(Interpret Read)		29°	187°	
T(Proof Read)		54.5°	187°	
SLP 25	AA-AC 21-22			
DCPL	AC 21-22	96°	248°	
OFLO	AB 21-22	96°	248°	
ON	AA 21-22	0°	360°	
SLP 50	AD-AF 21-22			
LLCTL	AF 21-22	96°	248°	
OFLO	AE 21-22	96°	248°	
ON	AD 21-22	0°	360°	
SLP Selector	AE-AG 35			13
C	AG 35	0°	360°	
25	AF 35	0°	360°	
50	AE 35	0°	360°	
Stacker	A-C 23-26			
Comp	A-C 26	152°	159°	
Ctrl X	A-C 23	198°	210°	
IMM PK	A-C 24	0°	360°	
Int Rd	A-C 25	5°	146°	
Suppress Print	N-S 21-22			
Interpret X		5° 17°	12° 24°	
N Switch (Upper)		204°	254°	12,14
Non-Suppress Switch (Left)		204°	254°	2,15
Proof X		42.5°	46.5°	
X Switch (upper)		204°	254°	12,14
X-O Split	A-B, 1-2			
Interpret		24°	187°	
Proof		46.5°	187°	
X-O Split or Control X Selector Pick-up	A-B, 3-10	198° 24°	210° 187°	16
Zero Print Control	AE-AK 1-20			
Upper		358°	273°	17
Lower				18

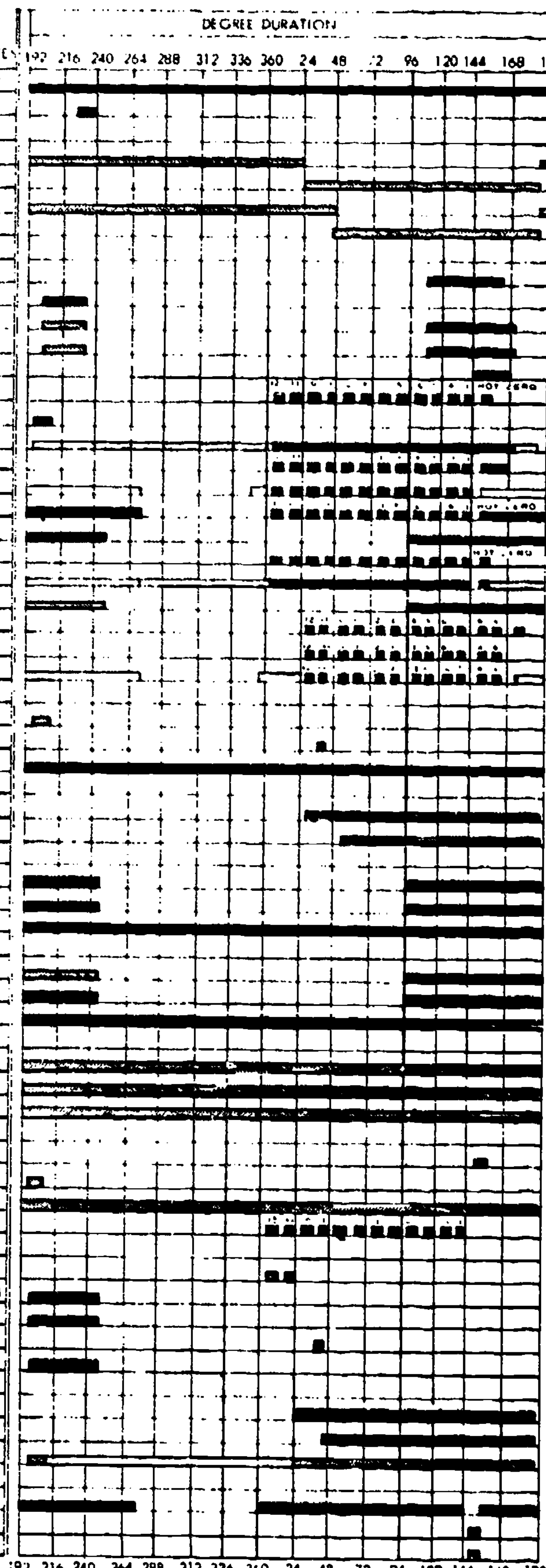

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Figure 5-8.—Timing chart, IBM 557 Alphabetic Interpreter.

However, a machine may be capable of performing several functions such as feeding cards, printing, or punching. If card feeding is occurring during the cycle, then it is a CARD-FEED CYCLE. A machine cycle can be qualified by any function occurring during the cycle, such as print cycle, total cycle, or punch cycle.

A more detailed explanation of cycles will be given in individual machine chapters.

CONTROL STATIONS

You know that reading stations deliver the timed read impulses to the control panel and you then control the operations by panel wiring. Once the panel is wired, it will deliver the same impulses to the same place every time. This provides for consistency in operation and eliminates the possibility of the "human error" of forgetting a step. However, in wiring the panel to process the cards, ALL conditions must be planned for.

Those things that are to happen once for every hundred cards or so must also be taken into account. Usually, these exceptions to the rule are keypunched with a certain punch in a certain preplanned column. An example of this would be an 11 or 12 punch in the units position of an amount field to denote a negative field.

The normal wiring on a machine capable of adding and subtracting would probably be to add a certain field. When a card appeared that contained a negative amount, you certainly wouldn't want to add it. The overpunch (11 or 12) is in the card so that it may be detected (if wired for) and the machine properly wired to change actions.

If you think about it, you will see how this could be a problem. On a machine that reads the cards 9-edge first the numeric amount in a field would have already been read and delivered to a counter by the time the overpunch can be read.

There are other situations that are similar to this such as: print name (on the interpreter) for all cards except those with a control punch in column ________; punch (on the reproducer) all EAOS fields unless there is a control punch in column ________; etc.

Control Read Stations

The manufacturers have made allowances for this need of early reading by supplying a CONTROL READ STATION on most machines.

This control station has either single read brushes which may be manually placed to read any column, or permanently installed brushes (80 or less) which have clip-on or plug-in wires (figure 5-9).

These brushes are located just ahead of the normal read stations to sense the presence or nonpresence of control punches (figure 5-10). If

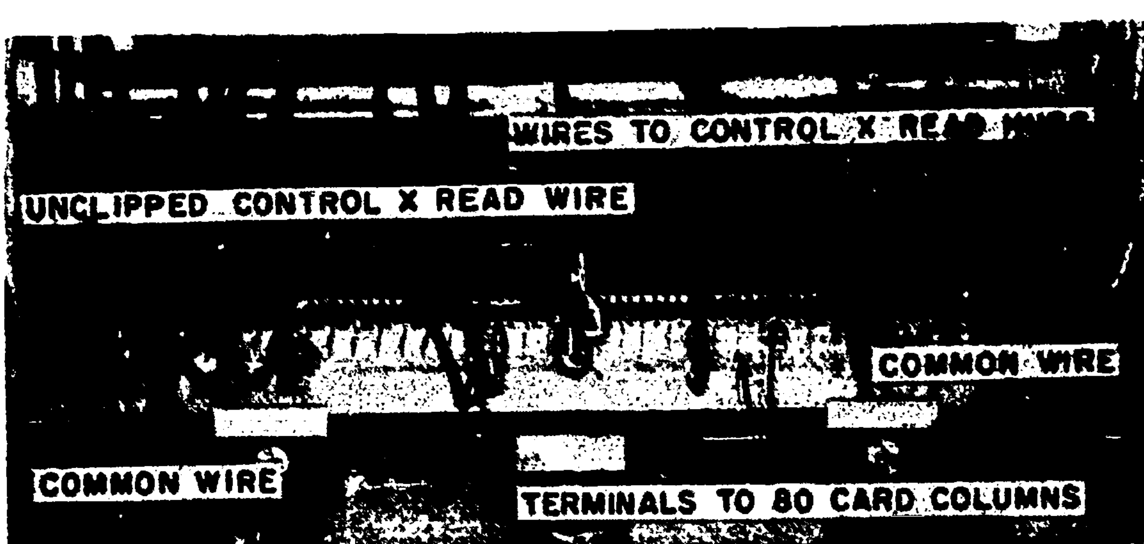

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Figure 5-9.—80 column pre-sensing station (control X read).

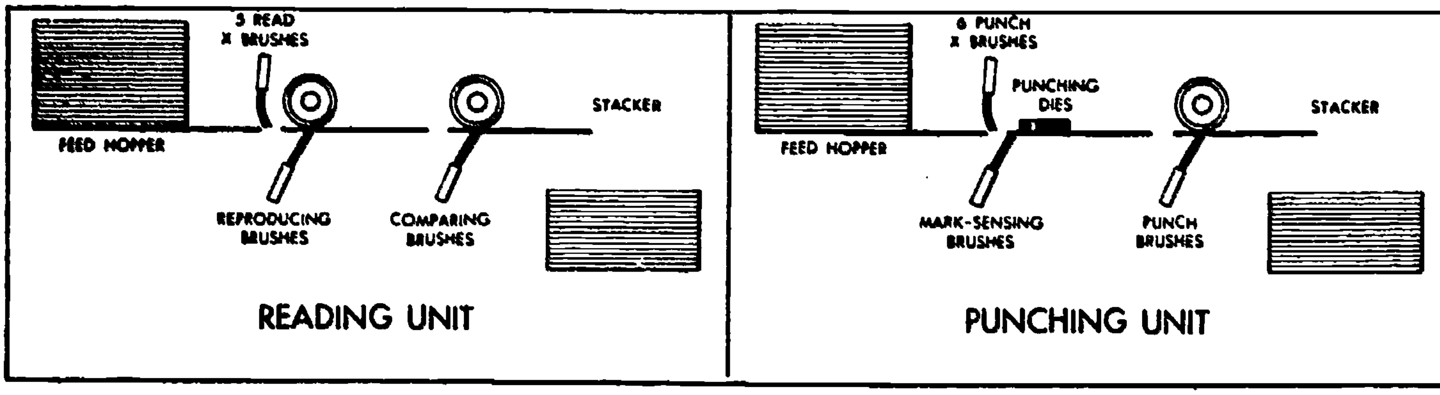

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Figure 5-10.—X brush location.

present the impulse is delivered internally to a control panel exit hub.

This station does not deliver all the read impulses, only those for 12 time or 11 time or both. In figure 5-8 you will notice the Control X Read shows as an exit for a single read impulse prior to the normal reading (interpret read).

This control reading allows the impulse to be available at the control panel ahead of the normal reading. Using the proper control panel wiring, you may then rechannel your impulses from the normal function to another (subtract instead of add, nonprint instead of print, etc.).

The control punch is usually an 11 punch which is referred to as an "X" punch. The "X" punch use and its respective read exit hubs will be explained later within this chapter and in the chapters on the individual machines.

COLUMN SPLITS

Suppose we want to reproduce the punches in an original deck of cards into a new deck of cards. The original, or master deck, has an X punched in column 80. Also, part of the amount field is punched in column 80. The X in column 80 is not needed in the new deck. We can prevent the X from being reproduced when we reproduce the digit in column 80 by the use of a column split.

If we interpret a deck of cards that has an X punched over one of the amount fields we wish to print, we will print alphabetic information instead of the desired numerical information. This happens because an X and a digit form a letter. We can prevent the X-punch from reaching the typebars, and print just the digit, by the use of a column split.

Splitting a column means separating the digit punches (0-9) from the 11- and 12-punches. When a brush in an IBM machine reads a card column, it reads all the holes punched in that column. If a column is punched 12 through 9, all twelve punches are available out of the reading-brush exit hub. It is often necessary to divide the punches of a column into two separate groups, 0-9, and 11 and 12.

ELECTROMAGNETS

Let's see what a column split looks like, and how it operates. The column split is nothing more than a magnet, an armature, and contact points for internal connections. These internal connections allow the hubs on a panel to be utilized for selection of the 11 and 12 impulses or the 0 through 9 impulses once an external wire on the panel directs a certain column reading into the column split unit. Figure 5-11 shows the schematic of a column split position.

The magnet in IBM machines is slightly different from the horseshoe type. It is a piece of iron (called a core) that becomes a strong magnet only when an electric impulse goes through a length of wire (called a coil) wrapped around the core. When the electric impulse is not going through the coil, the core is not magnetized. When an electric impulse is going through the coil, the core becomes a magnet.

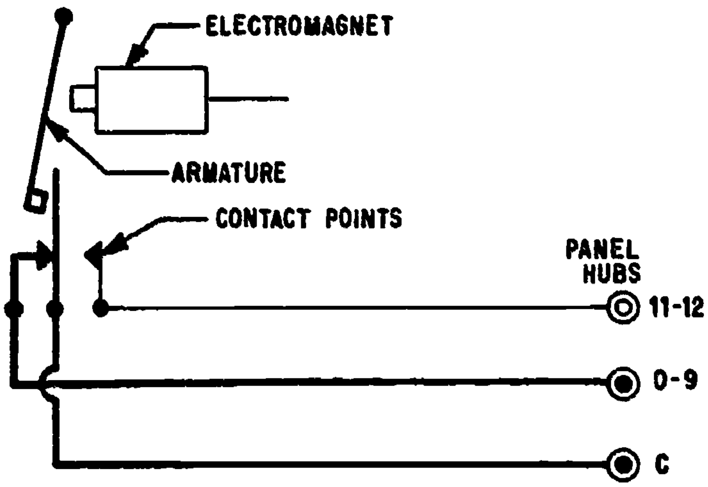

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Figure 5-11.—Column split schematic.

Therefore, you can see that the difference between the horseshoe magnet and the magnets used in IBM machines is that in the IBM type, the magnetism can be turned off and on by the presence or absence of an electric impulse.

The type of magnet used in IBM machines is called an electromagnet.

The electromagnet of a column split is internally and automatically energized each time a card passes the normal read brushes. The magnet remains energized during 11 and 12 time of each CARD FEED CYCLE allowing an internal connection between the hubs labeled 11-12 and C (figure 5-12). The C hub is called COMMON because it is the one that is connected at all times to either the hubs 11-12 or 0-9.

When the magnet is deenergized, the connection is between COMMON and 0-9 (figure 5-11). Since these column split units do not control functions (read, punch, print), once a wire has been plugged into one of the three hubs, the impulse delivered is going to die unless another wire allows the impulse to continue.

If a read hub is wired to the COMMON hub and a wire connects the 0-9 hub to a punch hub, only the punches 0-9 in the respective read hub card column are going to cause punching. Any 11 or 12 read punch delivered to the COMMON will not come out, as the internal connection does not allow the wired COMMON and 0-9 path during this time (figure 5-12). This would remain true even if the wiring were reversed, that is, from the read hub to the 0-9 and out the COMMON hub.

The COMMON can, therefore, be used as either an EXIT or an ENTRY hub. Also, the 0-9 and 11-12 hubs can be either EXIT or ENTRY hubs.

When we wire the card column to COMMON, we divide the card column in two. The 0-9 impulses are available out of one hub on the control panel, and the 11-12 impulses are available out of another hub on the control panel.

When we wire the card column to the 11-12 we are eliminating any 0-9 punches from COMMON. When we wire the card column to the 0-9 hub, we are eliminating any 11-12 punches from COMMON. Therefore, the hubs of a column split are either entries or exits, depending on the results we wish to obtain from their use.

Figure 5-8 shows the Column Split hubs, Interpret 11-12 and 0-9 (lines 4 and 5) as entries. This does not restrict them to being entries, as we have explained; it depends on your wiring as to whether they are exits or entries. The timing chart also shows that the transfer

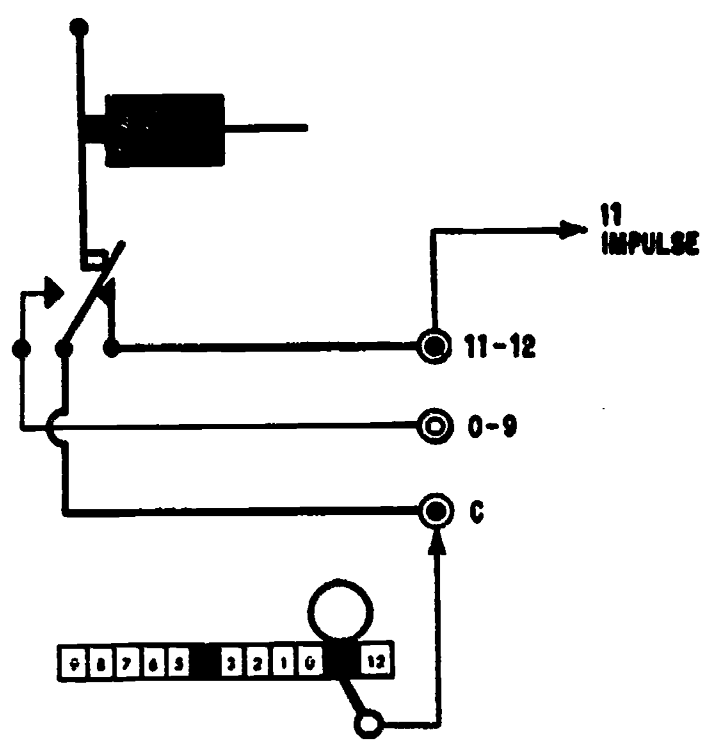

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Figure 5-12.—Energized magnet (12 and 11 time).

from 11-12 hubs to 0-9 hubs takes place between the 11 and 0 timed impulses (24°).

Figure 5-13 shows various examples of how column splits may appear on different control panels.

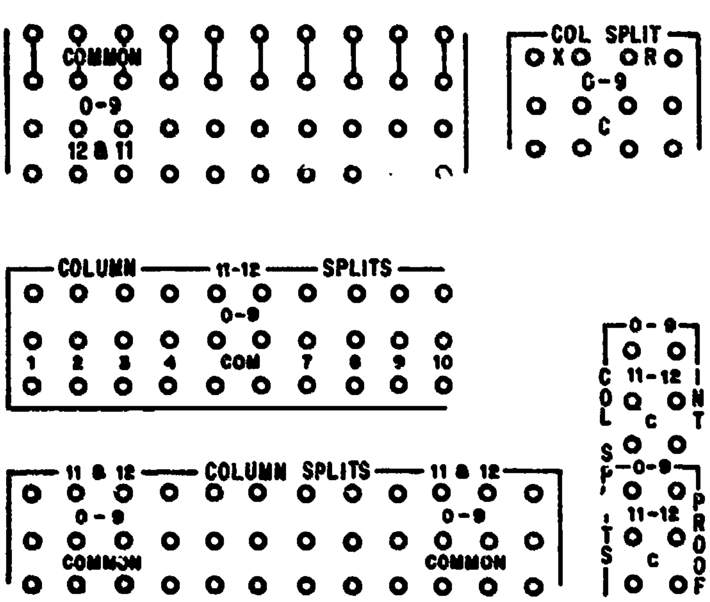

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Figure 5-13.—Control panel hubs, column splits.

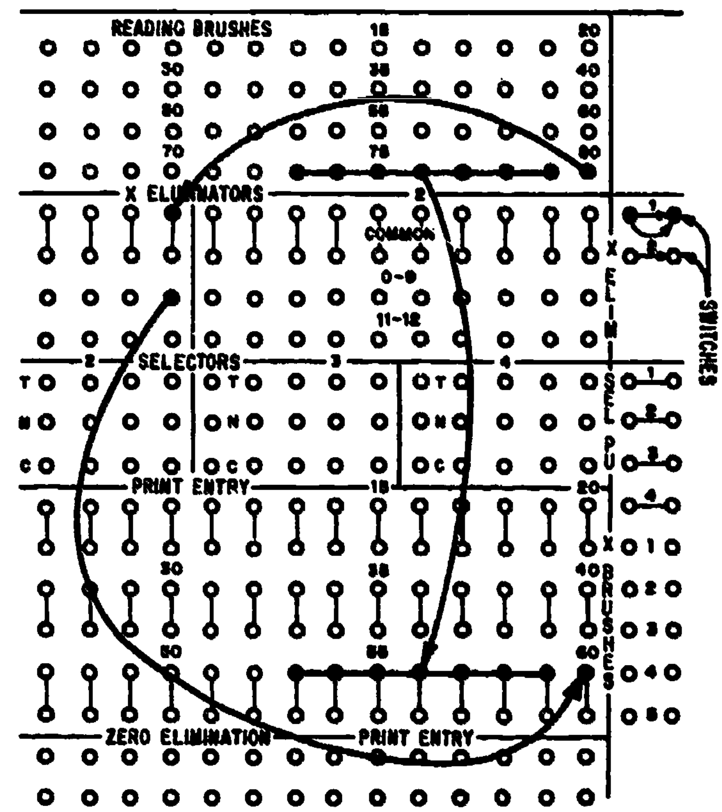

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Figure 5-14.—Control panel diagram of X elimination.

X-ELIMINATORS

On some types of machines this function of column splitting may be taken care of with a group of hubs labeled X-ELIMINATORS. These hubs are labeled the same, and the unit performs the same function. The only difference is that a switch is provided (and must be wired ON) to allow the electromagnet to operate.

Figure 5-14 depict a switch and other wiring to eliminate the control X impulse from reaching the print entry. This job would be wired exactly the same using a panel with hubs labeled column splits instead of X-eliminators except there would be no switch wiring involved.

Remember, the X-eliminators have switches; column splits do not (the function is automatic).

When alphabetic characters are read and the wiring is from read hubs to COMMON and out the 0-9 hubs only the numeric digits will exit for 11 and 12 zone characters. ZERO (0) zone characters (S-Z) will be allowed to exit because they are within the 0-9 time.

DIGIT EMITTERS/SELECTORS

Frequently we want to print or punch repetitive information like a date or a decimal point in the amount of a check that does not originate from a brush reading a punched card. Therefore, we have to generate the impulses required. The IBM machines have a simple solution to this problem. By means of a device called an emitter, the machines can generate impulses for all 12 positions of coding. This is an internal source of current delivered to the hubs of a control panel.

In general, two types of emitters are used in IBM machines. These are called digit emitters and digit selectors.

DIGIT EMITTERS

A digit emitter is simply a switch with twelve positions (figure 5-15). Each position is accessible at the control panel and numbered to correspond to a punching position.

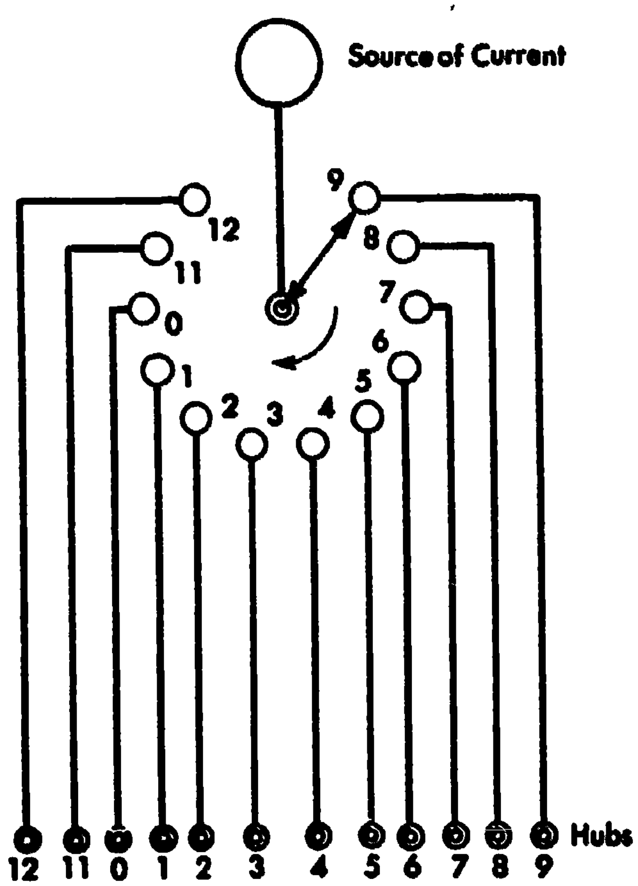

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Figure 5-15.—Digit emitter schematic.

The switch is internally designed so that the 12 positions are connected to the source of electricity one at a time, in time with the read cycle of the machine. Thus, the 12-hub emits an impulse at the same time that a 12-hole would be read in the card. The 11-hole would be read, etc.

When these impulses are wired to other machine functions, they have the same effect as if the corresponding holes had been read from a card.

Emitter Exit Hubs

The arrangement of emitter exit hubs varies, depending on the type of machine, but the hubs are all used for the same basic functions (figure 5-16).

An impulse is available from the emitter exit hub labeled 2 during 2-time of each card-feed cycle. This 2 can be used to perform any function a 2 punched in a card can perform.

If, for example, this emitted digit is connected by a control-panel wire to a punch-entry hub, each card passing the punches is punched with a 2.

Figure 5-8 shows that the interpret emitter hubs are active as normal exits during the exact degrees as the read impulses (Interpret Read).

An example of control-panel wiring for numerical punching is shown in figure 5-17. Wiring necessary to punch the date 9-17-60 into each card as it passes the punch station is illustrated.

Another type of digit emitter that may appear on a control panel is shown in figure 5-18. This emitter is not automatic. It must have its switch (C) wired on before the impulses are available out of the corresponding 12 through 9 hubs. This is similar to the case of X-eliminators and column splits.

What really happens is that the right hub of the switch is the exit hub for all 12 of the timed impulses. When this hub is wired to the left hand hub, it delivers the impulses to the other hubs by internally timed connections. At 12 time the internal impulse comes out the right hub of the switch, into the left hub and then out the 12 hub. This same sequence happens for the other timed impulses, but the internal connection changes so each impulse is available out of its own (and only its own) labeled hub.

This DIRECT IMPULSE (right hub of switch) can be wired into the left hub C (common to all the others), and the internal connections are automatic. Internal switching of connections happens regardless of what is wired into the COMMON hub. Because of this, a read hub may be wired into the COMMON hub, and any specific punch from a column may be selected out. This ability classifies this unit as a DIGIT SELECTOR even though it is labeled as a digit emitter.

DIGIT SELECTORS

Any read hub can be wired into COMMON of a digit selector. Once this done, all impulses that are read from the column are delivered to the COMMON hub. The internal switching of connections will take place automatically. Therefore, if a 5 punch were read, it would be delivered to COMMON and available only out of the 5 hub(s). If the 5 hub is not wired to a

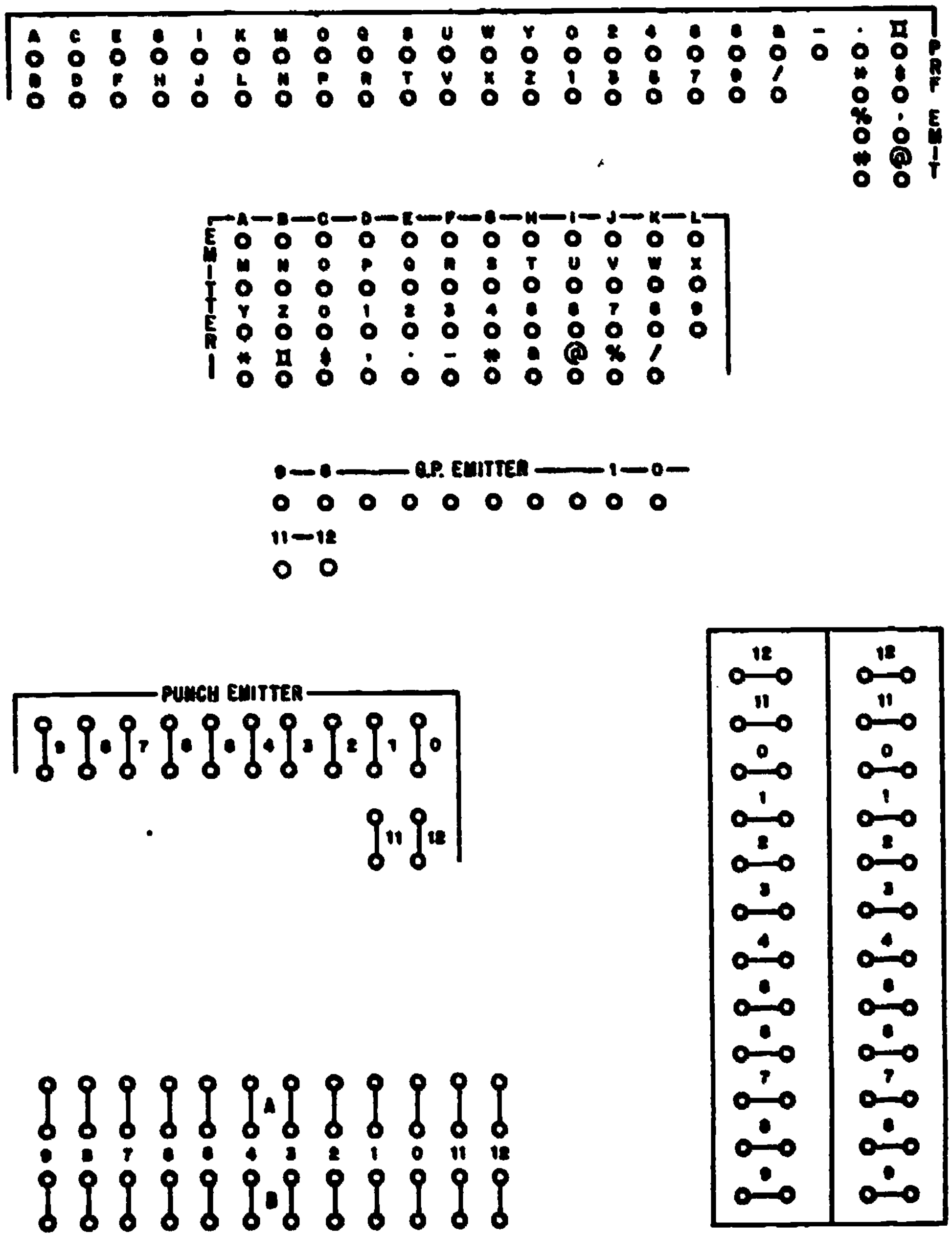

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Figure 5-16.—Control panel hubs, emitter exits.

punch hub, the 5 will not be punched. If, however, there is also an 8 punch in that card column (or in any other card) and the 8 hub is wired to the punch hub, the 8 would punch but not the 5.

With the digit selector any one or combination of punches from a column of each and every card read, with which we want to be concerned, can be selected and treated as the job requires. No matter what punch or combination of punches are read, only the one(s) selected (wired for) will be considered.

As an example, suppose the job called for only those personnel of Pay Grade E-5 in a personnel file to be LISTED (printed on a report). You could, of course, use the sorter and select these cards out, but that would divide the file.

It could be done by wiring from the read hub of the column containing pay grade to the COMMON hub of a digit selector. From the 5 hub you could then wire to controls allowing the machine to LIST. No cards except the ones containing a 5 in the pay grade field would list,

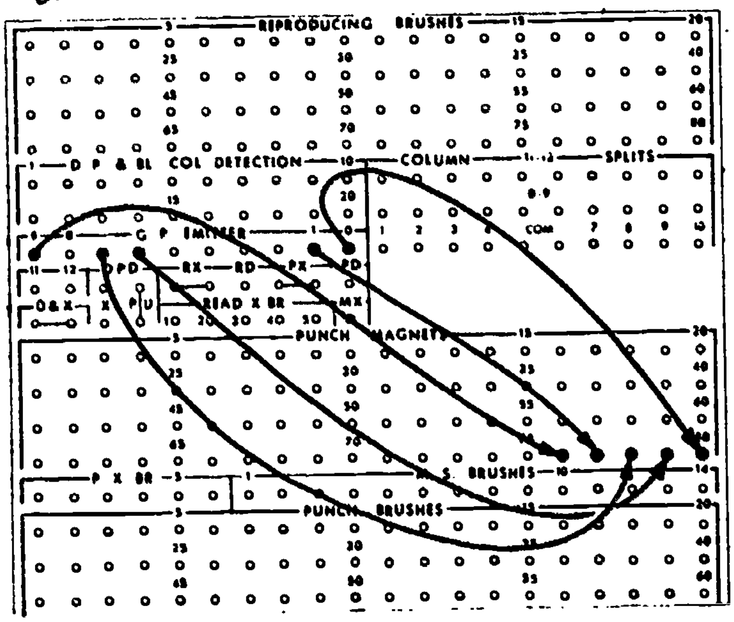

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Figure 5-17.—Control panel wiring for emitting.

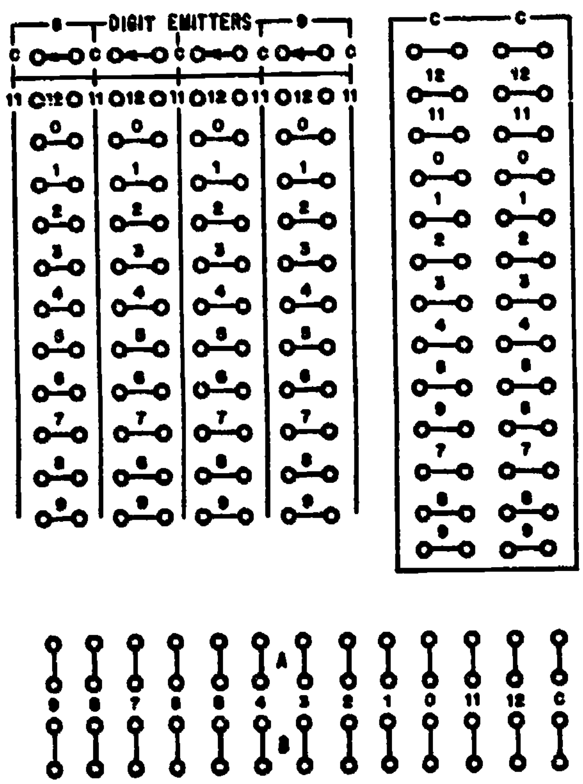

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Figure 5-18.—Control panel hubs, digit selector.

as that would be the only time the machine is told to list.

As all digit selectors have a COMMON hub as part of the unit (figure 5-18) any digit selector can be an emitter. This is accomplished by wiring a direct impulse into the COMMON hub and selecting out those impulses desired for numeric digits or in combination for alphabetic or special characters.

Digit selectors are useful in many respects and will be discussed further in this manual, especially in the chapter on ACCOUNTING MACHINES.

SELECTING

Selection, in the usual sense of the word, means making a choice or decision.

In DP terminology we mean exactly the same thing, but it is a choice of electric impulses. If a choice is to be made by a machine, it must be set up by means of the control panel, using a SELECTOR.

The use of selection is basic in most IBM machines. Although the operation of the selectors can be slightly different in various machines, their basic operations are the same.

An understanding of the principle and uses of selection is essential for data processors using electric accounting machines.

SELECTORS

Consider the column split. Fundamentally, it is a selector.

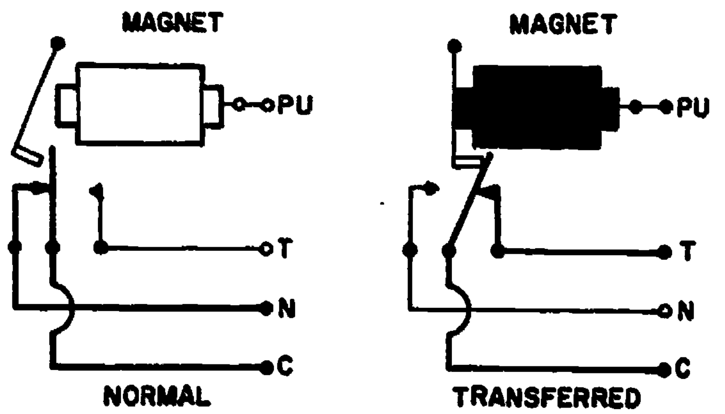
The column split consists of the C (COMMON) hub, 0-9 and 11-12 hubs, an armature, and a magnet that is energized automatically between 0- and 11-time. A selector consists of the same parts: a magnet, an armature, and three control-panel hubs.

A selector differs from a column split in these ways:

1. The labeling on the control panel is different. Both the selector and the column split have a C (COMMON) hub. The function of these hubs is the same in both cases, for the C hub is internally connected by means of the armature to only one of the other hubs at any one time.

The other hubs on a column split are called 0-9 and 11-12. On a selector they are called NORMAL and TRANSFERRED (figure 5-19).

The NORMAL hub gets its name from the fact that, when the magnet is not energized, the



49.26

Figure 5-19.—Selector schematic.

armature is in its usual (normal) position, and the internal connection is between the COMMON and the NORMAL control-panel hubs.

The TRANSFERRED hub gets its name from the fact that when the magnet is energized, the armature is transferred, and the internal connection is between the COMMON and TRANSFERRED.

2. The transfer of the selector armature is NOT automatic. The column split armature transfers from the 0-9 to the 11-12 connection during each card-feed cycle, and this tranfer is automatic. No special control-panel wiring is required to energize the magnet and cause the transfer of the armature. The selector differs in that the armature NEVER transfers without special external control-panel wiring.

Each selector has one or more PICKUP hubs, which are entries to the magnet. The magnet is not energized, and the armature does not transfer, unless a pickup hub has been impulsed.

Because it is necessary to impulse the magnet of a selector through its pickup hub, you will hear people say, "the selector has been picked up" or, "the selector has been picked." All that means is that the pickup hub was wired, and an impulse to the magnet caused the armature to transfer.

The selector must have its pickup hub wired from a control station (X read brushes) or the first read station of a two read station machine to control the selector properly at the time the card is at the action station. The action station is the station from which the reading affects actual printing, punching, adding, subtracting or comparing.

Once the selector has been transferred, it will remain in the transferred state for at least the rest of the cycle for which it was transferred.

Selector Pickup Hubs

Selectors can be used in a variety of ways. Accordingly, the selector pickup hubs vary as to the type of impulses they accept to cause the transfer of the selector. Although the labeling of pickup hubs differs the basic function of the hubs is the same, for in each case the pickup hub is the entry hub to the selector magnet. When an ACCEPTABLE impulse is brought to the pickup hub, the selector is conditioned to transfer at an appropriate time.

X-PICKUP hubs are so labeled because they often accept X-impulses only. The name of these hubs is not always precise, for the hubs sometimes accept 12-impulses as well as X-impulses, depending on the type of IBM machine.

D-PICKUP hubs are designed to accept all the digits 0-9, and the 11 and 12 impulses. Any card impulse wired to the D-PICKUP reaches the magnet and causes the transfer of the selector. Frequently the selector is designed so that any machine impulse can be wired to the D-PICKUP to cause the selector to transfer.

DIGIT PICKUP in the 557 operates like D-PICKUP on other machines. It allows any digit (0-9) or the 11- or 12-punch to reach the magnet and cause the transfer of the selector.

X-0 SPLIT or CONTROL X PICKUPS in the IBM 557 Interpreter accept impulses from two different sources:

1. An X-punch read at the pre-sense or CONTROL-X READ station
2. Impulses from X-0 SPLIT exit hubs in the 557 control panel

The timing chart (figure 5-8), again, explains how and when things happen for a particular type machine. The control X read is an exit from the read X brushes (only the 11 timed control impulse in this example), which can be delivered to the X-0 split or control X selector pickup (an entry at this same timing).

The digit selector pickup is shown as an entry for the entire read cycle which may then be wired from interpret read to cause immediate transfer of the selectors.

What is evident is that the selector(s) may be transferred prior to read time and remain so during all 12 impulses or transferred at any one of the 12 timings during read. If transferred during read time, it remains transferred for the remaining digits to be read.

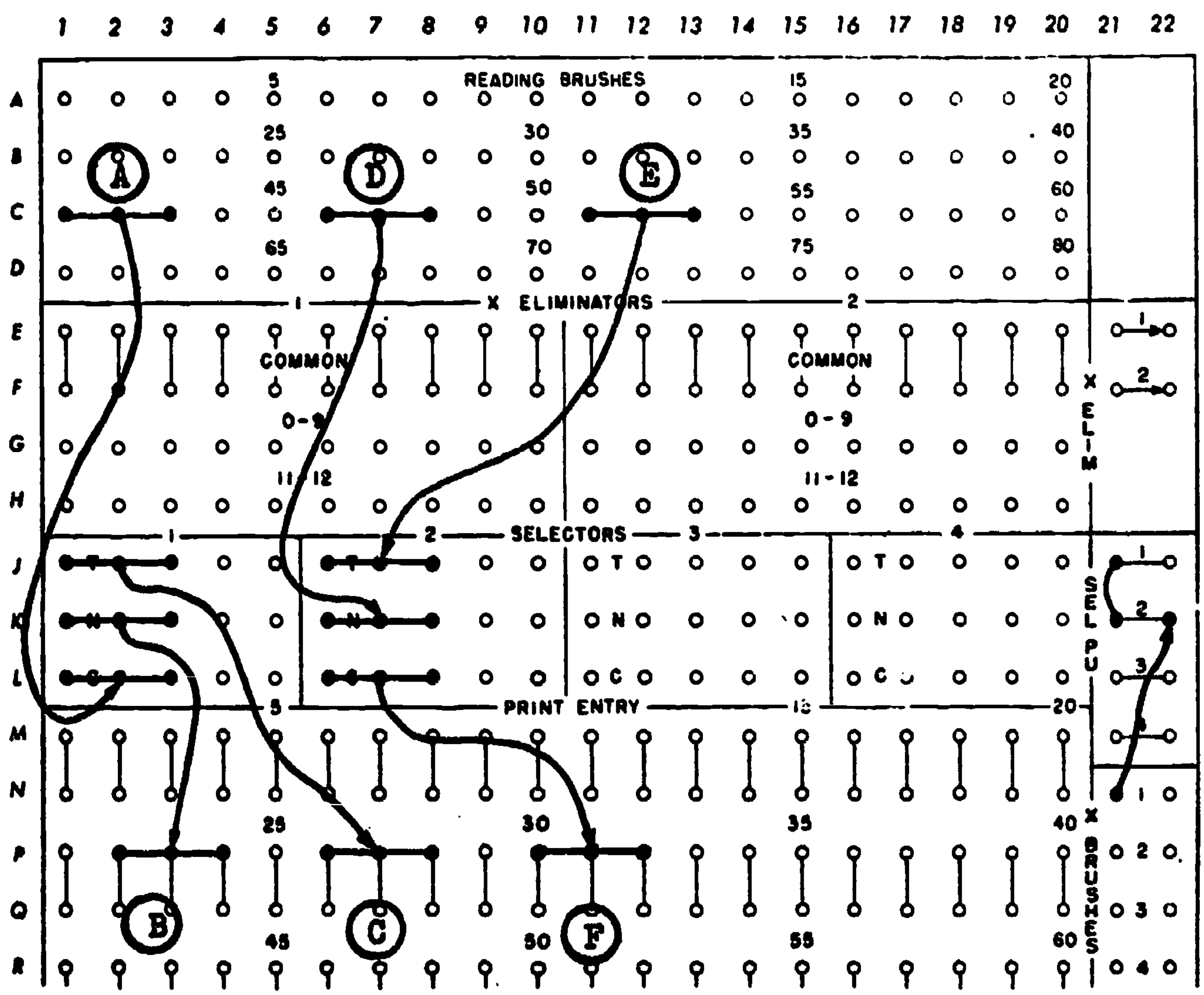
Data Selection

Under column splits it was mentioned that the three labeled hubs may be either entries or exits. This holds true for selectors also. It all depends on whether they are wired into or out of, as they do not emit (or read) impulses or control functions. Selectors simply provide a means of rechanneling impulses.

The way in which the COMMON, NORMAL and TRANSFERRED hubs are wired classifies the selection method as either CLASS or FIELD.

Class selection means that a field in a card can be printed (punched, etc.) in either of two places on the card, depending upon the presence or absence of an 11 punch. Field selection means that either of two different fields can be printed (punched, etc.) in the same place on the card, again depending upon the presence or absence of the controlling X punch.

Wiring for class and field selection is shown in figure 5-20. Assume that some cards contain an



49.27

Figure 5-20.—Class and field selection.

11 punch in column 60, and X brush number 1 is set to read that column. X brush number 1 is wired to the pickup hubs of selectors 1 and 2, causing both selectors to transfer when an X-60 card is read.

For class selection, Field A is read from the card and printed in position B when NX-60 (no X punch) cards are read, and in position C for X-60 cards. For field selection, Field D is read from the card and printed in position F when NX-60 cards are read, and Field E is read and printed in position F for X-60 cards.

Notice that in class selection the impulses travel from the reading brushes to the common hubs, and from the normal and transferred hubs to print entry. In field selection, the impulses travel from the reading brushes to the normal and transferred hubs, and from the common hubs to print entry.

When the selector pickup hub is wired from the X brushes, the control X causes the selector to be transferred before the card containing the 11 punch reaches the reading brushes, thereby permitting all 12 punching positions to be selected. The nonpresence of a control X leaves the selector normal for all 12 digit readings of the NX-60 card. For these reasons either alphabetic or numerical data can be selected by the same control panel wiring.

It should be noted that one selector position consists of three hubs, but each position does not have its own pickup. In figure 5-20 selector pickup hub 1 controls the first set of five selector positions. Each set of five has one common pickup. Generally selectors are arranged (and controlled) in sets (groups) and are outlined on the control panel. The group is then referred to as selector 1 (2, 3, or 4) corresponding to the numbered pickup hubs.

When the pickup is impulsed, all positions (5 in this case) of the selector are transferred at once. This does not mean that you can wire into common of position 1 and get the impulse out of the Normal or Transferred hub of a different position within the group. What goes in the C, N or T hub comes out of the C, N or T hub in its own position (vertical)..

If a field to be controlled is longer than the positions available in one selector, two or more selectors may be utilized and their respective pickup wired from the same control. In figure 5-20 one X brush controls two different types of selection, but the fields do not utilize the same selector. Usually fields are separated to ensure correct control.

If fields D, E and F were rewired, they could be positioned next to A, B and C so as to utilize all of selector 1 and only one position of selector 2 as they are controlled by the same impulse. If, however, the class selection were controlled by X-60 and the field selection by X-70, the fields would have to be wired to separate selectors so that X-60 would not control part of what should be controlled solely by X-70 and vice versa.

PILOT SELECTORS

Another type selector that should be discussed is the PILOT SELECTOR. This type of selector is used on only one type of machine—the accounting machine.

It may be utilized for a multitude of purposes, but its one use of controlling other selectors justifies it being discussed at this time.

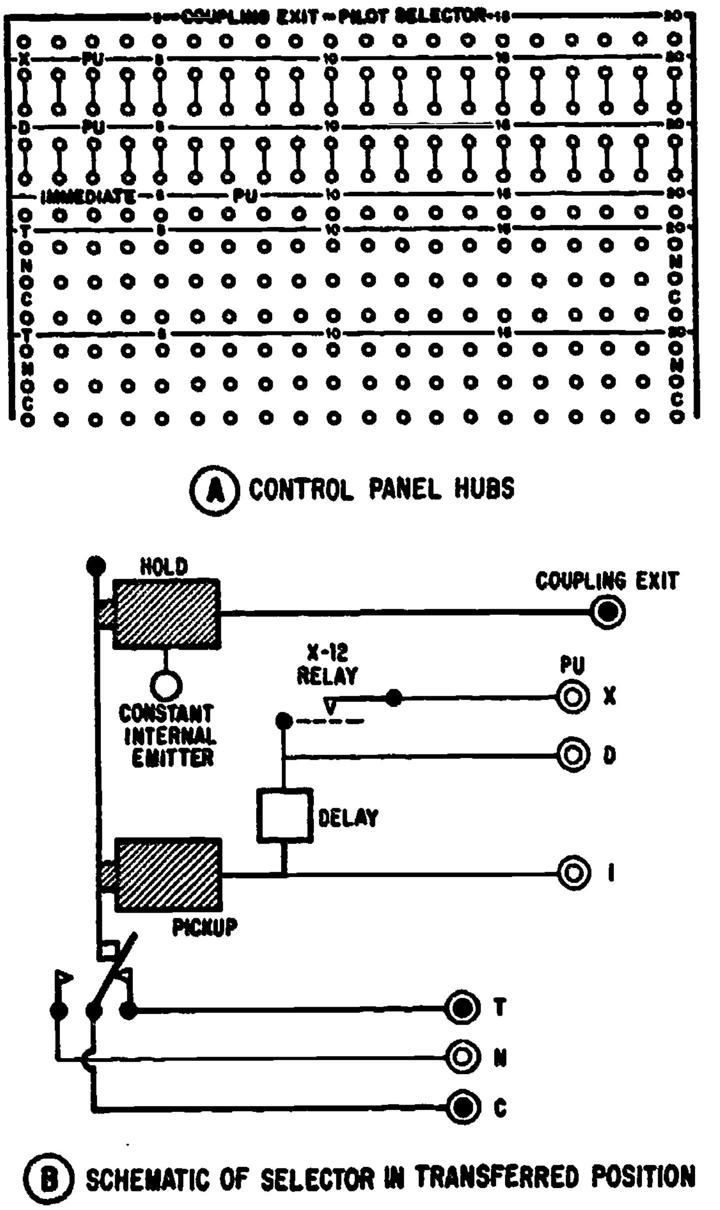
Understanding the pilot selector schematic in figure 5-21(B) is the first step in proper use of this unit.

Figure 5-21(A) shows the pilot selector section of a control panel. All hubs in a vertical line pertain to one pilot selector. Each pilot selector contains a COUPLING EXIT, common X PU (pickup), common D PU, IMMEDIATE PU and a two-position selector (T, N, C - T, N, C).

The schematic (figure 5-21(B)) shows the coupling exit, X, D and I PU's, but only one selector. Even though the second selector is not depicted, it works in conjuction with the top one. When one is transferred, the other is also transferred; when one is normal the other is also normal.

Immediate Pickup

You will notice in the schematic that all three pickup hubs connect to the electromagnet just above the armature. The I hub, however, is the only one that leads directly to the magnet. This means that any acceptable impulse to the I hub will cause immediate transfer of both selectors. The acceptable impulses include any of the 12 reading times.



49.397

Figure 5-21.—Pilot selectors.

During reading time, then, the two selectors may be transferred to allow selection or rerouting of the remaining digits to be read from the column(s) wired to the pilot selector.

At the time of transfer, not only does the internal transfer take place, but an impulse is also made available at the coupling exit.

Coupling Exit

Regardless of which pilot selector pickup hub receives the impulse to cause transfer, the coupling exit impulse is available immediately at the time of, and for the duration of, the transfer.

This impulse is utilized (mainly) to provide a control impulse to the pickup of other selectors (CO-SELECTORS). Once received by the co-selector pickup, the co-selector is immediately caused to transfer. This provides the means of transferring 5, 10, 15 or more selector positions at the appropriate time. In a sense this simply expands the pilot selector to be as many positions over two as you desire.

X-Pickup

The X-pickup accepts only the 12 or 11 impulse from the read stations. The accepted impulse is then delivered to the internal DELAY relay unit for later transfer of the pilot selector.

Once released from the delay unit, the selector transfers immediately, and an impulse is available from the coupling exit.

D-Pickup

The D-pickup accepts all 12 impulses from the read stations. The accepted impulse is then delivered to the internal delay unit for later transfer of the pilot selector.

Once released from the delay unit, the selector transfers, and an impulse is available from the coupling exit.

DELAY UNIT

On a machine such as the accounting machine no pre-sensing station (or X-brush) is provided for control. It does, however, have two reading stations. The first reading station in the cards path allows a control-X (or any other) punch to be read and utilized in a manner similar to X-brushes.

If the column the control punch is available in is wired to the correct pickup hub (X if nothing but a 12 or 11 is controlling, D if any punch present in the column will be acceptable), the impulse is delivered to the delay unit.

In the case of most other machines the X-brush read station immediately precedes the normal read station. It is, therefore, required that the selector utilized be transferred im-

mediately to be ready to read the entire card. This is not the case with accounting machines.

The first read station is a full reading station, and if the selector were allowed to transfer immediately, it would be too soon. The second read station in accounting machines is the "action" station. Wiring for printing comes from the second read station. It is when the card reaches this station that selection should take place.

By delaying the control impulse from activating the electromagnet until the card is moving to the second (action) read station we can properly control selection. This is the purpose of the delay relay unit of the pilot selectors.

In most cases once the impulse is delivered to the delay unit, it causes transfer of the selector for the next CARD or PROGRAM CYCLE. Cycles and their influence on when and for how long a selector transfers will be further discussed in the chapter on accounting machines.

The example diagram in figure 5-22 depicts a pilot selector utilized for control of two units. (Numbers on the diagram correspond to the paragraphs below.)

1. First reading 80 is wired to the X pickup of pilot selector 1.

2. NX-80 cards are added by wiring a card cycles impulse through the normal side of pilot selector 1 to counter control plus entry.

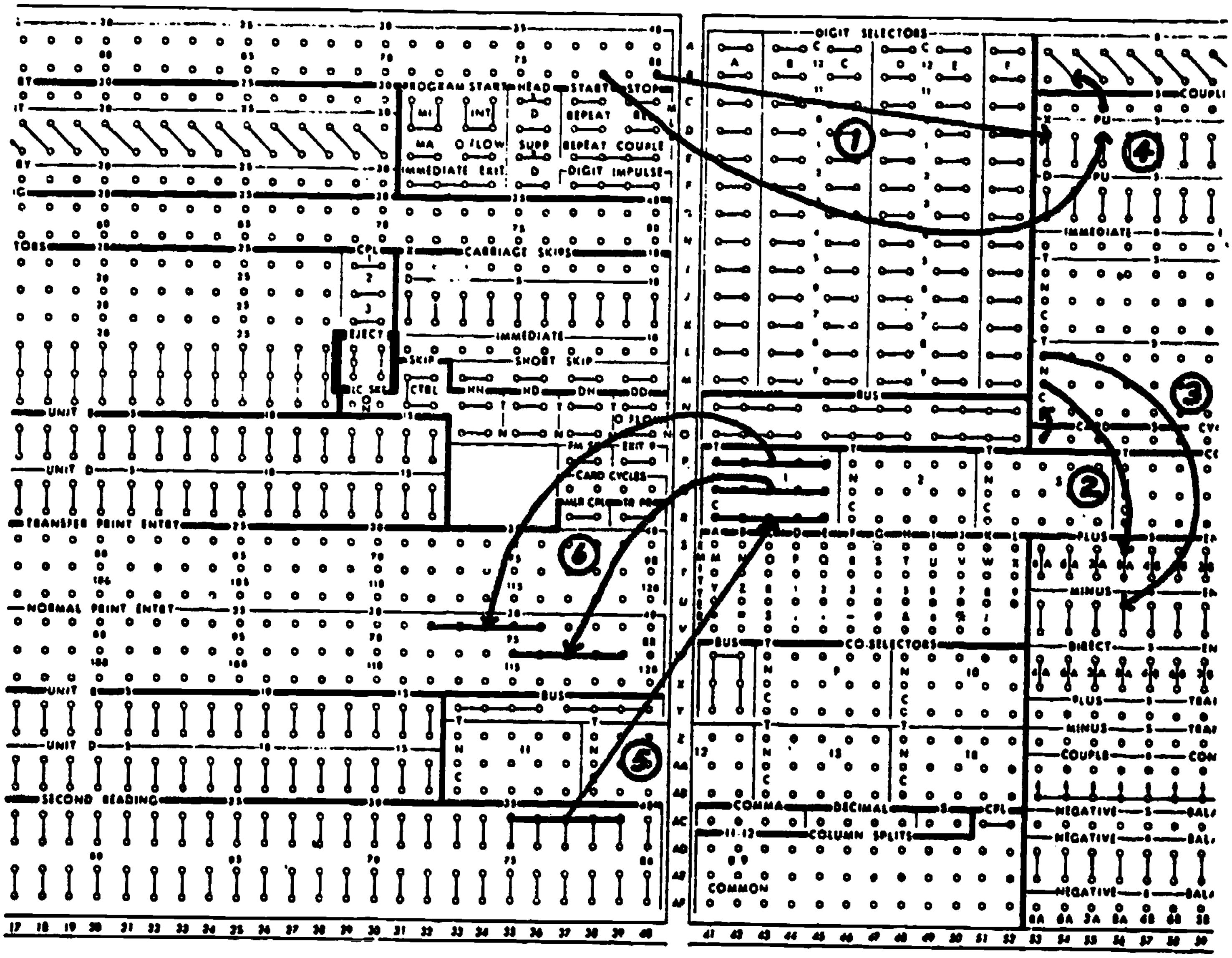


Figure 5-22.—Selection. 49.112

At this time card cycles can be thought of simply as an emitted impulse available for each card feed.

Counter plus entry causes addition in a counter.

Counter minus entry causes subtraction in a counter.

3. X-80 cards are subtracted by wiring the card cycles impulse from the transferred side of pilot selector 1 to counter control minus entry. The pilot selector will be picked up if a card at first reading is punched with a control X, and will be transferred when that card reaches second reading.

4. A 5-digit field can be class selected by using a co-selector. However, since the co-selector transfers as soon as a pickup impulse is received, this impulse must be delayed until the controlling card reaches second reading. This is done by wiring the control field from first reading to the pickup hub of a pilot selector, and wiring the pilot selector coupling exit to the pickup hub of the co-selector. Thus, since the pilot selector will not transfer until the end of the cycle on which impulsed, the co-selector will not be transferred until the controlling card reaches second reading.

5. The field to be selected is wired to common of the co-selector since it is to print in one place for X cards and in another for NX cards.

6. The normal hubs of the co-selector are wired to print in one place for NX-78 cards, and the transferred hubs are wired to print in another place for X-78 cards.

COMPARING

Comparing, in the usual sense of the word, is the process of examining the character or qualities of two or more persons or objects for the purpose of discovering in what way they are alike or in what way they are different. Often items are set side by side to determine their relative value, size, weight, etc., or to establish proper relationship.

Comparing, when used as a term in data processing means basically the same thing. However, the process of comparing is absolute, not relative. No means is available to ascertain how much the two or more items are different from each other. The IBM machine determines only whether two or more items of information are or are not identical. The operator by means of control-panel wiring, predetermines the operation of the machine for either decision, depending on the purpose of the function: verification or control.

Verification

Verification is a process of testing for the correctness of punching. For example, after a machine has copied or reproduced the holes from one card into another card, you should compare the holes in the orignal card with the holes in the new card to verify the accuracy of the punching.

Control

Control is the process of directing a machine to perform specific operations. For example, you may need to check a file of cards to make sure that they are in correct ascending or descending order, or sequence. It is necessary to compare the first card with the second card, the second card with the third, the third card with the fourth, etc. If a card is out of order (sequence), you want to control the machine to stop so that you can locate the card that is out of sequence and refile it in its correct place.

The cards shown are in ascending numerical sequence (02, 03, 04) in figure 5-23(A).

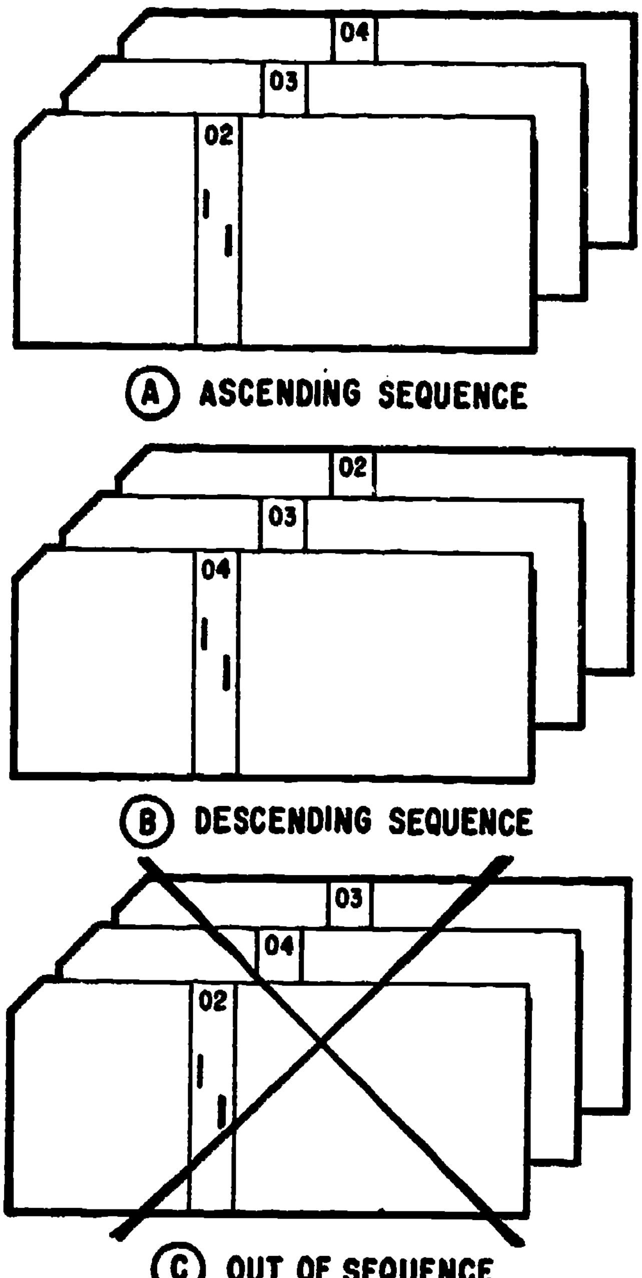
The cards shown are in descending numerical sequence (04, 03, 02) in figure 5-23(B).

The cards shown in figure 5-23(C) are not in proper ascending or descending sequence. The middle card is out of sequence for ascending order, and the first card is out of sequence for descending order.

By comparing the first card with the second, the second with the third, etc., an IBM machine can recognize that the cards are out of sequence, and the machine can be controlled to stop.

Another example of the need for comparing in order to control machine operations is shown in figure 5-24.

This is a report prepared by an IBM accounting machine. As cards are passed through the accounting machine, it prints commodity number, unit cost, quantity, and sales amount from each card.



49.398
Figure 5-23.—Sequence examples.

Commodity Number	Unit Cost	Quantity	Sales Amount
11102	556	4	276
11102	556	2	138
11102	556	20	1380
		26	1794 *
11202	664	40	3320
11202	664	15	1245
11202	664	40	3320
11202	664	40	3320
11202	664	3	249
11202	664	40	3320
		178	14774 *
13102	673	75	6300
13102	673	45	3780
13102	673	25	2100
13102	673	75	6300
		220	18480 *
14202	709	15	1320
14202	709	4	352
14202	709	15	1320
14202	709	15	1320
14202	709	30	2640
14202	709	20	1760
		99	8712 *

49.399
Figure 5-24.—Accounting machine report.

We also set up the machine to compare the commodity number of the first card with the commodity number punched in the second card, the commodity number of the second card with the commodity number of the third card, etc.

Whenever the machine recognizes, by means of its comparing feature, a difference in commodity number from one card to another, the machine stops feeding cards and prints a total for quality and sales amount. All this happens only if the control panel is properly wired. So, you see, whether we wish to verify the correctness of punching, or control IBM machines to perform the desired operations, we must compare.

Now, let us see how comparing is done.

MACHINE METHOD

Machines compare cards by substituting mechanical units for human intelligence.

An IBM machine reads cards by means of its reading brushes. To compare any two cards at the same time, it must have two sets of reading brushes. One set of brushes reads one card at the same time the other set of brushes reads the other card.

When two cards are read by two sets of brushes, the movement of the cards is synchronized, or timed together By this we mean that a 12-time the 12-position of one card is being read by one set of brushes, and at the same time, the

12-position of the other card is being read by the other set of brushes.

The comparing operation takes place in IBM machines in the COMPARING MAGNETS.

If we put a metal bar between two identical electro-magnets and take identically timed electric impulses to each of these magnets, then the metal bar stays in place and does not move toward either magnet (figure 5-25(A)). However, if at a given time, only one of the two electromagnets receives an impulse and is magnetized, then the bar is attracted to the magnet that has received the electric impulse (figure 5-25(B,C)).

Comparing Position

IBM machines use electromagnets in pairs to perform the comparing operation. Each pair of electromagnets is called a COMPARING POSITION or a pair of comparing magnets. Therefore, there are TWO HALVES to each comparing position or magnet.

This means that there are two separate sets of entry hubs for each comparing position provided. (The number of comparing positions available depends on the type machine.)

For example, hubs might be labeled comparing entry A (with hubs numbered 1 through 80) and comparing entry B (with hubs numbered 1 through 80). One reading station may be wired with card column 5's impulses delivered to comparing entry A (hub 1). The card column of the other card to be compared must be wired into comparing entry B (hub 1) from the other read station.

This allows comparing position 1 to have impulses delivered from cards at two different synchronized read stations.

Whenever you are using a comparing position, remember that if you use one half of a comparing position to record the reading of one card, then you must use the other half of that same comparing position to record the reading of the other card.

TWO CONDITION COMPARING

For a concrete example of how comparing magnets are wired the reproducing punch can be used. Assume that you are comparing the punching operation.

First, you must understand the basic idea of a reproducer. Refer to figure 5-26 for the following explanation.

Two separate (synchronized) card feeds are available. The read hopper holds the old punched cards. The punch hopper holds the blank cards that are to become duplicates of part or all of the old cards.

A card is fed from both hoppers at the same time. A panel is wired to allow what is read by the reproducing brushes to be delivered to the punch dies to cause identical punching. This is indicated by the arrow headed line labeled PUNCH.

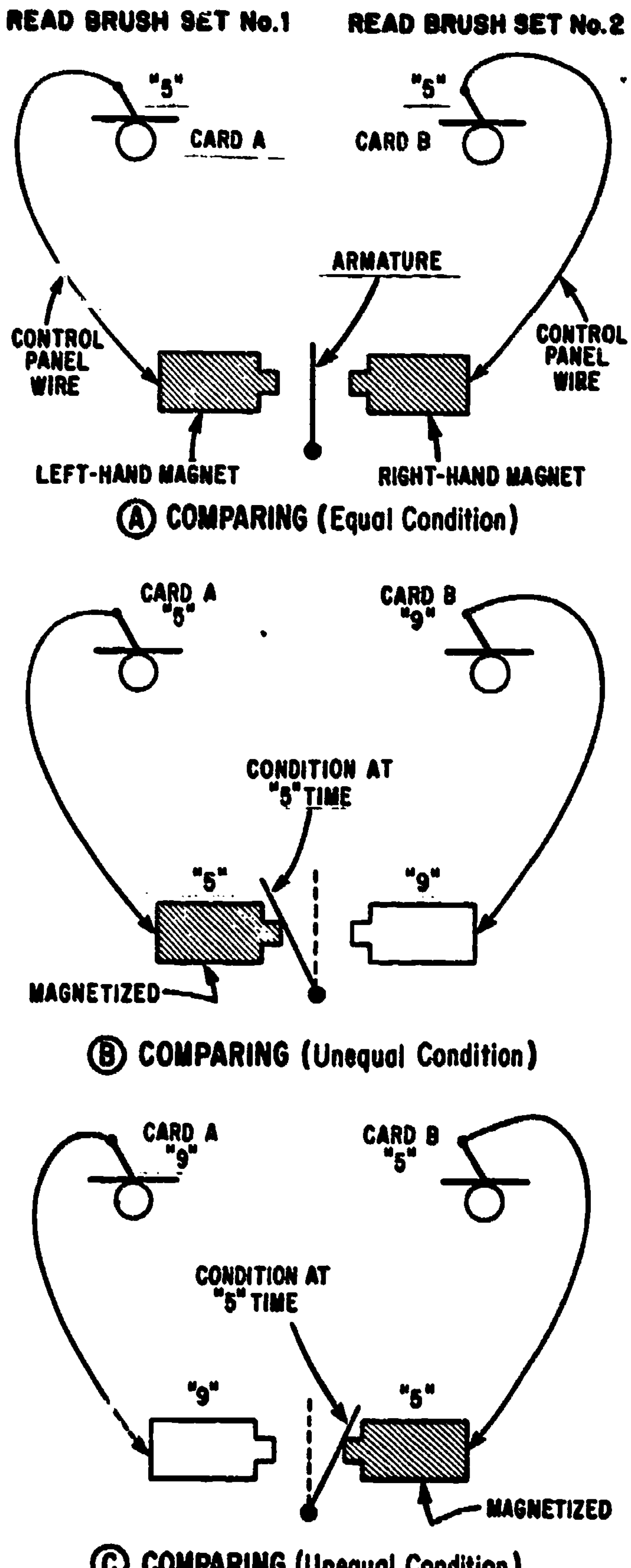
To ensure that identical punching took place both cards are read at the next read station in their card path. Figure 5-27 shows that the comparing brushes are wired to one entry of a comparing position and the punch brushes to the other side of the same position. This causes a reading from the old card and the new card to be directed to one set of electromagnets.

Figure 5-28 shows a properly wired panel diagram for reproducing and comparing one field of a card file. If the field had been wired from punch brushes to comparing positions 1 to 6, then the comparing brushes would also have to be wired to 1 to 6.

In a reproducer if a difference is detected by any one of the comparing positions, the machine stops. This means one of the electromagnets of a set was energized when the other was not. An indicator on the machine tells the operator which comparing position did not match. The operator must then take corrective steps before continuing the operation.

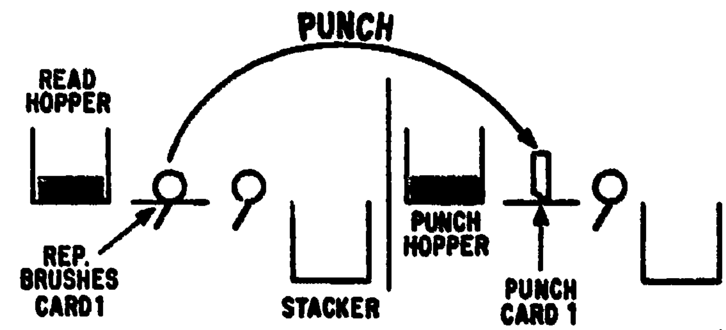
The accounting machines comparing feature operates in about the same manner. In this type machine, however, a comparing nonmatch does not automatically cause the machine to halt. The unequal condition can be used for controlling printing functions (figure 5-24) or whatever else you may desire.

The reproducers and accounting machines both utilize this "two condition" type comparing. Results are either EQUAL or UNEQUAL.



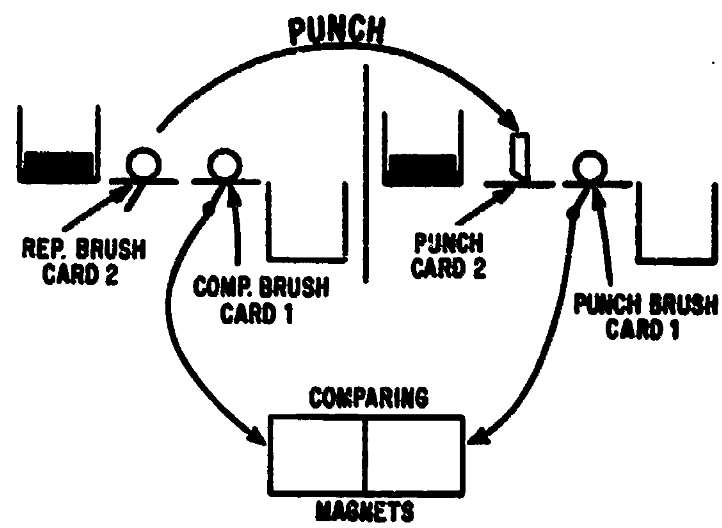
49.400

Figure 5-25.—Comparing conditions.



49.401

Figure 5-26.—Reproducer punch schematic.



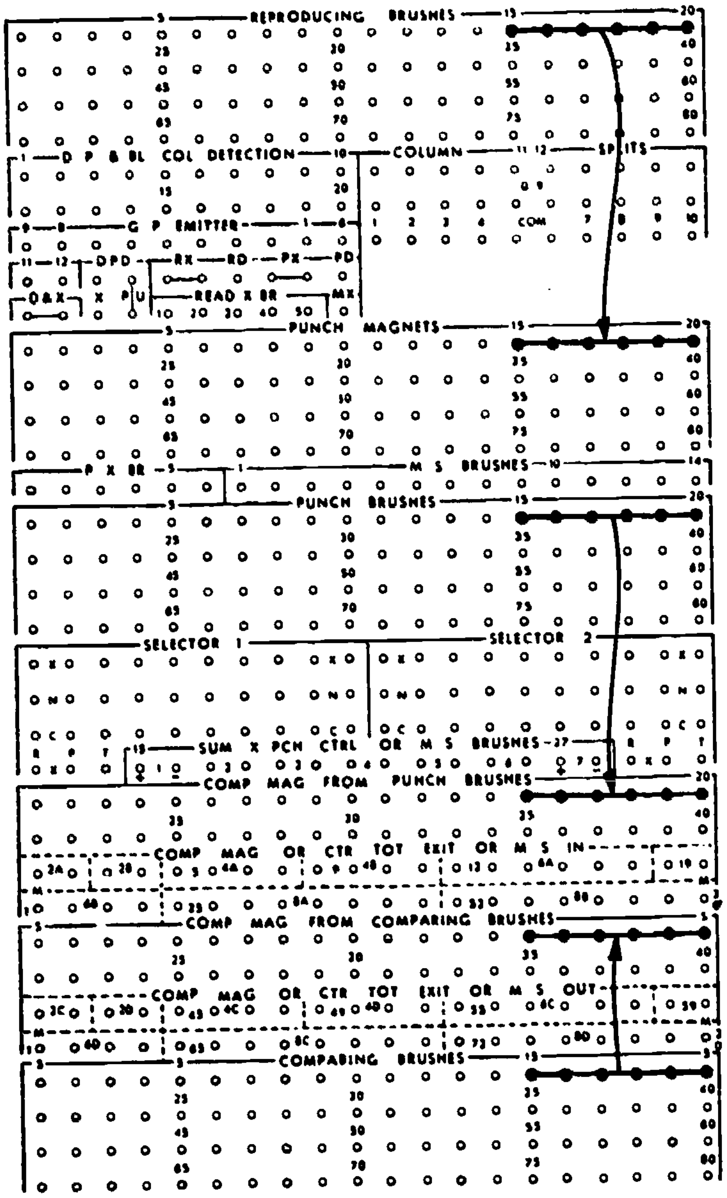
49.402

Figure 5-27.—Reproducer punch and comparing schematic.

THREE CONDITION COMPARING

Let's change our machine type and use a schematic similar to that of a collator (figure 5-29).

With this setup for comparing, the cards enter the machine 9 edge first and are read by station B first. Once cards are at both stations, comparing takes place between cards in the same feed path. The second card is compared to the first; third to the second, etc., by proper control panel wiring. Therefore, each card except the first and last to enter the machine is compared twice, once with the card ahead of it and once with the card behind it.



49.403

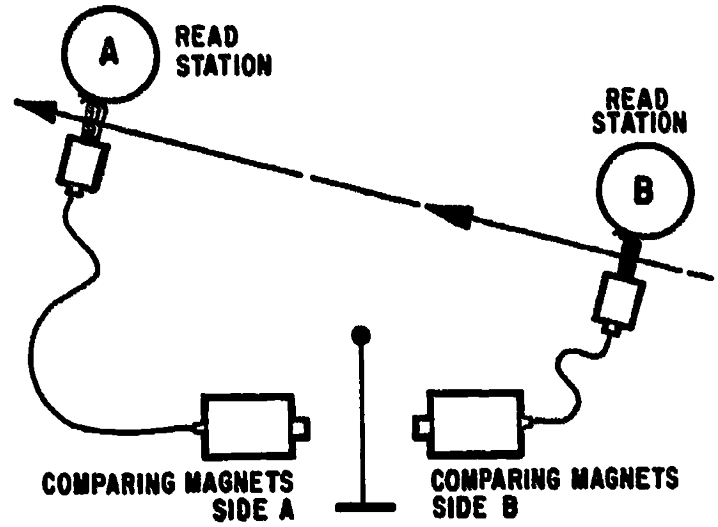
Figure 5-28.—Wiring for comparing.

Proper wiring is: read station A wired to comparing magnet, side A, and read station B wired to the other side of the same position.

Figure 5-29 shows the normal state of the magnets. This exists if the cards at both stations contain identical (EQUAL) punches in the columns wired.

The armature will be pulled to one magnet or the other, depending on which magnet is impulsed first, just as with two way comparing.

Figure 5-30 indicates what will happen if a punch is encountered at station B before one at station A. (Remember, cards are fed 9 edge



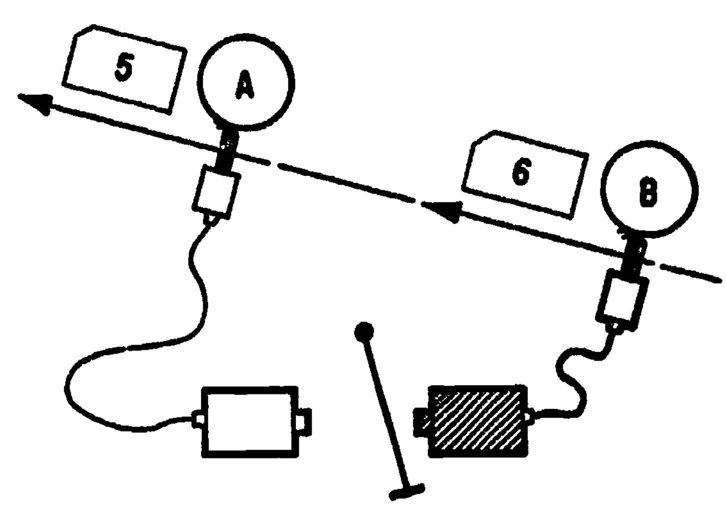
49.404

Figure 5-29.—3-way comparing (equal).

first.) This unequal condition does not automatically halt the machine.

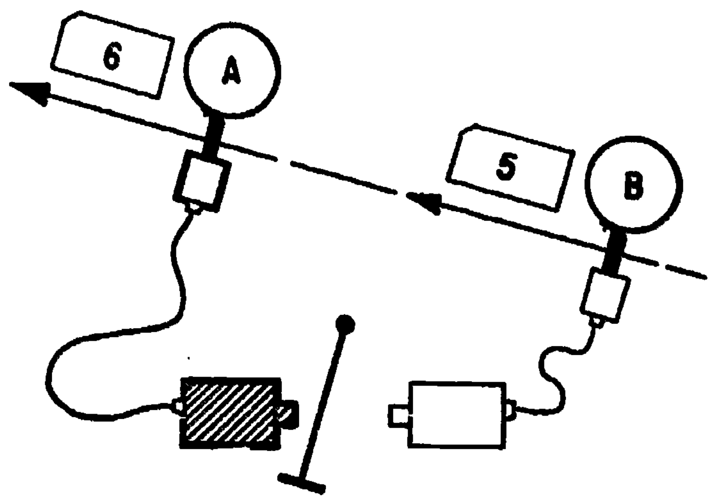
If we were checking to ensure a file were in proper ascending sequence, and the arrangement was as in Figure 5-30, this would be an acceptable condition. Even though comparing is unequal, it is a step-up condition (5 to 6). This is proper ascending and we do not wish to halt operation. This will later be called a HIGH condition.

The opposite magnet would be energized if the cards had entered in reverse order. Figure 5-31 illustrates this condition. If we were still checking ascending sequence, this particular



49.405

Figure 5-30.—High condition.



49.406
Figure 5-31.—Low condition.

condition would indicate an error (the 6 precedes the 5). This will later be called a LOW condition.

So far we are still discussing two way comparing (equal or unequal). In sequence checking with a collator, however, we must be able to split the unequal condition. By adding a few internal connections to our basic schematic, three conditions instead of two become easily attainable.

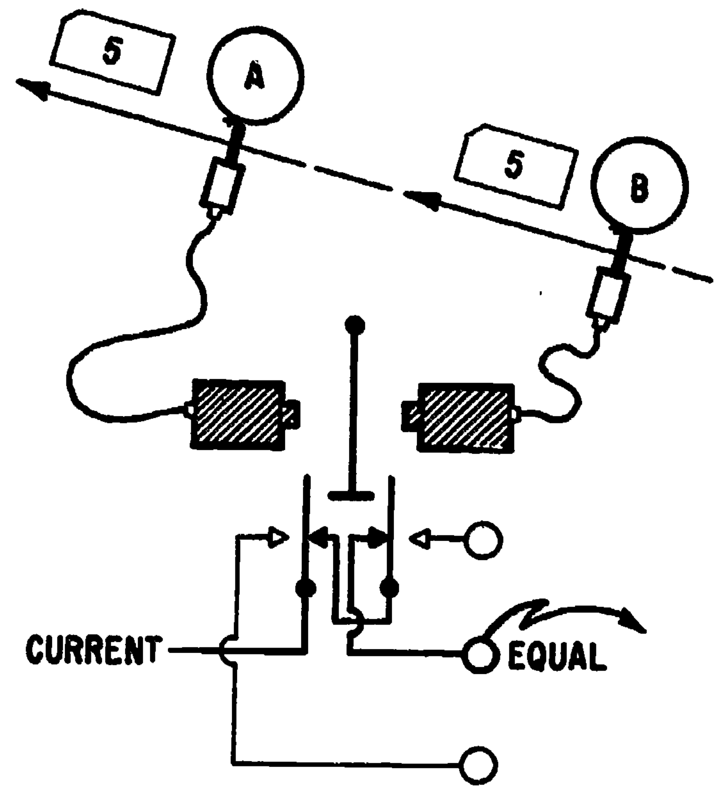
Equal Sequence

Figure 5-32 shows the additional contact points and a current flow. It also shows three hubs that are available on a control panel. The internal impulse will be directed to one of these hubs.

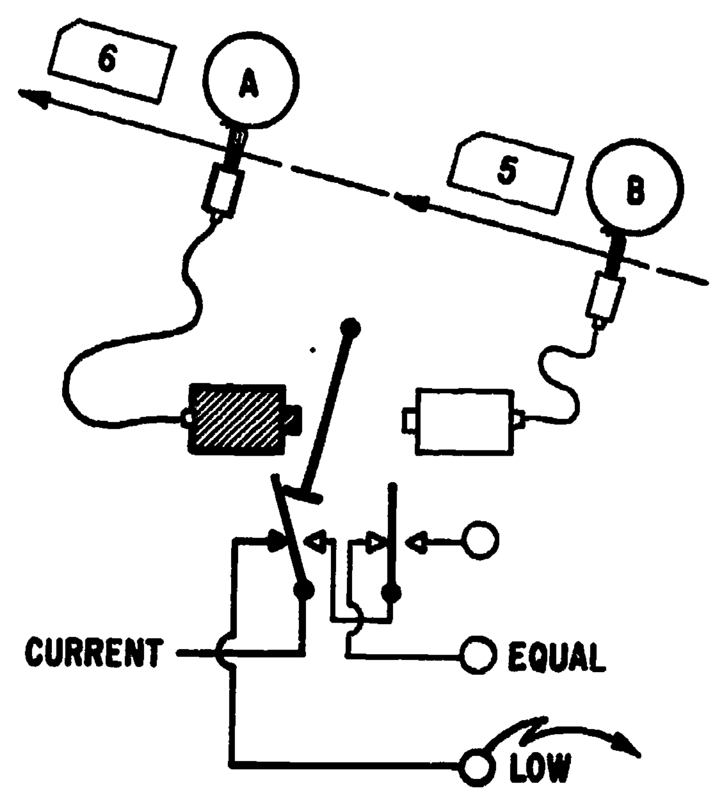
When neither magnet is impulsed, the armature does not move and we have an EQUAL condition (figure 5-32). In this case the impulse is available at the EQUAL hub for your use.

Low Sequence

When you are checking ascending sequence files and the cards are out of sequence, it is signaled by a LOW condition (figure 5-33). This occurs when a digit in the card at station B is lower than the card at station A. That is, a punch was detected at station A before station B. In this case the comparing magnet would trip



49.407
Figure 5-32.—Equal sequence.



49.408
Figure 5-33.—Low sequence.

to the left and direct the impulses to the LOW hub. This is known as LOW SEQUENCE.

Low sequence is an error condition for ascending sequence, and the LOW hub would be wired to a stop hub to halt the machine. If the file were in descending sequence, this would not be the error condition.

High Sequence

If in ascending sequence, the card at station B is higher than the card at station A, it is correct (figure 5-34). This represents proper ascending sequence. The armature would, however, trip to the right and cause an impulse to be available at the HIGH hub. This is known as HIGH SEQUENCE. The HIGH hub would be wired to a stop hub for sequence checking descending sequence files.

For collators the card that is wired to comparing entry B is the one that establishes the comparing difference. It is always HIGHER than, LOWER than, or EQUAL to the card reading wired to comparing entry A.

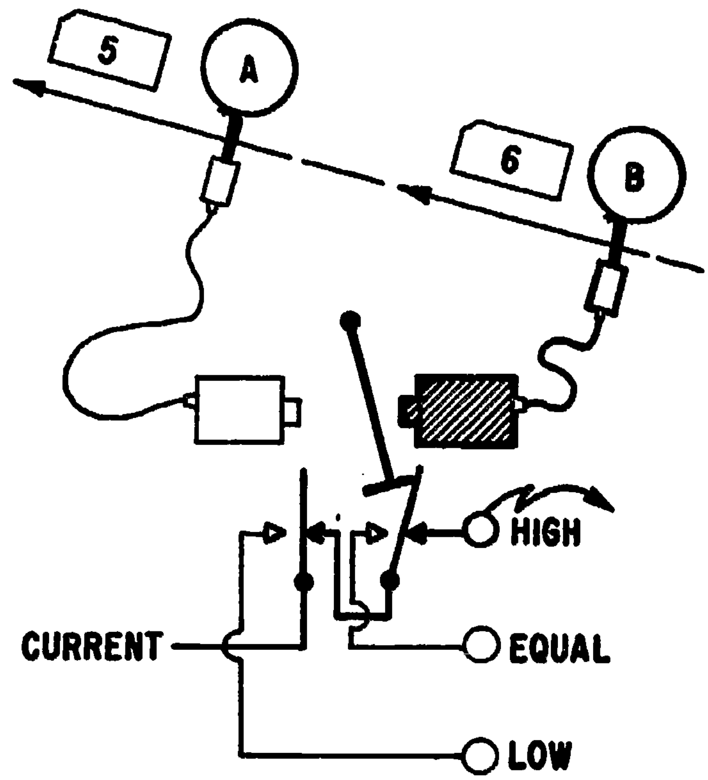


Figure 5-34.—High sequence.

The information in this chapter was presented in rather general terms. As was pointed out in the beginning, it was not the intent to familiarize or restrict you to a specific machine. The purpose was to inform you of those functions and operations that are similar in many different machine types.

Your knowledge of functional wiring principles should prove to be an important factor for you.

IBM EAM TECHNICAL MANUALS

This manual presents the technical information sufficient for advancement in paygrades E4 and E5.

Your job assignment in the Navy may require much greater knowledge of specific machines. If you find yourself in this position, there are a few things you may do.

First, consult your immediate supervisor. Request (if not offered) any on-the-job or formal classroom training provided by the command. You will be given one or both of these in most cases.

To supplement this manual, on-the-job training and classroom training, you may make use of the many manufacturer's technical reference manuals.

These manuals are written for ease of understanding. They do, however, require that you be familiar with data processing terminology.

Generally speaking, the material covered in these reference manuals includes:

MACHINE SPECIFICATIONS–such as speeds, hopper and stacker capacities and machine part nomenclature.

MACHINE FUNCTIONS–such as printing, punching, listing, adding and subtracting.

MACHINE CONTROLS–lights, switches keys and stations.

OPERATION EXAMPLES–detailed narratives and wiring diagrams of functions capable of being performed.

TIMING CHARTS–location of hubs, their own degree of exit or entry time, cycle information and related notes.

CHAPTER 6

INTERPRETERS

You have learned that data processing machines read cards by sensing the punched hole. It is possible also for you to determine the contents of a card by reading the punched holes, but this is a slow and tedious process. Interpreters are designed to read the holes punched in a card and print the data across the card. This makes it possible to use punched cards for many applications which would otherwise require the use of printed forms. For example, rotation data cards can be machine prepared, interpreted, and forwarded to activities for recording of data on personnel that are due for rotation. Muster cards, paychecks, and many other types of cards can be prepared and interpreted for use outside the data processing installation. You will find many uses for interpreting within your own installation. Each file of cards you maintain is usually interpreted in some manner to provide ready reference to the contents of the cards. Interpreted cards provide assistance when you refer to a file for a particular item of information. Manual card filing is made easier when the cards in the file as well as those to be filed are interpreted.

This is the first chapter on data processing machines which deals with wiring a control panel to direct machine operations. While the interpreter is relatively simple to wire and operate, a thorough understanding of the wiring principles presented in this chapter will enable you to better understand the wiring principles involved for machines that are more complicated.

The operating principles of all popular types of interpreters are basically the same. However, in order to acquaint you with their different characteristics each machine will be discussed separately.

INTERPRETER, TYPE 548

The type 548 interpreter, pictured in figure 6-1 is designed to translate numerical and alphabetic punched card data into printed characters across the face of the card. Printing is performed by a set of 60 typebars, allowing for printing a maximum of 60 characters on one line in one pass of the cards through the machine. Data can be printed on either of two printing lines, called UPPER LINE and LOWER LINE. A space or spaces may be left between different items of information. If all the data to be interpreted cannot be printed on one line, the remainder can be printed on a second line by rotating the printing position knob and passing the cards through the machine again. Flexibility of control panel wiring provides for printing the data in any sequence desired. Interpreting proceeds at a rate of 60 cards per minute.

OPERATING FEATURES

The MAIN LINE SWITCH supplies power to the machine, and must be ON for all machine operations. A green READY LIGHT goes on to indicate that the machine is ready for operation. The START KEY is depressed to start card feeding. It must be depressed and held until three cards have been fed in order for continuous card feeding to be effective. The STOP KEY is depressed to stop card feeding.

Hopper

The card hopper holds approximately 700 cards. Cards must be placed in the hopper with the face up, and the 12 edge toward the throat of the hopper. When the last card leaves the

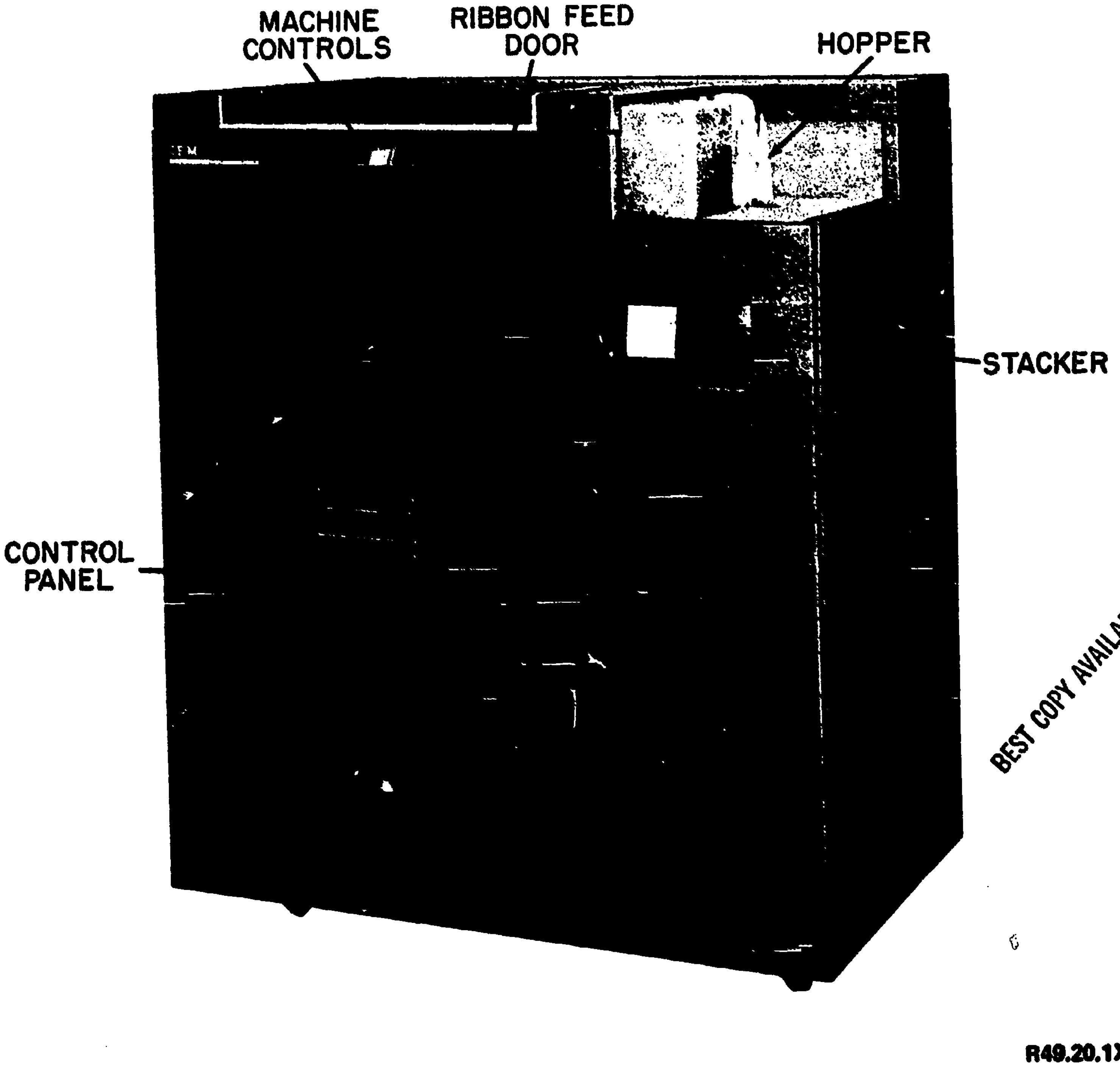


Figure 6-1.–Type 548 interpreter.

hopper, it will be interpreted and stacked automatically.

Stacker

The card stacker, located directly beneath the hopper, holds approximately 900 cards. If the stacker becomes filled, card feeding is automatically stopped. The cards must be removed from the stacker and the start key depressed in order to resume interpreting.

Printing Position Knob

Sixty characters can be printed on either of two lines across the face of the card. Upper line printing occurs along the top edge, above the 12 punching position. Lower line printing occurs

between the 12 and 11 punching positions. The line to be printed can be manually selected by rotating the printing position knob, located in a recess on the back of the machine, to the desired position (see fig. 6-2). When the knob is set at U, printing occurs on the upper line. When it is set at L, printing will be placed on the lower line. The printing line can be easily selected by pulling the knob and turning it clockwise for upper line printing, or counter-clockwise for the lower line.

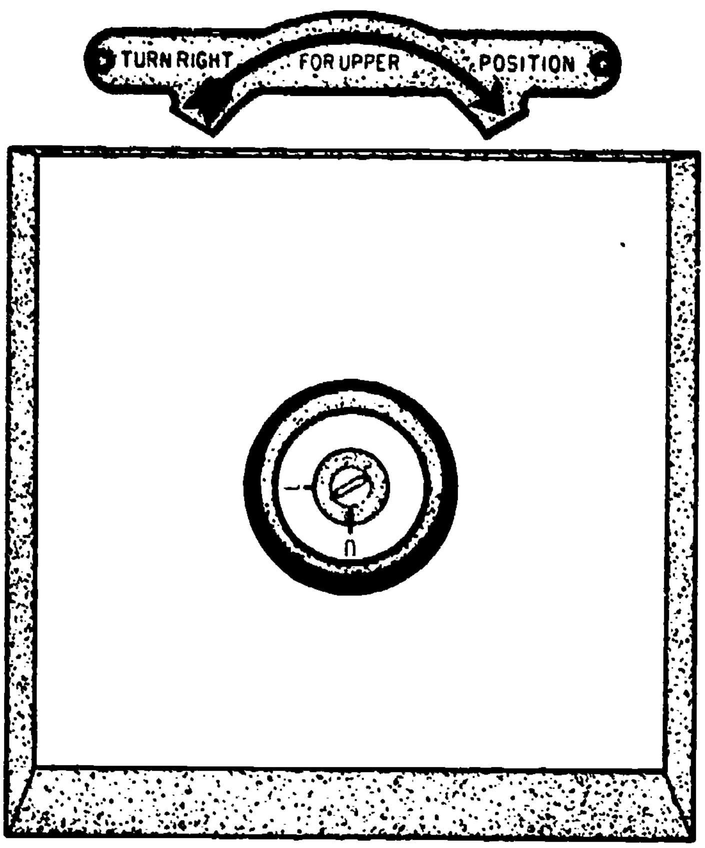


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Figure 6-2.—Printing position knob.

A deck of cards to be interpreted on upper and lower line printing must be fed through the machine twice. Not only must the print position knob be reset for the second pass of the cards, but a different control panel must be used.

If the same panel were used, the same characters would print on both the upper and lower line. Either a different permanent wired panel is inserted, or the control panel is rewired to print those columns not printed on the first pass.

INTERPRETING FEATURES

X Brushes, Terminal Block

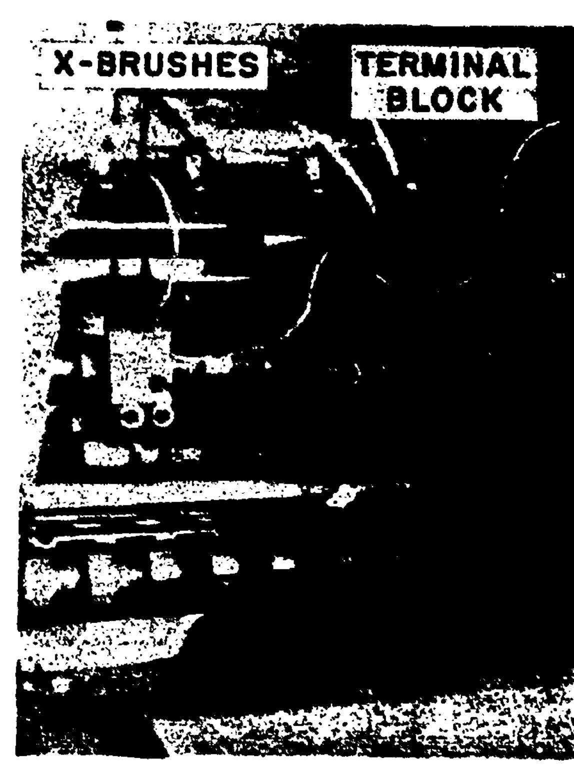
Interpreting of X or NX (no X) cards can be controlled with the use of selectors impulsed from any one of five X brushes located under the top cover, just to the left of the hopper. The five X brushes, as shown in figure 6-3, can be manually positioned to cover any five non-adjacent card columns. Two columns must separate adjacent brushes.

The X brush is wired to the X brush terminal block, which is a five hub panel located near the X brush station. When the X brush reads an X punch, the current is passed through the terminal block and is available at the corresponding X brush hub on the control panel.

The X brushes are timed to read only X-timed pulses and are normally used to pick up selectors, as indicated in the timing chart in figure 6-24.

Reading Brushes

A card is read by a set of 80 reading brushes, one brush for each column. As a card feeds from the hopper, it passes between these brushes and



R49.256X

Figure 6-3.—X brushes, terminal block.

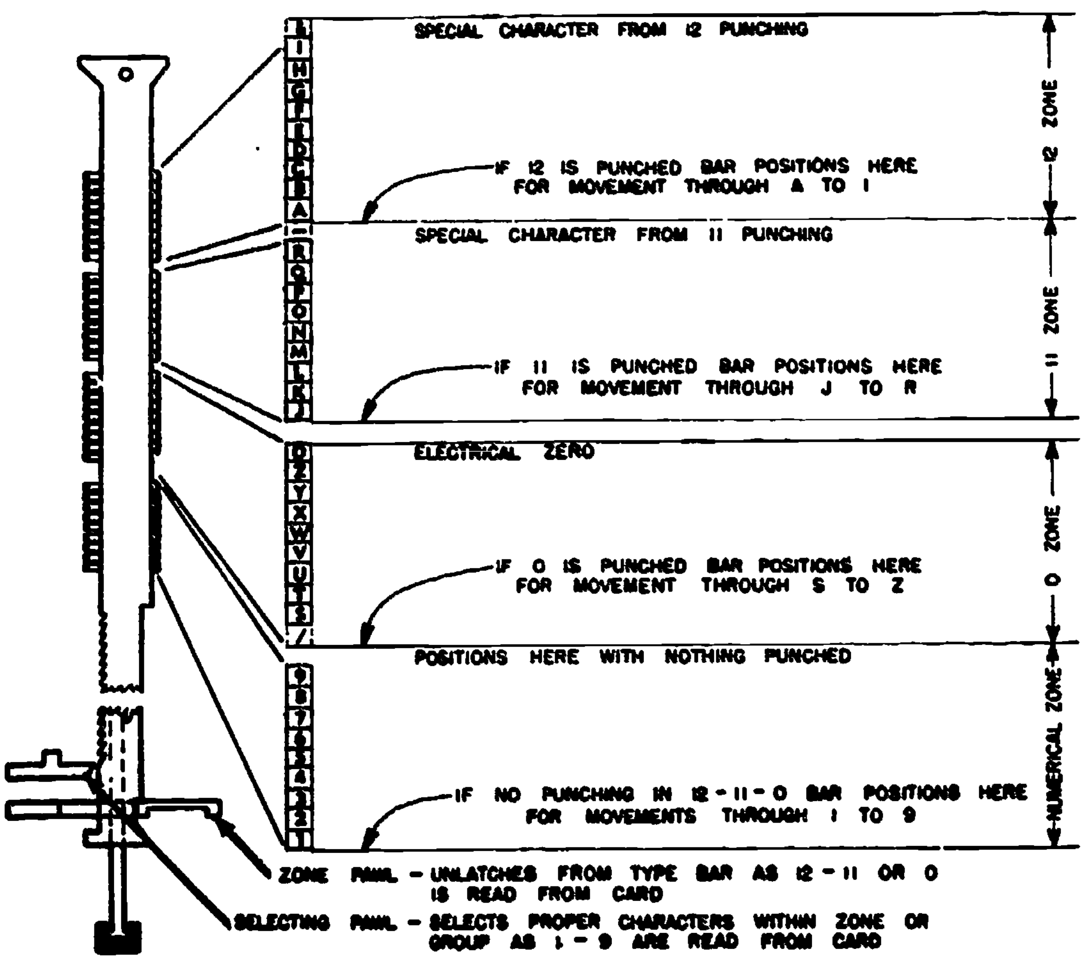
an electrical contact roller. Whenever a punched hole in the card is sensed by a reading brush, an electrical impulse travels from the roller through the brush, and is directed by control panel wiring to the typebar.

All punching positions 12 through 9 in any column of the card can be read as the card passes the reading brushes. All 12 punches are read first, followed by the 11 punches, then the zero punches, and so on through the 9 punches, since the cards are fed 12-edge first. However, the machine will recognize only the first zone and the first numerical punch sensed by a reading brush. Thus, if a column is punched with several zone and numerical punches, the machine will combine the first zone punch and the first numerical punch sensed by the reading brush to produce an alphabetic character. For example, if a column is punched with a 12, 11, 3, and 8, the 12 and 3 punches would be combined to print the letter C. Or, if a column is punched with several numerical punches but no zone punches, the first numerical punch read will be printed. For instance, if a column is punched with a 2, 5, and 9, the 2 would print since it is the first digit read.

The brush assembly is located just under the hinged top cover of the machine, to the left of the feed hopper. Access to the brushes may be gained by raising the front part of the cover.

Print Unit

The printing mechanism consists of 60 typebars, each containing 39 printing characters: 10 numerical (0 through 9), 26 alphabetic (A through Z), and 3 optional special characters. These special characters are actuated by a single 11, single 12, or combination 0-1 punch, as seen in figure 6-4.



R49.255X

Figure 6-4.–Layout of 548 typebar.

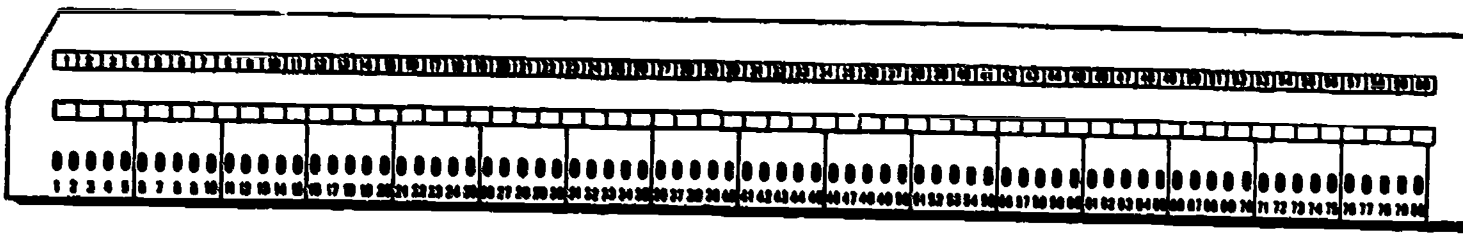


Figure 6-5.—Interpreter printing positions. R49.21X

In order to print in specific locations across the card, exact typebar positions must be determined before wiring the control panel. Since there are 80 columns in the card and only 60 typebars, the ratio of typebars to card columns is 60 to 80, or 3 to 4. This means that printing positions do not align over card columns.

Figure 6-5 shows each printing position in relation to the card columns.

Ribbon

The ribbon in the print unit is a little wider than the length of the card. It moves a little each time a card is interpreted, and reverses direction automatically. It does not normally require attention until the printing on the cards becomes too light to be legible. At this time, it should be replaced by a new ribbon, following the procedure described under operating suggestions.

CONTROL PANEL

The control panel for the 548 is depicted in the wiring diagram in figure 6-6. The hubs on the panel are as follows:

Reading Brushes

There are 80 hubs representing one exit for each reading brush.

X-Elimination

There are two groups of X-eliminators. Each group consists of 10 positions. One is standard equipment for the machine. The other is optional and may be activated upon the user's request if the jobs run require more than 10 X-elimination actions. (All optional features are indicated as shaded areas).

There is also one switch for each group of X-eliminators.

Selectors

There are four selector groups (two optional) of five positions each. There is also a PU hub for each selector.

Print Entry

There are 60 common hubs. Each represents an entry to activate its respective typebar.

X-Brushes

There are five common (even though no connecting line appears) hubs. Each hub represents an exit for a corresponding X reading bursh (figure 6-3).

Zero Elimination

There is one group of 20 positions for control of zero elimination. (This is used in controlling the nonprinting of high order zeros of numeric fields and will be explained later.)

Control panels are sometimes interchangeable between types of machines. If this practice is observed, paper overlays are utilized for correct identification of the hubs. The overlays are similar to the wiring diagrams and are placed on the face of the control panel.

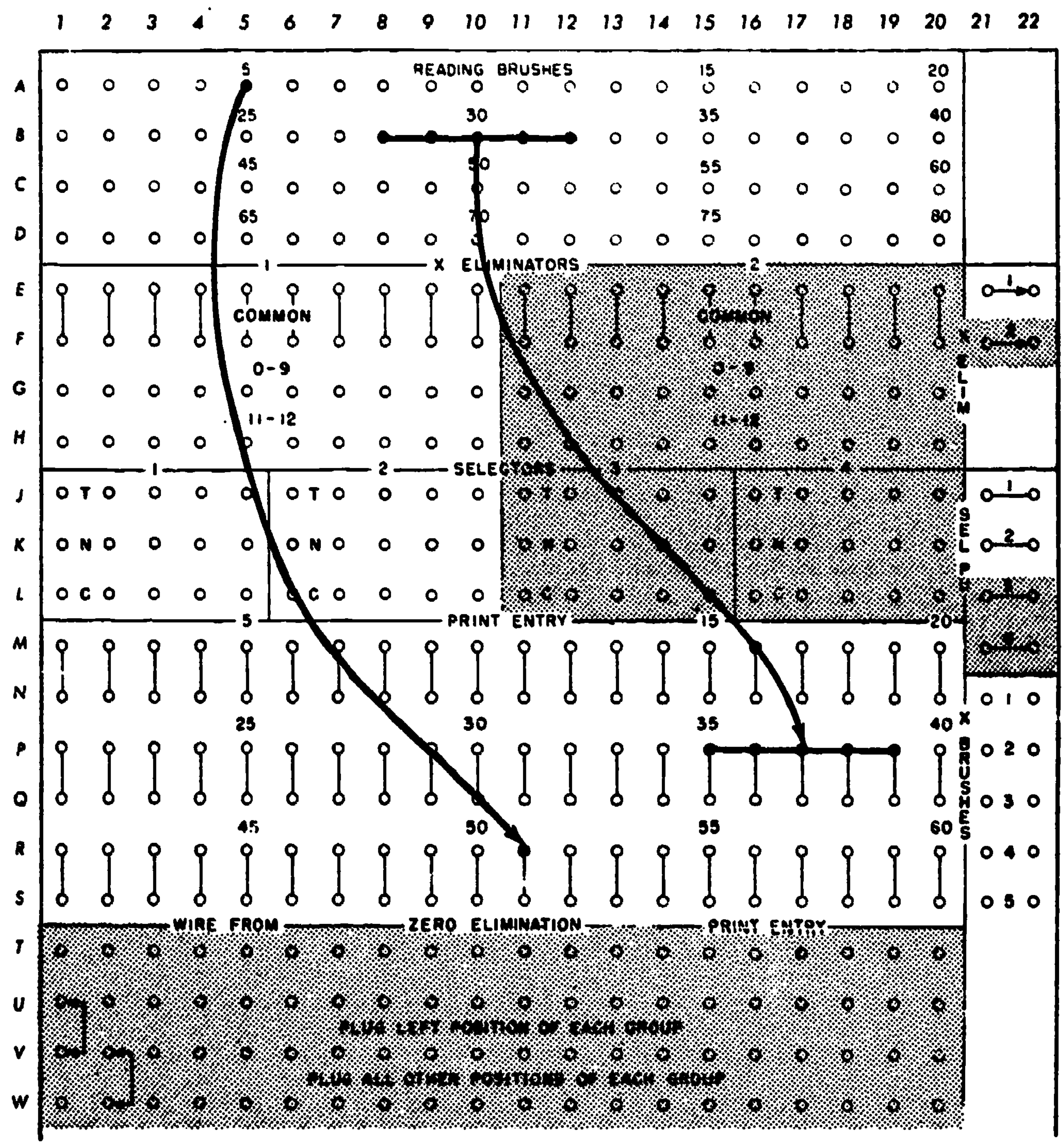
PRINCIPLES OF CONTROL PANEL WIRING

Control panel wiring for typical operations which may be performed on the type 548 is discussed in the following paragraphs.

Normal Printing

The arrangement of printing on a card is determined by control panel wiring. For example, if card column 5 is to be printed in print position 51, you would connect a wire from reading brush hub 5 to print entry hub 51. If card columns 28 through 32 are to be printed in print positions 35 through 39, you would wire reading brush hub 28 to print entry hub 35, reading brush hub 29 to print entry hub 36, and so on. Figure 6-6 shows the method in which the control panel is wired for normal printing.

Normal printing is a term pertaining to all fields that are wired directly from reading brushes to print entries with no other controls necessary (e.g.,–X-elimination or zero elimination).



49.23

Figure 6-6.—Normal printing.

Most installations will have what is called a 60/60 board. This is a permanently wired board for interpreting the first 60 columns of cards.

Controlled Interpreting

The explanation of selectors found in the chapter on functional wiring principles should be reviewed at this time.

Controlled interpreting involves selectors, selector pickup hubs, X brushes, reading brushes and print entry hubs.

Master cards, detail cards and X cards are utilized for controlled interpreting and are defined in the following paragraphs.

MASTER CARDS.–Those cards which either singularly or collectively (a file) contain relatively permanent data, or those cards that are treated as an authority (primary card, primary file) in a particular job.

Master cards are usually, but not always, identified by an 11- or 12-punch in a specific column. This provides a means of identification for use in control panel wiring or sorting operations. An example is a master card file containing (on each card) a man's social security number, full name and other service record data.

DETAIL CARDS.–Those cards which contain relatively transient data to be processed in combination with corresponding master cards.

An example is a card that contains social security number and secondary or additional information to a master card. No name appears on it.

By matching a detail card to its corresponding master card (social security number would agree on both), a complete report could be run on the man's Navy career. If the master cards do not have an identifying control punch, the detail cards will.

X CARDS.–These are not necessarily the X punched master or detail cards although some commands refer to X and NX cards rather than detail and master. X cards are file cards requiring special handling.

There may be master cards, detail cards and X cards (special master or detail cards) in a file. An example is a file of master cards with a control X punch in column 80 of all cards and another X punch in column 72 to denote a reservist.

For an example of controlled interpreting let's assume an interpreting job is to be performed on the combined file shown in figure 6-7.

The following is information about the files:

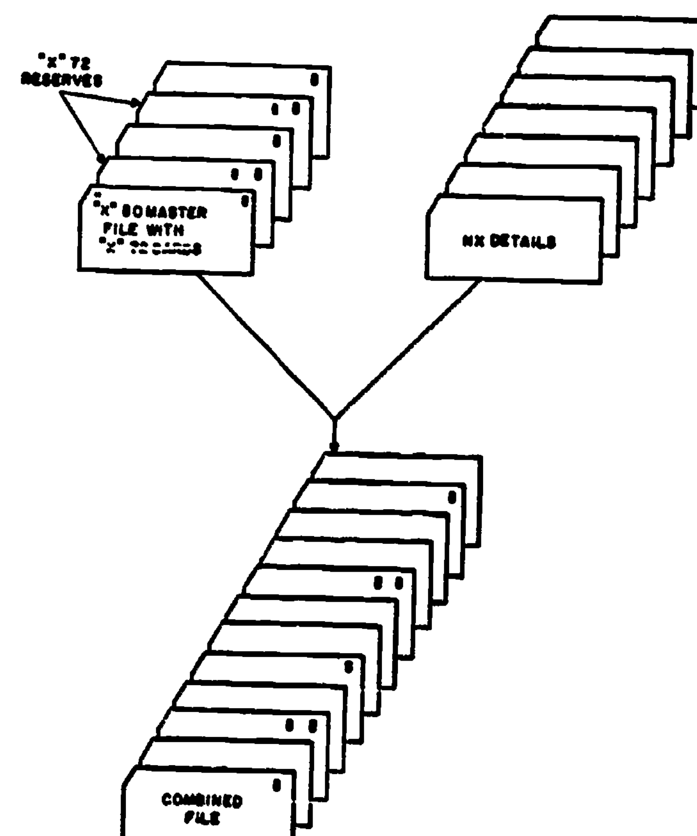
X-80 master cards with an "X" in column 72 have USNR punched in columns 55 through 58. The other X-80 master cards are blank in columns 55 through 58.

X-80 master cards have the serviceman's name punched in them. NX 80 detail cards do not have names (only matching social security numbers).

NX-80 detail cards have information punched in card columns 56 through 60. They also can have alphabetic information punched in card columns 70 through 76.

This job requires a panel to be wired to accomplish the following:

1. Interpret social security number on all cards from columns 1-9 into print positions 1-9.



49.410

Figure 6-7.—Master and detail combined file.

2. Interpret the man's name from columns 61-71 of all X-80 cards into print positions 21-31.
3. Interpret columns 55-58 (USNR) into print positions 57-60 from all X-80/X-72 cards.

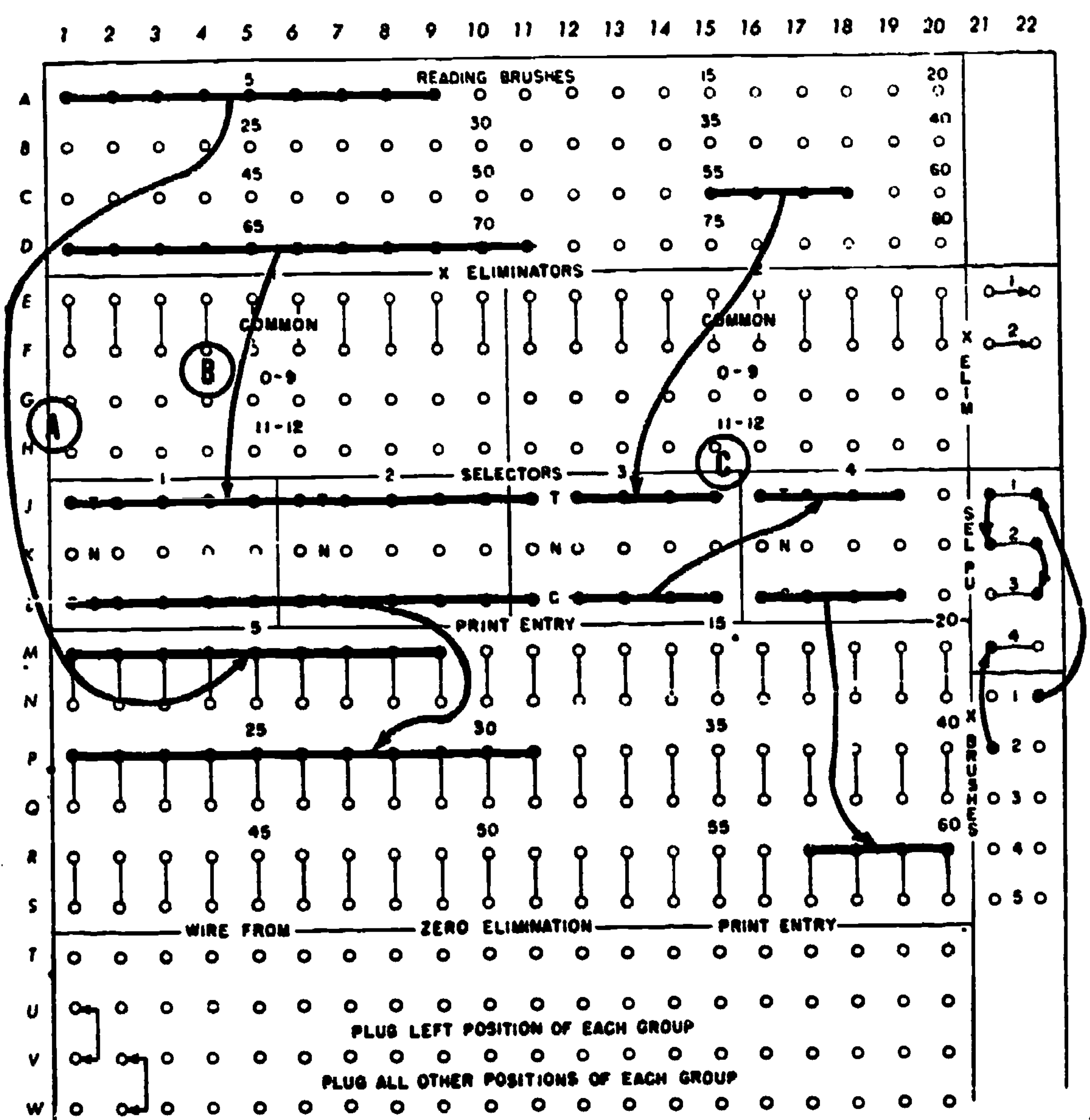
Figure 6-8 is a correct wiring diagram for the required wiring. The circled A wiring on the figure allows for each and every card (X and NX) to have social security number interpreted.

The circled B wiring is for interpreting the name field for only the X-80 cards. This field is wired through the transferred side of selectors to allow the read impulses to reach the print entries for X-80 cards only. (X-brush 1 is reading column 80 and wired to SEL PU's 1, 2 and 3.)

The circled C wiring is to interpred USNR in print positions 57-60 for all X-80 cards that also have an "X" in 72. This field is wired through two selectors, each picked up by a different X-brush (X-brush 2 is set on column 72).

Selector number three allows the information to transfer through on an X-80 card to selector number four. Selector four is transferred on an X-72 card and allows the interpreting. This ensures that it is a master (X-80) card for a reservist (X-72).

A single X-80 or a single X-72 will not allow the interpreting of USNR. Remember it was stated that the NX cards would have alphabetic data in column 72. Therefore, if we wired the



49.411

Figure 6-8.—Selective interpreting.

field through only one selector controlled solely by X-72, the selector could be transferred for detail cards as well as master.

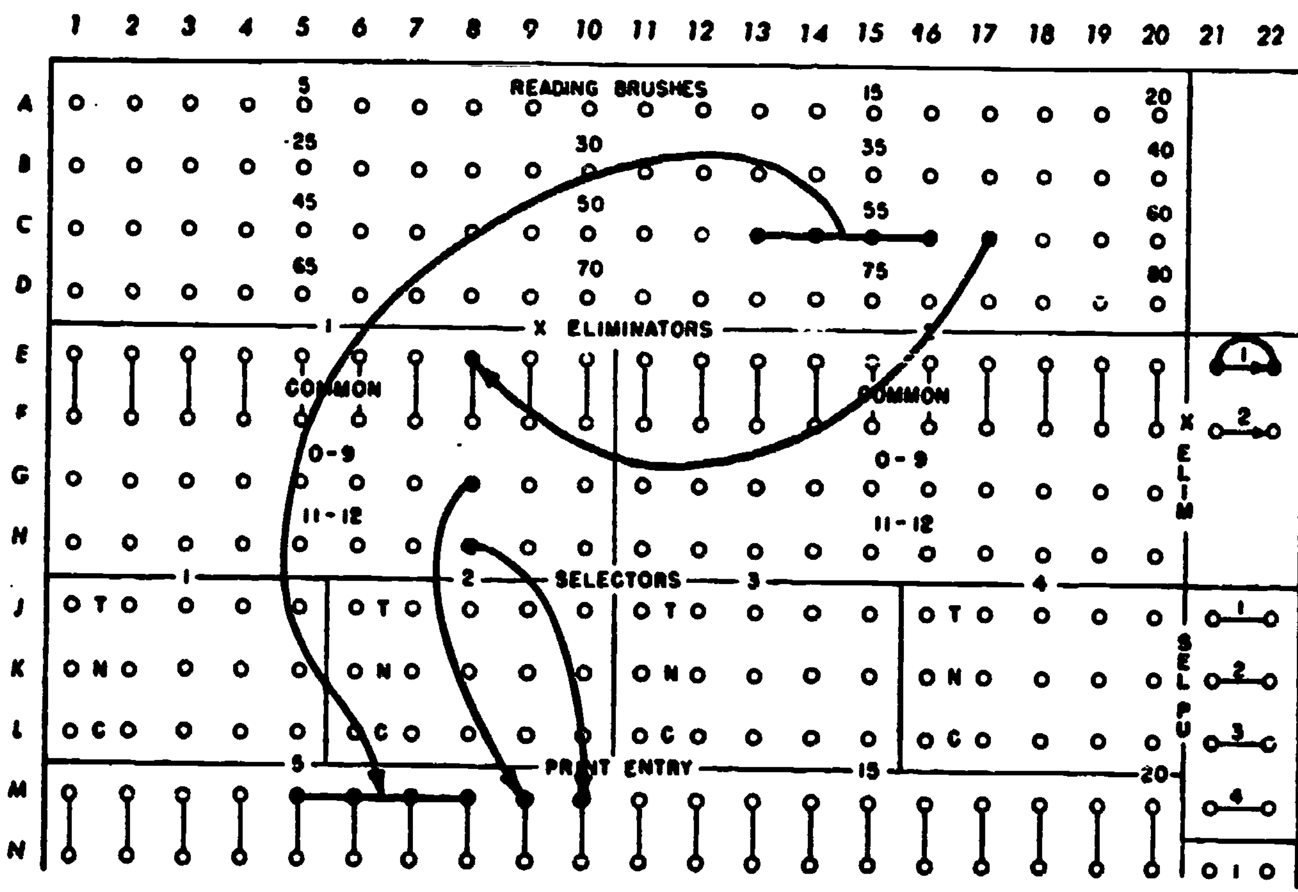
X Elimination

Some numerical fields in a card may contain an 11 or 12 punch over one of the columns for purposes of identification or control. If the column containing the 11 or 12 punch were wired directly to a print entry, the control punch would combine with the numerical punch in that column and cause an alphabetic character to print. The control punch can be prevented from reaching the print entry hub by using the X eliminator.

The X eliminator splits a card column between 0 and 11 punching positions. There is a common hub, a hub for 11-12 impulses, and a hub for 0-9 impulses. A connection exists between the common and 11-12 hubs whenever the 11-12 punches in the card are being read by the reading brushes. This connection automatically changes after the 11 position has been read so that the common and 0-9 hubs are connected while 0-9 punches are being read.

Assume you have the credit amount of 10327 punched in card columns 53 through 57, with an 11 punch in column 57 to identify the amount as being a credit. If you wired column 57 directly to a print entry hub, a P would print. However, if you wired it first to common of the X eliminator and out of the 0-9 hub to a typebar, a 7 would print. The 11 punch can be wired from the 11-12 hub to a print entry left or right of the amount to identify it as a credit. The control panel switch for the X eliminator must be wired ON for this operation. If the X eliminator switch is not wired, the common hubs will be connected to the 11-12 hubs for the duration of each card cycle, and any impulse 12 through 9 entered into a common hub is available from the corresponding 11-12 hub.

Figure 6-9 shows how the wiring for X elimination is accomplished. Columns 53 through 56 are wired normally. Column 57 is



49.25

Figure 6-9.—X elimination.

wired through a position of the X eliminator so that the units position of the field will be printed numerically. The 11 punch causes typebar 10 to print a special character provided that typebar has been equipped to print a character from an 11 punch.

Zero Elimination

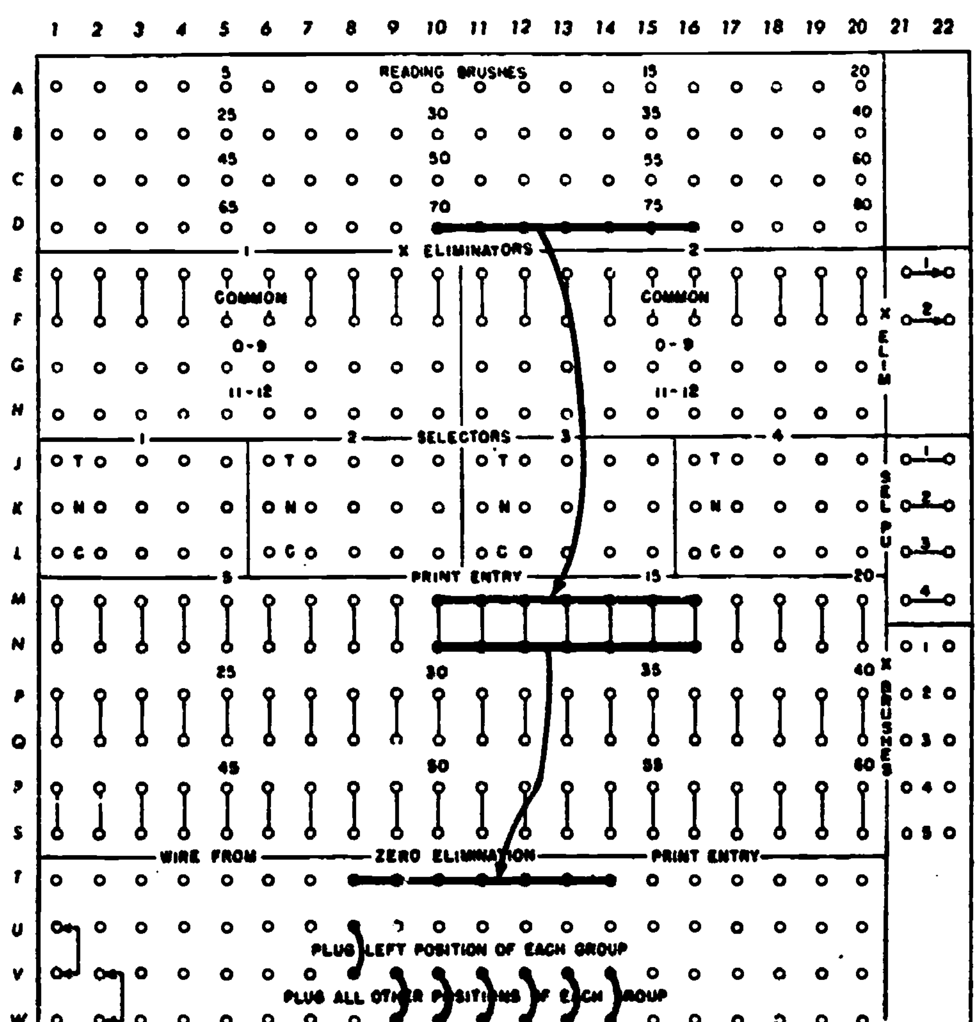
If a numeric field is wired normally or through selectors on the 548, all zeros punched and read will print. In those cases where many fields are interpreted the fields will be printed right next to each other. This often causes confusion when trying to read the interpreted card.

One way to alleviate this congestion is to wire the numeric fields for zero elimination. This will eliminate the interpreting of high order zeros.

If a field contained the number 0041440 and were normally wired, it would print as 0041440. If, however, it were wired for zero elimination, it would print as 41440. (The high order zeros or zeros to the left of the first significant digit do not print.)

To accomplish this let's assume the number 0041440 is in columns 70-76. Figure 6-10 shows the correct wiring for zero elimination of this field.

The field is wired normally from reading brushes to print entries. It is then wired from the print entry common hubs to the top row of the zero elimination section. (Any group of these zero elimination hubs may be used, but all of those used for one field must be adjacent.) The hubs below (rows U, V and W) are then wired as the panel labeling indicates. The high



49.412

Figure 6-10.—Zero elimination.

order (left) position of the field is wired between rows U and V. All other positions of that field are wired between rows V and W.

OPERATING SUGGESTIONS

Operating an interpreter is simple. Since it requires attention only about every 10 minutes, to refill the hopper and empty the stacker, you may perform other jobs at the same time. However, there are a few points you should remember about operating the interpreter.

1. Always use a test card or cards before starting an operation. This in necessary to determine if you have the right control panel, or if the panel you have just wired is wired correctly. The use of tests cards determines also if the machine is working properly.
2. Be sure to check the printing position knob before you start each operation. Make certain it is turned to the line on which you wish to print.
3. Joggle cards to arrange them in perfect alignment before placing them in the hopper in order to avoid card feed failures.
4. Remember that, because the cards are fed FACE UP, the last card in the handful placed in the hopper will be the first one of that group to be interpreted. If you are interpreting cards that must remain in the order they are in, you must start at the back of the file and work toward the front. You must return the interpreted cards to the file in the same manner in which they were removed.
5. If the machine stops with the hopper loaded and the stacker not filled, check the last card fed into the stacker. If this card did not stack properly because of folding or pleating, remove the damaged card and check to determine if it should be repunched in order to avoid feeding trouble in later machine operations. Remember that you must check all repunched cards to ensure that they are exactly the same as the original ones.

Ribbon Changing

When the printing on the cards becomes too light to be legible the ribbon should be replaced by a new ribbon, following the procedures outlined in figure 6-11.

INTERPRETER, TYPE 557

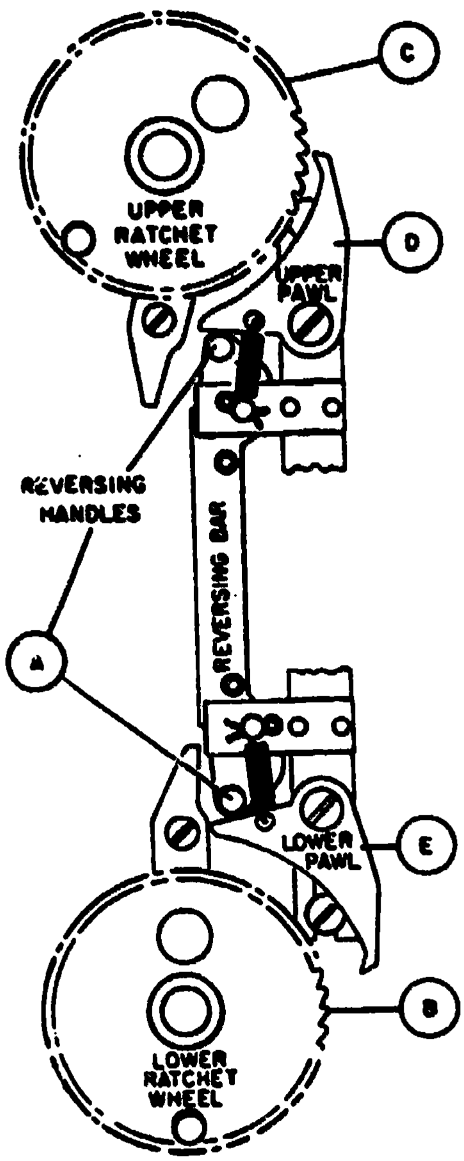
The type 557 interpreter, shown in figure 6-12, reads data punched in a card and prints that data across the card at the rate of 100 cards per minute. Printing is performed by the set of 60 typewheels, allowing for printing a maximum of 60 characters on one line in one pass of the cards through the machine. A total of 25 lines can be printed across the card by setting the printing position dial to the desired line. Figure 6-15 illustrates the 25 lines of printing. Cards must be passed through the machine one time for each line to be printed.

However, in addition to the usual interpreting operations, the type 557 interpreter can be equipped with several special devices which broaden the range of applications that may be performed. The following paragraphs will give you an idea of some of the additional features which can be installed and the functions they perform. While you are not expected to have a thorough understanding of all these special devices and their applications, you can learn more about them by referring to the type 557 reference manual prepared by the manufacturer.

1. REPEAT PRINT. Data can be read from a master card and printed on that card and the detail cards following it. At the same time, control data in each card can be compared to ensure that printing occurs on the proper cards.
2. SELECTIVE STACKERS. As many as four stackers can be installed on the 557. Cards are directed to the stackers by proper control panel wiring. Duplicate master or detail cards, unmatched cards, and cards containing a control punch can be selected.
3. SELECTIVE LINE PRINTING. Cards can be controlled to print on each of 25 printing lines.

When posting ledger cards, the selective line printing device automatically locates the next available posting line, and prints the data.

4. INTERPRET EMITTER. This device emits impulses corresponding to each character which



548 RIBBON CHANGING PROCEDURE

1. UNLATCH AND RAISE BRUSH ASSEMBLY.
2. OPEN FRONT DOOR EXPOSING RIBBON FEED MECHANISM.
3. PUSH EITHER REVERSING HANDLE "A" DOWN TO DISENGAGE LOWER PAWL E, IF IMPOSSIBLE TO DISENGAGE LOWER PAWL "E", TURN LOWER RATCHET WHEEL "B" CLOCKWISE.
4. TURN UPPER RATCHET WHEEL "C" COUNTER-CLOCKWISE UNTIL RIBBON LEADER IS WOUND AROUND RIBBON.
5. PUSH EITHER REVERSING HANDLE "A" UP TO DISENGAGE UPPER PAWL "D".
6. TURN UPPER RATCHET WHEEL "C" CLOCKWISE UNTIL LEADER CLIP IS IN VIEW.
7. DISCONNECT LEADER CLIP.
8. REMOVE RIBBON BY PUSHING SPOOL TOWARDS REAR OF THE MACHINE.
9. INSTALL NEW RIBBON WITH NOTCHED END OF SPOOL TOWARD FRONT OF MACHINE WITH CONNECTING LOOP ON TOP.
10. ATTACH RIBBON LEADER CLIP TO RIBBON LOOP.
11. TURN BOTTOM RATCHET WHEEL "B" CLOCKWISE APPROXIMATELY TEN TURNS.
12. LOWER AND LATCH BRUSH ASSEMBLY. CLOSE COVERS.

R49.343X

Figure 6-11.—Ribbon changing procedure.

can be punched in the card. This makes it possible to print emitted characters in addition to characters punched in the card.

5. PROOF. Data that is printed on the card is checked by this device to make sure that the proper characters are printed. Print suppression, repeat print operations, and typewheel alignments can also be checked. If an error is indicated, card feeding stops.

6. CARD COUNTER. All cards can be counted when this device is installed, except those for which the proof device has signaled an error.

7. PRINT ENTRY. Printing is performed by 60 typewheels. Either of two control panel entries (print entry 1 and print entry 2) can be selected by a manually operated switch, located on the front of the machine. This makes it possible to interpret two types of cards in different ways while using the same control panel.

8. PRESENSING. This device consists of a set of control X hubs which can be used to control selectors for selecting alphabetic data in the same manner as the type 548. It can also be used to control the repeat print device to allow printing from a master card onto the following detail cards.

OPERATING FEATURES

The MAIN LINE SWITCH supplies power to the machine. The RUNNING INDICATOR light

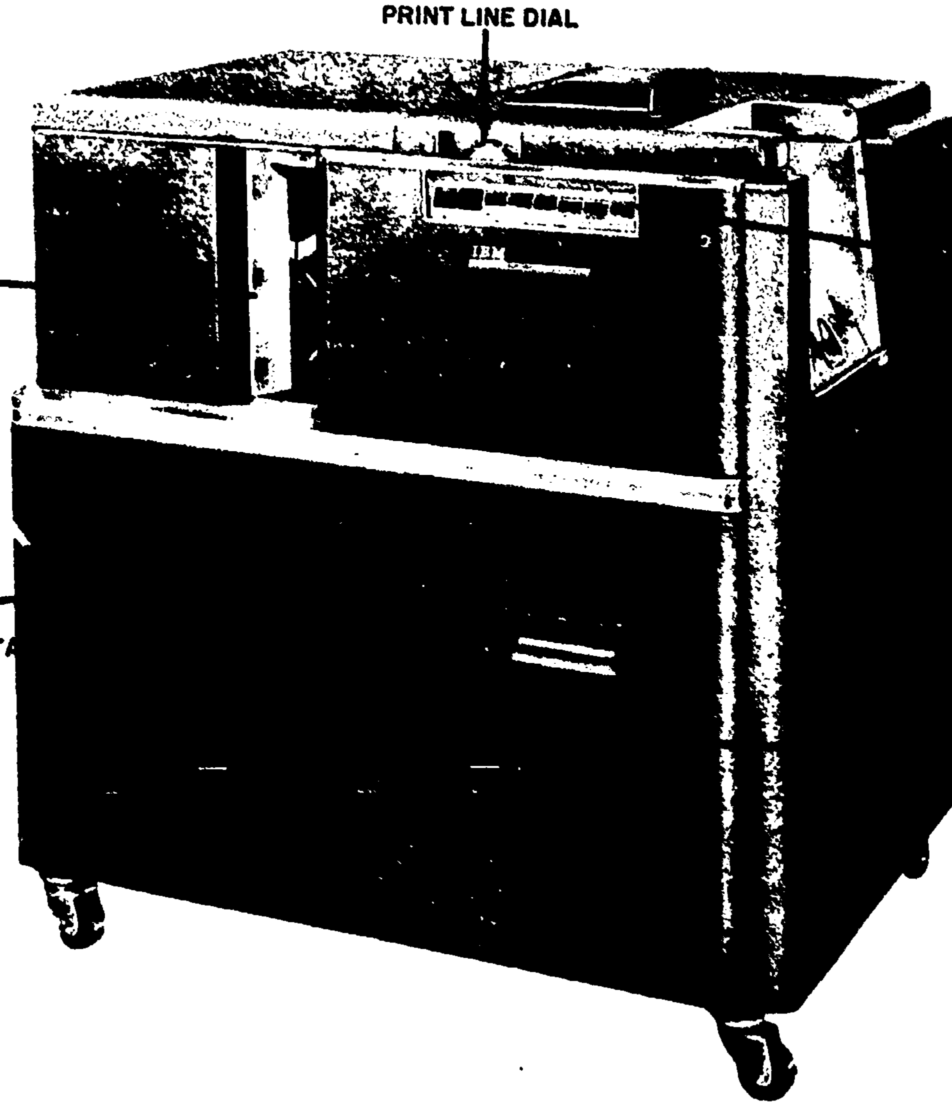


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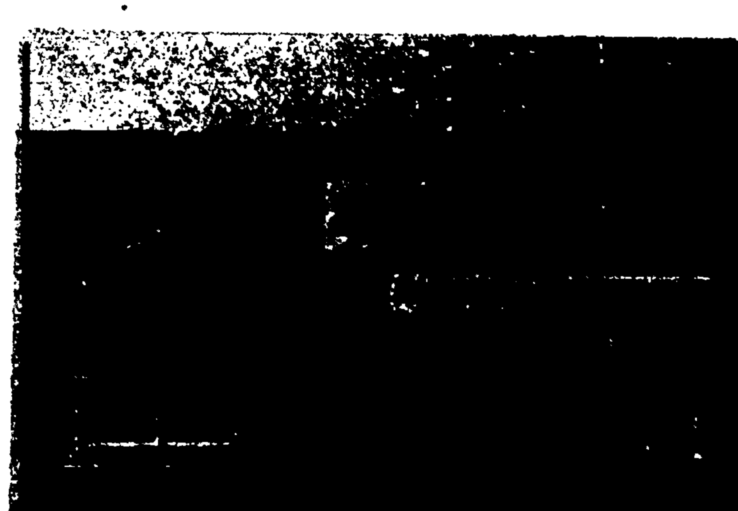
Figure 6-12.—IBM type 557 interpreter.

goes on to indicate that the machine is ready for operation, and goes OFF when the machine is in use. The START key is depressed to start card feeding. It must be depressed and held until three cards have been fed in order for continuous card feeding to be effective. When the STOP key is depressed, card feeding stops, but those cards already in the machine will be fed automatically into the stacker.

The ENTRY 1, ENTRY 2 SWITCH manually controls the selection of one of two different printing setups wired on one control panel. The two lights operate in conjunction with the switch and indicate which print entry is operating (fig. 6-13).



R49.20.2X

Figure 6-13.—Machine controls.

Hopper

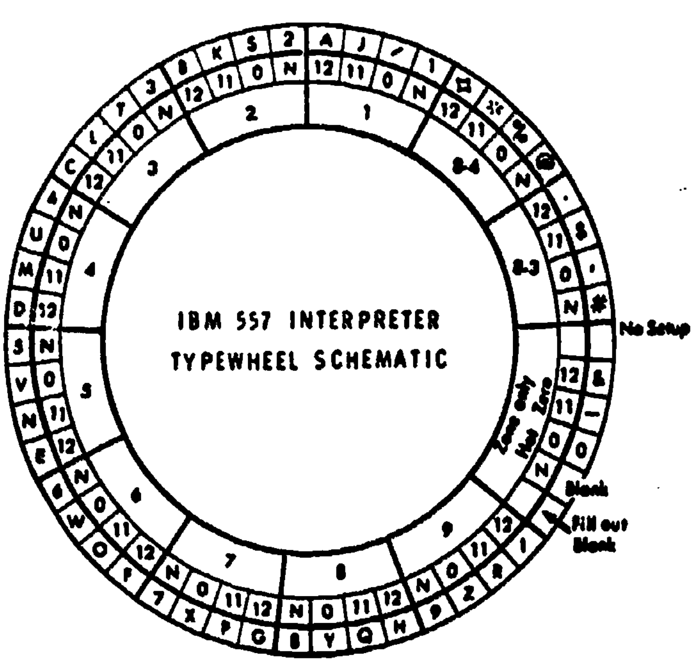
The capacity of the card hopper is approximately 800 cards. The cards must be placed in the hopper FACE DOWN, with the 12 edge toward the throat of the hopper. Therefore, you must work from the front of a file of cards toward the back in order to keep the cards in their original sequence.

Stacker

The capacity of the stacker is approximately 900 cards. When the stacker becomes filled, a stacker stop switch causes the machine to stop. After you remove the interpreted cards, the operation can be resumed by depressing the start key. Cards stack in their original sequence.

Print Unit

The printing mechanism consists of 60 typewheels. Each typewheel, as shown in figure 6-14 can print numerical, alphabetic, and special character information. Printing of special characters that have more than one numerical punch, such as the dollar symbol, requires a special character printing device.



R49.30X

Figure 6-14.—Type 557 typewheel schematic.

Printing Position Dial

The printing position dial, as shown in figure 6-13, can be manually set to cause printing on one of 25 printing lines. These lines are located from the 12 to 9 edge of the card as illustrated in figure 6-15. When the dial is set on position 1, printing occurs above the 12 punching position. When it is set on position 2, printing occurs at the 12 position. When it is set on position 3, printing occurs between the 12 and 11 positions. Each succeeding position causes printing to occur lower on the card, with the line 25 printing below the 9 position.

CARD FEED SCHEMATIC

The card feed schematic as shown in figure 6-16 should be referenced for determining the cards' position during explanation of operations in the control panel wiring section of this chapter.

557 CONTROL PANEL

The control panel for the 557 interpreter is illustrated in figure 6-17. The panel itself is like two panels in one. The left side is for control of the interpreting. The right side is for the proof feature, which is an option.

The hub groups are indicated by circled numbers in figure 6-17 and described in the following paragraphs.

1. X-0 Split-Interpret. This hub emits the impluse needed to control selectors to become column splits. This impulse times the selector for use as a column split with the interpret brushes.
2. X-0 Split-Proof. This hub emits the impulse to control selectors to be column splits. Selectors picked by this impulse are timed for use with the proof brushes.
3. Selector Pickup X-0 Split or Control X. This hub accepts impulses to cause the corresponding selector to transfer immediately. It is usually wired from the X-0 split hub to use the selector as a column split or from the control X hubs to allow selective control of X punched cards.

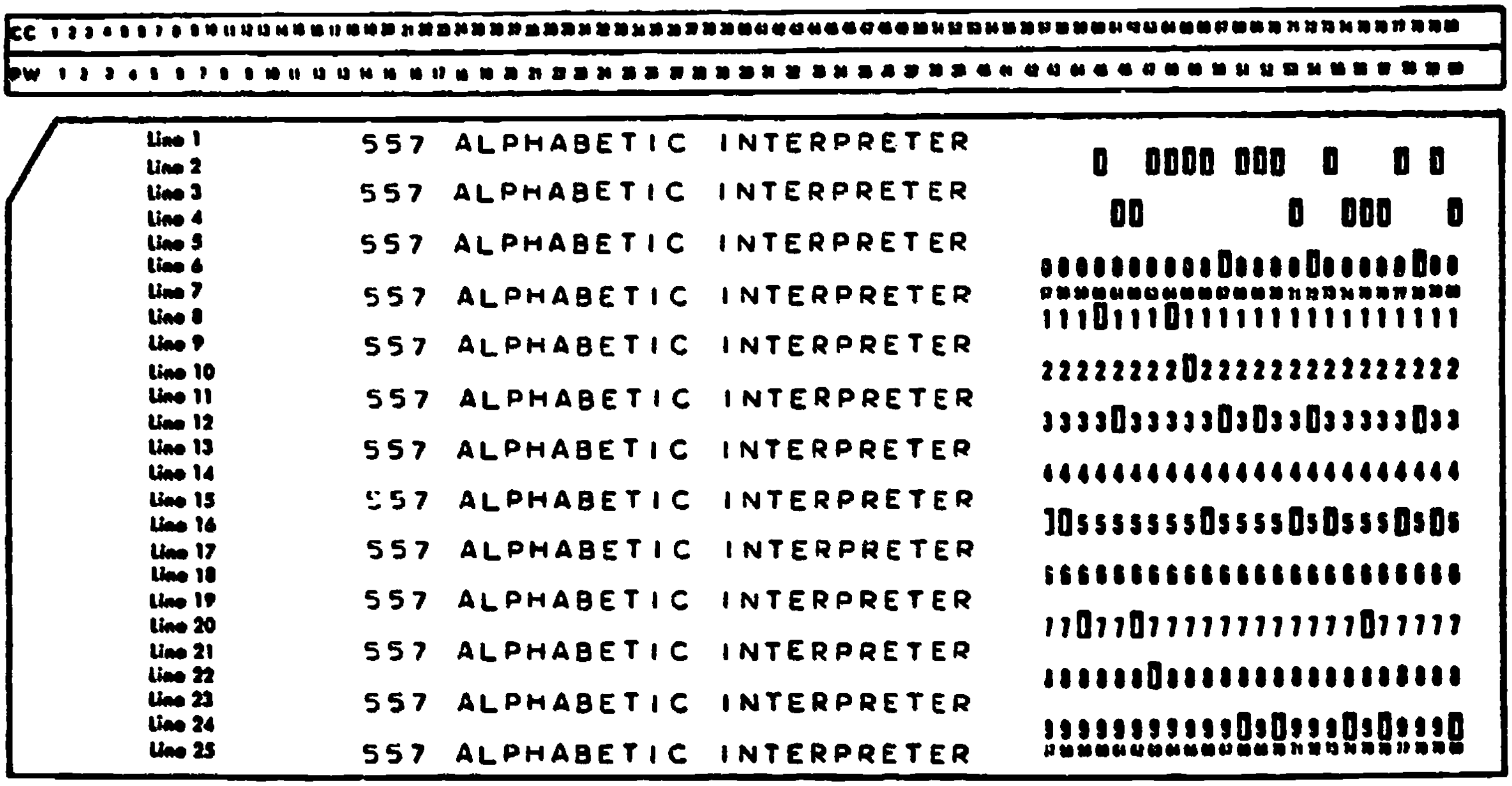


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Figure 6-15.—Interpreted card.

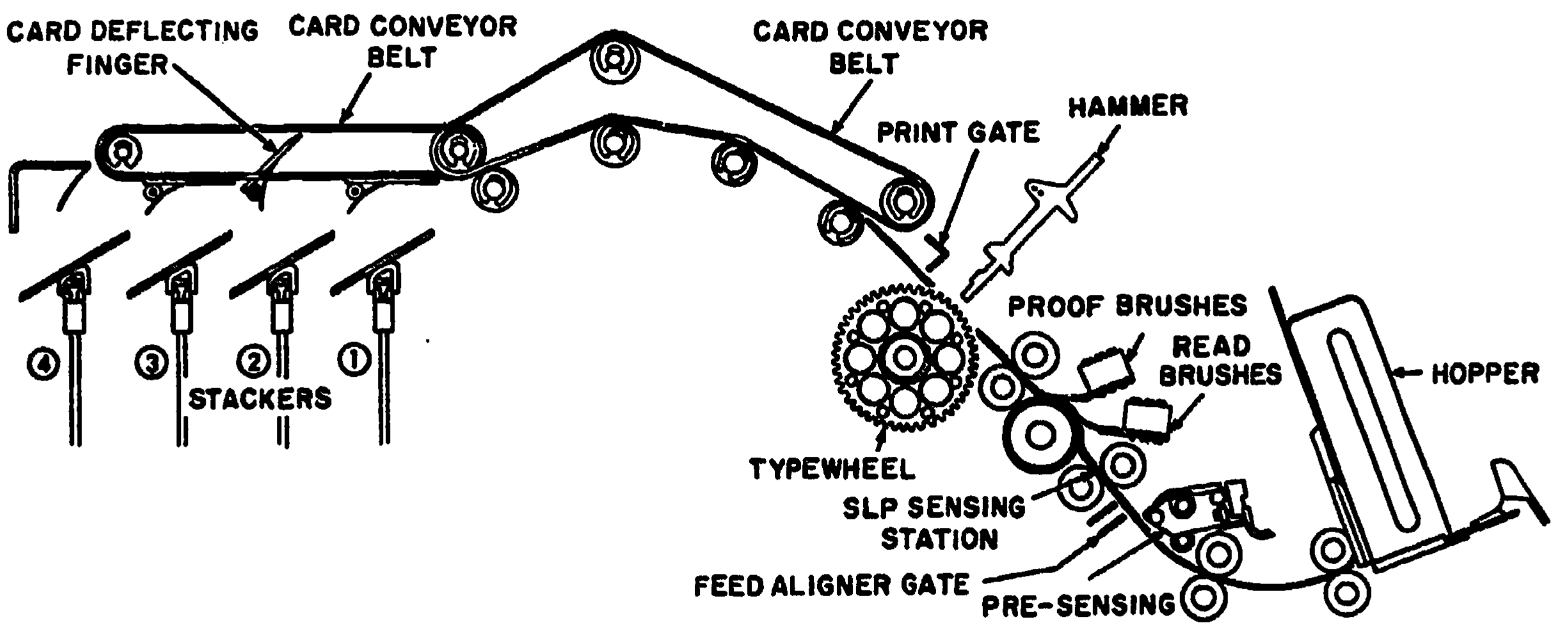

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Figure 6-16.—Card feed schematic.

4. Selector Pick-up-Digit. This hub accepts impulses to cause the corresponding selectors to transfer immediately. Digit pickups are normally wired from interpret or proof reading through the 11-12 side of a column split. When wired from proof reading, the pickup impulse must be filtered through a permanent column split.

5. Control X read. This is a pre-sensing station to read an X punch in a card for control

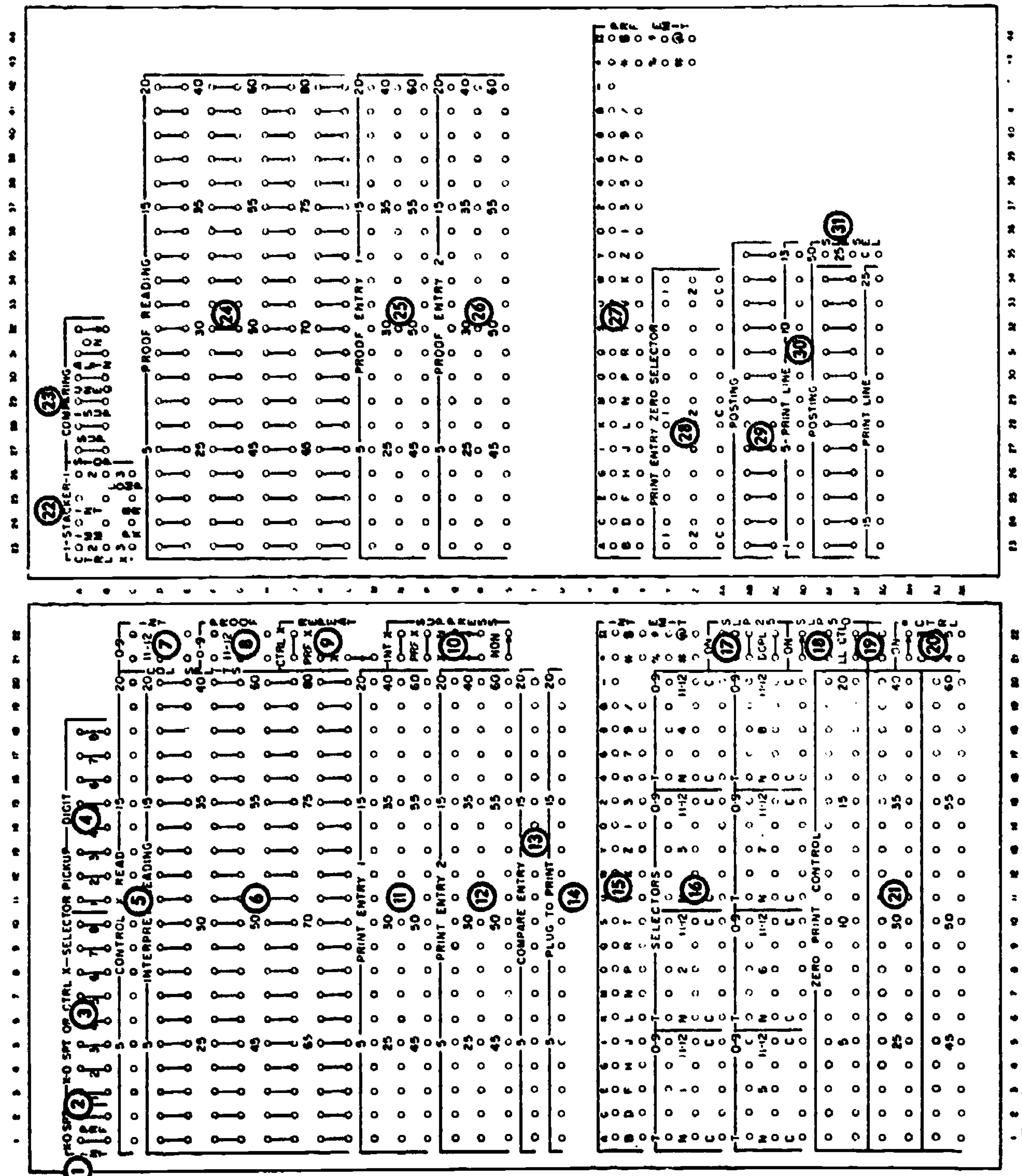

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Figure 6-17.–Control panel diagram.

purposes. It is used to control repeat print and control selectors for alphabetic selection.

6. Interpret Reading. These are exits for reading 80 columns of the card. They are usually wired to print entry for printing.

7. Column Splits-Interpret. These are automatic column splits timed for use with interpret reading. If more "points" are needed, X-0 split-interpret can be wired to the X-0 split pickup of a selector. The five points in the selector then assume the same function as the automatic column splits.

8. Column Splits-Proof. These are automatic column splits timed for use with proof reading.

9. Repeat.

CONTROL X. This hub accepts an impulse from control X read only to cause the information set up from that card to print again on

the next and succeeding cards until the next control X read impulse.

PROOF X. This hub accepts an impulse from proof reading only to check that the machine has performed the repeat print operation as directed.

X Switch. This hub is wired when master cards are X punched.

10. Suppress.

INTERPRET X. This hub accepts X or 12 impulses to cause the suppression of printing for that card. When used with proof, X's only must be used.

PROOF X. This hub accepts only X impulses to check the suppression of printing as controlled above.

X SWITCH must be wired except when suppressing printing of NX cards.

N SWITCH suppresses printing of all NX cards.

NON-SUPPRESS forces the printing of error cards. It is operative only if a proof device is installed on the machine.

11. Print Entry 1. This is an entry to 60 typewheels to cause printing, usually wired from interpret reading or interpret emitter. These hubs accept information only if the print entry switch is set for entry 1 at the operator's station.

12. Print Entry 2. This is an alternate entry to the typewheels to cause printing, usually wired from interpret reading or the interpret emitter. These hubs accept information only if the print-entry switch is set for entry 2 at the operator's station (i.e., keys and lights).

13. Compare Entry. These are entries to storage from interpret read for control information read from a master card. The control field in the following detail cards is then compared with the control field stored from the master card to check proper grouping.

14. Plug to Print. The compare entry hubs are connected internally through filters to the plug-to-print exit hubs. Information being compared, if it is also to be printed, must be taken from the plug-to-print hubs to the typewheels.

15. Interpret Emitter. These hubs emit the impulses necessary to cause the printing of characters indicated at each hub. To print special characters, however, the machine must be equipped with the special character printing feature.

16. Selectors. These are the points of the selectors, five per selector. Each point consists of three hubs arranged vertically: The bottom hub is the C or common hub; the middle, the N or normal hub; the top, the T or transferred hub. A connection normally exists between the C and the N hub unless the pickup hub of the selector has been impulsed and the selector thus transferred. The connection then is between C and T. When used as a column split, the hubs are C or common, 11-12, and 0-9.

17. SLP-25.

ON. This switch must be wired to activate SLP-25.

OFLO. This is an exit hub that emits only after all 25 lines of the card have been posted, i.e., on the 26th pass of the card. This impulse can be used to select the filled card to one of the selective stackers or to stop the machine. Print suppression is automatic when OFLO-25 emits.

DATA CARD PRINT LINE (DCPL) hubs are exit hubs that control printing on the master-data card. They are normally wired to a print-line hub to print all data cards during a specific pass of the file.

18. SLP-50.

ON. This hub must be wired on for all SLP-50 operations.

OFLO. This hub emits an impulse after the 25 lines have been posted on the right half of the card, i.e., on the 51st pass of the card. It can be used to select ledger cards to the stackers or to stop the machine.

LL CTL. This is an entry hub usually wired from a posting hub immediately following the last desired posting pass of the card. If fewer than 25 lines are being printed on each half of the card, the impulse to LL CTL causes one of the OFLO hubs to emit. The OFLO impulse is then used to initiate further desired action.

19. Card Counter. A switch to control the counting of cards.

20. Asterisk Control.

ON. When this switch is wired ON, asterisk printing is available in six predetermined typewheels. Asterisks print to the left of the highest-order significant digit. With the switch wired ON and no other control wired, all six print entry positions must be wired.

C, *5, *4, *3. When only 5, 4, or 3 positions of the field are wired, the C hub must be wired to the 5, 4, or 3 hub as indicated by the number of print entry hubs wired. It is not possible to wire fewer than three positions of the field and have * print for zeros to the left of the highest-order significant digit.

21. Zero Print Control. A pair of hubs for each typewheel controls printing of 0, 11, and 12 coded characters.

22. Stacker. These are control hubs for the selective stackers (stackers 1, 2, and 3).

CONTROL X. These hubs accept impulses from control X read to select cards that are X punched in a given column.

IMMEDIATE PICK. These hubs are used with UNEQ or ALTN to select the card preceding the card causing UNEQ or ALTN to emit.

INTERPRET BRUSH. These hubs receive any impulse from interpret reading to select the card being read.

COMPARE. These hubs are used with UNEQ or ALTN to select the card for which UNEQ or ALTN emits.

23. Comparing.

STOP. This is an entry hub normally wired from UNEQ or ALTN hubs to stop the machine.

SUPPRESS. This hub accepts UNEQ, ALTN, or ISUP impulses to suppress printing on cards for which these impulses emit. When impulsed, SUP bypasses the non-suppress switch.

IMMEDIATE SUPPRESS. This hub emits when two or more master cards immediately follow each other.

UNEQUAL. This hub emits an impulse on the compare cycle when detail information compared to master information in storage is unequal.

ALTERNATE. When the 557 is wired for comparing, the ALTN hub emits if the card sequence is not alternately master and detail.

ON. This switch must be wired ON to activate comparing.

24. Proof Reading. These are exits for reading 80 columns of the card. They are usually wired to proof entry hubs.

25. Proof Entry 1. These are sixty entry hubs to prove that typewheels print correctly. They are wired from proof reading.

26. Proof Entry 2. These are sixty alternate entries used to prove printing using print entry 2. They are wired from proof reading.

27. Proof Emitter. These hubs emit impulses to be wired to the proof entry hubs to prove that characters emitted by the interpret emitter to the print entry hubs print correctly.

28. Print Entry Zero Selector. This is a 12-position selector operating under control of the print entry switch. It is normally used for selection of zero print control wiring when the setup for print entry 1 and print entry 2 is different. It may also be used to change wiring setups in much the same fashion as a selector except that the print entry zero selector is controlled manually by the print entry switch.

29. Posting. These hubs emit impulses used to select the line to be printed on a given pass of the file. They may also be wired to the COMP hub of a selective stacker to select a card on a specific pass of the file.

30. Print Line. These hubs accept posting impulses to position the card at a print line for printing.

31. SLP Selector. This is an automatic selector used with a posting impulse to select a ledger card directly after posting is completed. Since a posting impulse emits during an SLP-50 operation for the left and the right halves of the card, determination of its identity as either a 1-25 impulse or 26-50 impulse must be made. This is the function of the SLP selector.

PRINCIPLES OF CONTROL PANEL WIRING

Operations which may be performed are directed by control panel wiring. Wiring for normal print, print suppression, column splitting, selection and zero print control involving only the left side of the panel will be discussed

and illustrated. Discussion of the proof feature follows.

NORMAL PRINTING

There are 80 pairs of interpret reading hubs on the control panel, representing the 80 columns of the card. For normal printing, they are wired to the 60 print entry 1 hubs representing the 60 typewheels. The interpret reading hubs may be wired to any of the print entry 1 hubs to cause data to be printed in any desired sequence across the card.

Zero Print Control

When a punch is read in a card, the impulse is delivered through an external wire on the board to a typewheel (print entry hub). The typewheel is immediately set up to print the character. the printing does not take place, however, until the entire card is read (after 9 time).

Before a typewheel can actually print, a print magnet must be energized by an impulse during read time. Once energized, the print magnet causes the firing of a hammer for that particular print position. This hammer presses that one character position of the card against the previously set character on the typewheel.

All impulses except the zeros and single 11 or 12 punches automatically reach the print magnets. Remember that on the 548, additional wiring is necessary to eliminate the printing of numeric zeros. On the 557 additional wiring must be done to cause them to print. The control panel board has hubs which provide for external wiring to force the typewheel hammers to fire for those impulses not accepted. These hubs are labeled ZERO PRINT CONTROL.

Referring to figure 6-17, you will notice a pair of zero print control hubs for each printing position. The hubs in the lower row, numbered from 1 to 60, are diagonally connected internally to the hubs in the upper row as illustrated by the dotted lines in figure 6-18. The first hub in the upper row (AE-1) represents the upper hub of zero print control position 60 (AK-20).

Jackplugging the upper hub of one position to the hub directly below it links an exit hub (top) of one print position to an entry hub (lower) of another. If an impulse from a significant digit has been read and delivered to the print magnet

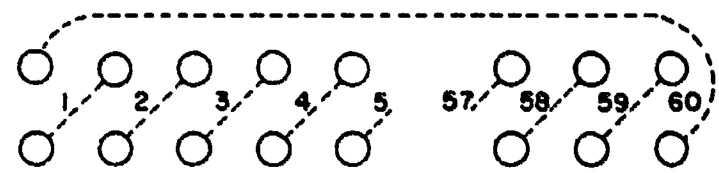

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Figure 6-18.—Zero print control hubs.

of the typewheel hammer represented by the top hub, the jackplug will allow an internal impulse to flow to the bottom entry hub of the position to the right. The impulse is then delivered to that position's print magnet just as if that position had received an impulse from a significant digit.

Figure 6-19 shows three methods of wiring for zero print control. Refer to this figure while reading the following paragraphs.

If all zero print control hubs for a field are jackplugged (circled 3), then zeros to the right of a significant digit will print. But suppose you wish to print zeros to the left of the first significant digit (circled 2). Since the low order position of the field will have a path to the fuse, either by being a significant digit or because a significant digit to the left has supplied an internal machine impulse, this impulse can be wired from the upper zero print control hub of the lower order position around to the lower hub of the high order position, thus energizing the print magnets for the high order zeros. When zeros are controlled to print to the right or left of a significant digit, ten consecutive zeros can be carried or controlled to print.

In order to print a field which contains all zeros, such as a zero balance, the lower hub of the high order printing position must be wired from interpret reading (circled 4).

Special characters which are actuated by only an 11 or 12 punch do not normally have a path to the fuse. For this reason, they must be controlled to print in the same manner as zeros.

Column Splits

If a numerical column, punched with a significant digit and a control X, is wired directly to a print entry, an alphabetic character will be printed. This can be prevented by wiring that particular column through a column split.

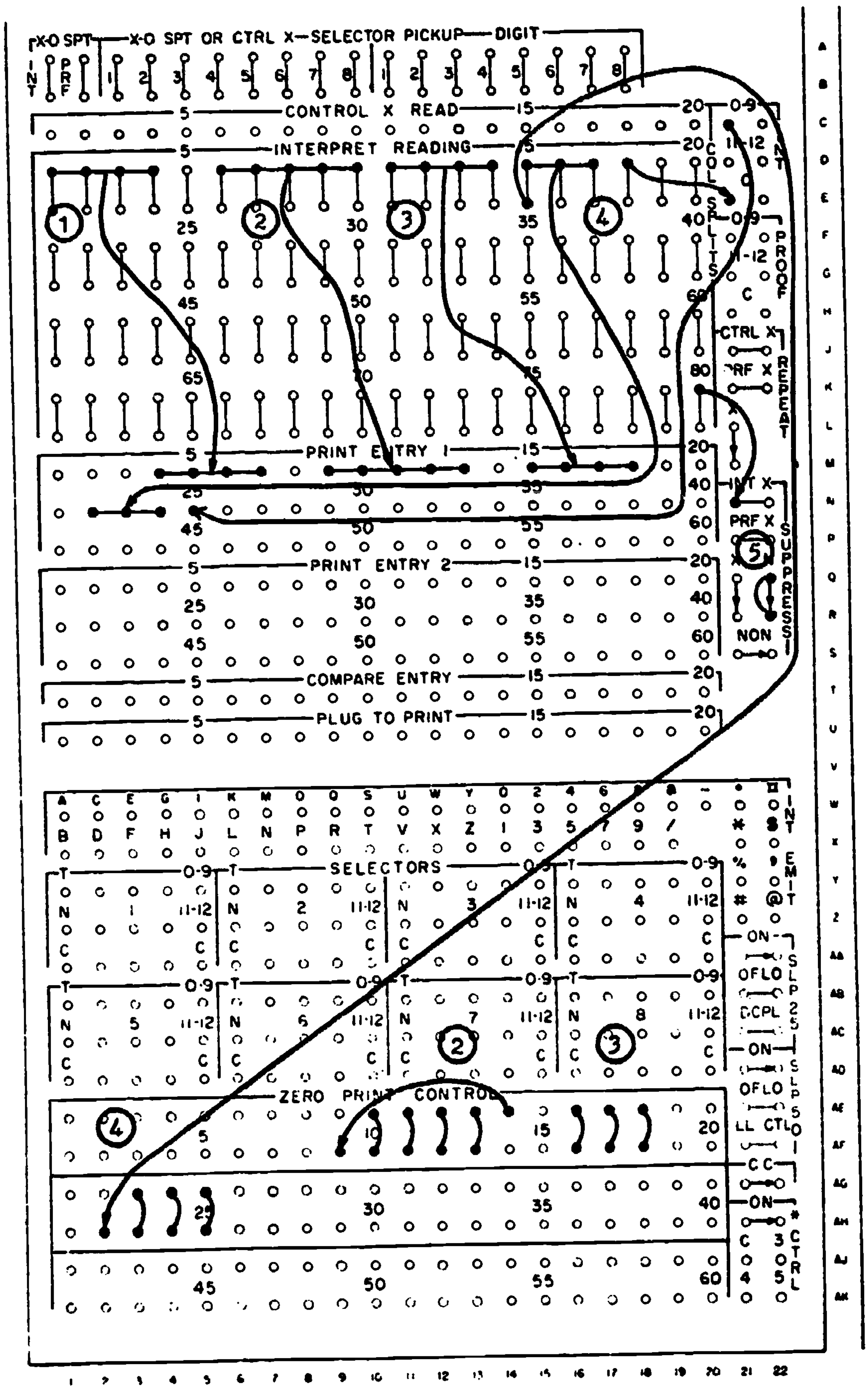

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Figure 6-19.–Normal printing, zero print control, X elimination and print suppress.

The column split device operates on the same principle as the X eliminator in the type 548. Any impulse zero through 9 in a column wired to common is available from the hub marked 0-9, while 11 and 12 impulses are available from the 11-12 hub. By wiring the column containing the control X to common and from the 0-9 hub to a print entry hub, the numerical punch in that column will be printed without the interference of the control punch.

Print Suppression

Selective printing of an entire card can be performed under the control of an X or NX condition. This permits you to interpret all cards of one type without separating the file or printing on the other cards in file. Either an 11 or 12 punch can be used for control.

The column containing the control punch is wired from interpret reading directly to the interpret X hub. No column split is required, since the pickup hub does not accept 9 through 0 impulses. If you wish to suppress printing of X cards, the X switch must be wired ON. If you wish to suppress printing of NX cards, the NX switch must be wired ON. The X switch must always be wired for all operations except when suppressing printing of NX cards.

Wiring

Figure 6-19 illustrates the wiring necessary for normal printing, zero print control, X elimination, and print suppression.

1. Columns 1-4, an alphabetic field, are wired to typewheels 4-7.
2. Columns 6-10, a numerical field, are wired to print from typewheels 9-13, with zeros controlled to print to the left of the high order significant digit.
3. Columns 11-14, a numerical field, are wired to typewheels 15-18 without printing zeros to the left of the high order significant digit.
4. Columns 15-18, an amount field, are printed in typewheels 22-25 with zero balances printed as all zeros, and with the credit X eliminated.
5. An X punch in column 80 impulses the print suppression pickup hub. The NX switch is wired ON to suppress printing of all NX cards. The X switch must be wired ON at all other times, whether or not printing is being suppressed.

SELECTION

Selectors may be used for two purposes; selection and splitting columns. When used as a selector, they operate on the same principle as those in the type 548. When used as a column split, they function in the same manner as an X eliminator. Since the standard 557 does not contain X brushes, all control punches must be read from interpret reading. Because of this, alphabetic selection can be performed only if presensing (Control X read) is installed. When installed, the optional presensing station is as shown in figure 6-20.

Four 5-position selectors are standard. Each selector has two separate pickups, which are X-0 Split or Control X, and Digit Pickup. These two pickup hubs should NEVER be connected to each other. Each pickup should be activated by a specific impulse for a specific function. When either pickup is impulsed, the selector transfers immediately and remains transferred for the duration of that card cycle.

The X-0 Split or Control X pickup can be wired from the X-0 Split hubs to cause a selector to operate as a column split. The interpret X-0 Split hub times the selector for use with the interpret reading brushes. The normal side of the selector becomes the exit for any 11-12 impulses that enter the common hubs, and the transferred side becomes the exit for any 0-9 impulses that enter the common hubs.

The Digit Pickup hubs are normally wired from interpret reading. Since these hubs accept any impulse 12 through 9, a column split should be used to select only the 11-12 control punch to be used.

The wiring diagram in figure 6-21 shows the wiring for numerical class selection, and for X elimination using a selector, as a column split.

1. Selector 1 is picked up from the X-0 Split hub, which causes the selector to operate as a column split. The X-0 Split hub emits an impulse just after the 11 position in a card has passed interpret reading, and before the zero position is reached. This allows the 11-12 impulses to

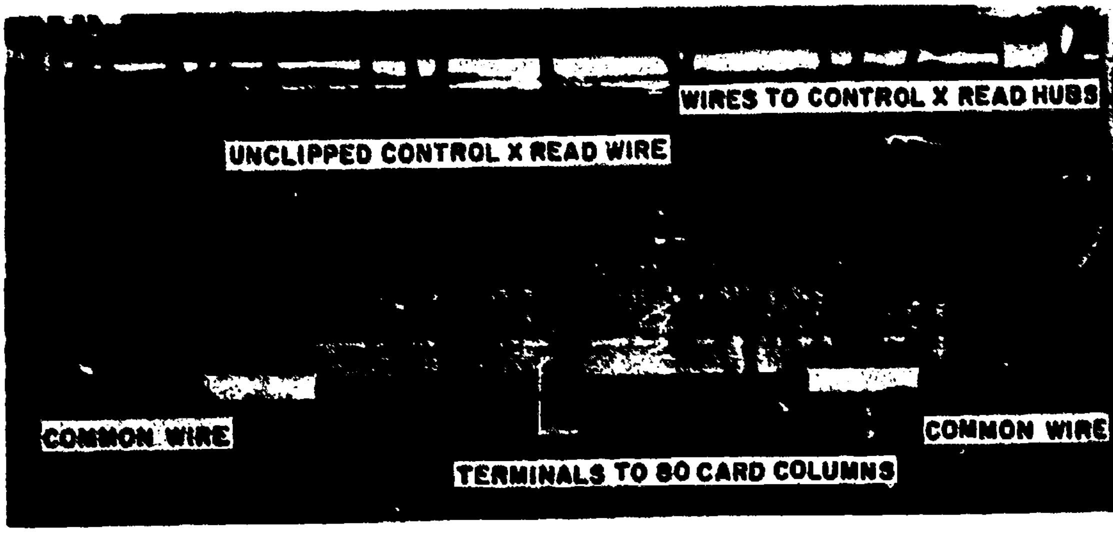

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Figure 6-20.—Presensing (control X read).

become available out of the normal side of the selector, and the zero through 9 impulses out of the transferred side.

2. Column 62 is wired through the transferred side of selector 1 to print only the numerical punch in the column.

3. Selector 2 is picked up from an X in column 39, which is wired through a column split to eliminate digit punches in that column.

4. Columns 42-45 are wired through selector 2 so that printing occurs at location A for X cards and at location B for NX cards.

5. All zeros are controlled to print.

6. The suppress X switch is wired ON to allow interpreting of all cards. If it were not wired, no cards would be interpreted.

PROOF

The proof feature is optional on the 557 interpreter. Once it is installed, it is mandatory that the proof side be wired as a duplicate of all interpret and control wiring. If this wiring is not done, an error condition will result for every card even though no errors are made.

Figure 6-22 illustrates one job correctly wired on a machine equipped with proof. The circled wiring is as follows:

1. Wiring to read a five-column numerical field eliminating the X in the units position.

2. If the X is not present, the field prints in typewheels 29-33.

3. When the X is present, selector 1 is transferred and printing occurs in typewheels 21-25.

4. Zero print control is wired to print all zeros.

5. All control and position wiring is duplicated for proof. Selector 4 controls the selection of proof entry.

OPERATING SUGGESTIONS

Card handling is as important on this machine as any other, and the standard rules as explained for other machines are to be followed.

Machine Errors

If the proof feature is installed, there will be a proof indicator unit (figure 6-23) to help identify the type error.

Any error indicated by the proof device stops the machine, suppresses printing on the error card, and lights the stop light on the front of the machine. When the error is sensed, no additional cards are fed from the hopper, and all cards already in the feed are advanced into the stacker before the machine is stopped. In addition, an indicator on the proof indicator unit is extended to indicate the type of error that has occurred. Figure 6-23 shows indicator 35 extended. An error reset cover is provided on the proof indicator unit which, when depressed, resets the indicator and turns off the stop light. The

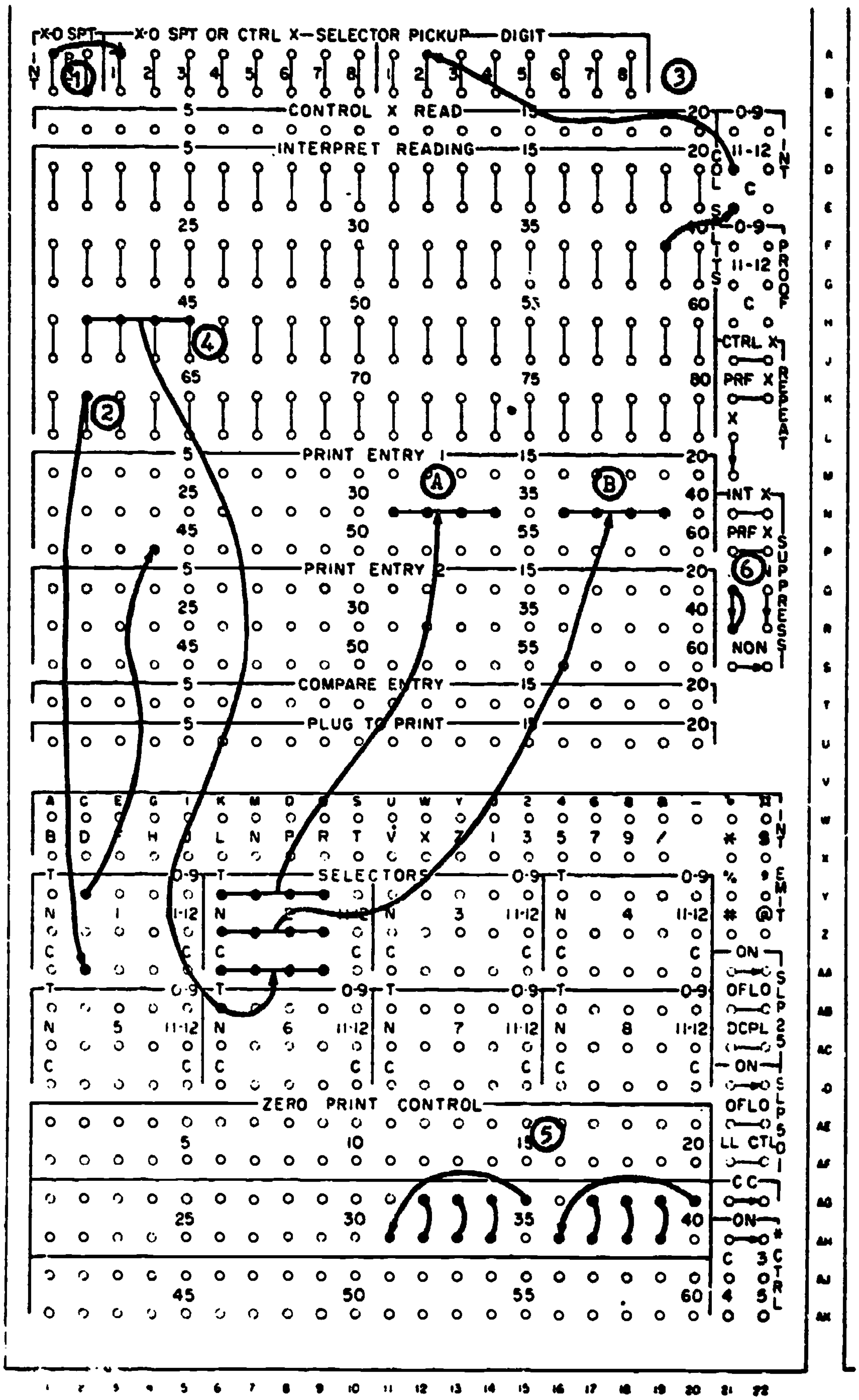

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Figure 6-21.—Numeric class selection and X elimination.

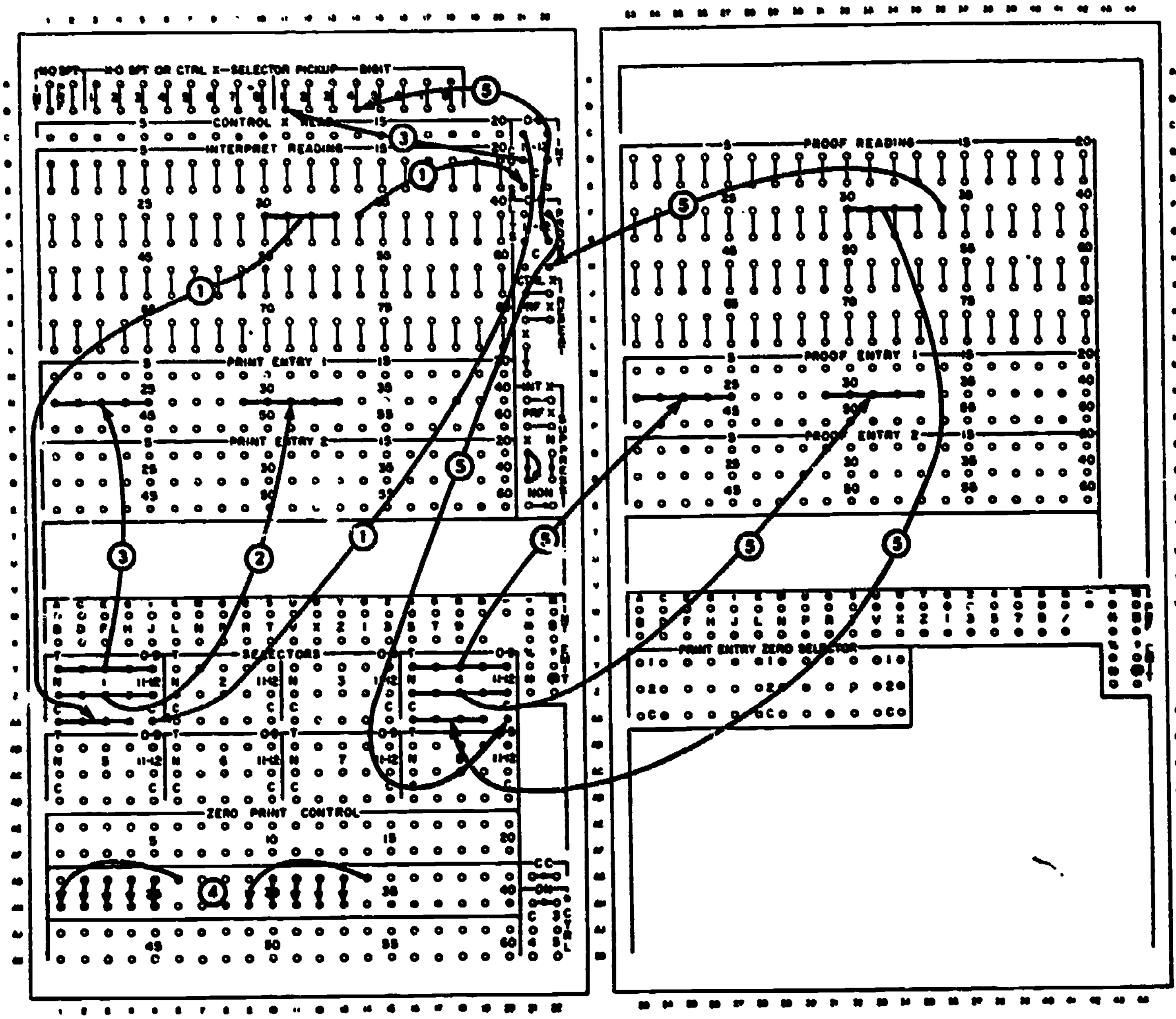

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Figure 6-22.—Proof.

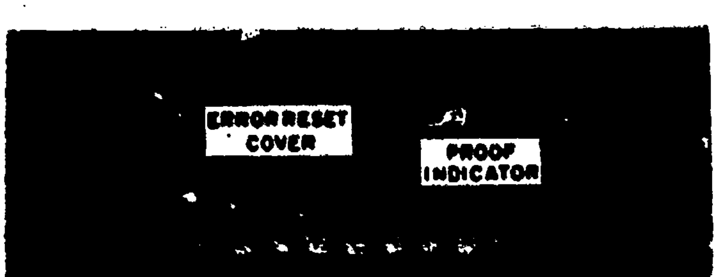

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Figure 6-23.—Proof indicator unit.

various numbers and letters on the proof indicator unit represent the following:

1-60. These numbers indicate the typewheel in which a printing error has occurred.

SP. This indicator is extended if the suppress print has been controlled correctly, but the machine has failed to perform the operation. The machine stops on the cycle following the indication.

SPX. This indicator is extended for an error in the control to cause the suppress print-operation. It may mean that the control panel is

incorrect, or that the machine is in error. If a 12 punch appears in the suppress print-control column on a master or detail card, the proof device will treat such a punch as an SPX error.

TA. This indicator will be extended if the typewheels are not in proper alignment for printing. The machine stops on the cycle following the indication. Printing is not suppressed on this type of an error card but is suppressed on the following cards.

RP. The indicator will be extended if the repeat print operation has failed, that is, the control is correct, but the machine has failed to perform the operation.

RPX. This indicator will be extended if there is an error in the control to cause repeat print or to check repeat print. It may mean that control-panel wiring is incorrect, or that the machine is in error. If a 12 punch is in the repeat print-control column of a master or detail card, the proof device switch reads such a punch as an RPX error.

Timing Chart

A timing chart is a good reference when learning a machine. Use of the timing chart together with the control panel hub descriptions and the card feed schematic will provide a complete picture of the machine.

As you gain confidence with the machine and are called on to wire more complicated jobs, the timing chart will become an invaluable aid. It will allow you to make use of proper control impulses for panel wiring. It will explain why some jobs that are supposedly wired correctly do not work (the control impulses are too short or at the wrong time; what was thought to be an exit is really an entry; etc.).

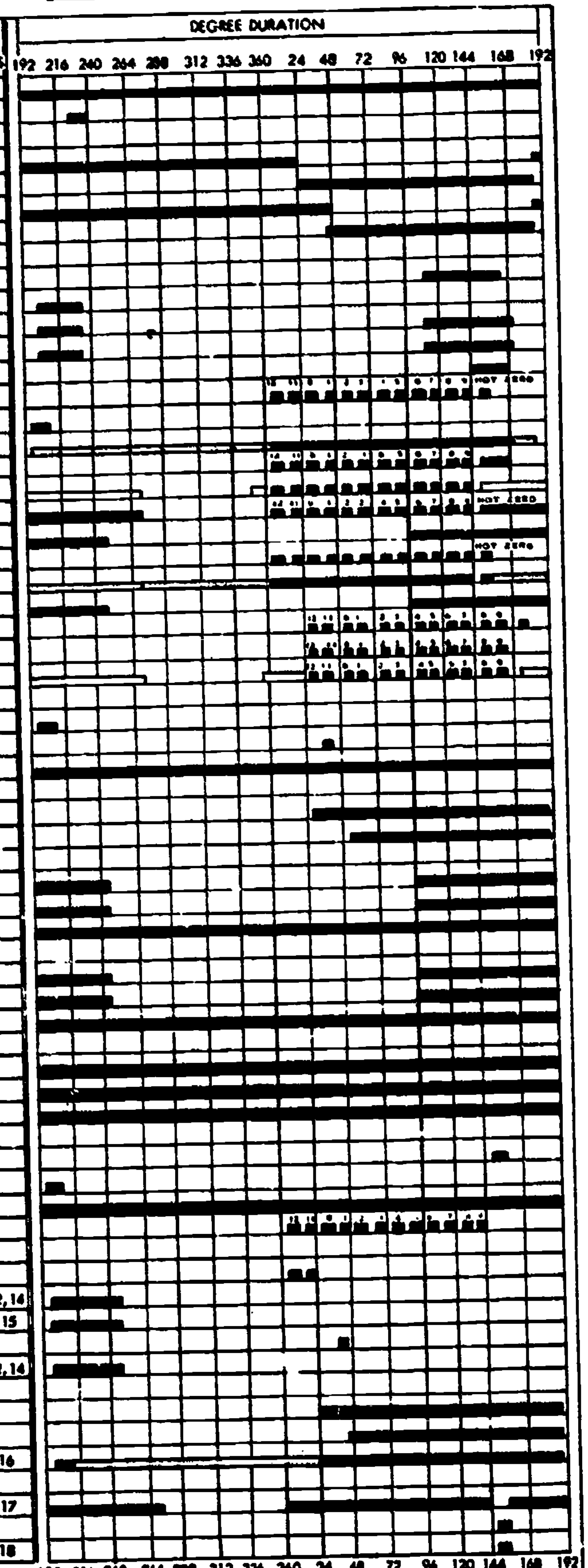
Figure 6-24 and the following timing chart notes are provided for the 557 interpreter.

Notes for Timing Chart

1. The asterisk control switch (left) is connected internally with the C hub (AJ-21); 3, 4, 5 hubs (AJ-22, AK-21 and 22) are entry hubs that accept impulses from the C hub only.
2. Wire to the right-hand hub only.
3. This hub emits only during a comparing operation if the card sequence is not alternately master and detail.
4. This hub emits only during a comparing operation when two or more master cards immediately follow each other.
5. This hub is to be used as an entry for 12, X, and digit punches only, from interpret and proof read.
6. The "hot zero" (zero print impulse) is part of the impulse emitted from 149 degrees to 169 degrees.
7. The "hot zero" (zero print impulse) is part of the impulse emitted from 149 degrees to 273 degrees.
8. The "hot zero" is the zero print impulse described in the "Zero print Control" section.
9. The print entry zero selector hubs are used for selection of zero print control impulses from the upper zero print control hubs. They operate in conjunction with print entries 1 and 2 and are controlled by the print entry switch at the operator's station.
10. When wiring from proof read for control purposes, send all impulses through a proof column split. Otherwise, the impulse from 172 degrees to 273 degrees would erroneously act as a control factor.
11. This is operative only when the machine is equipped with the presense unit.
12. Wire to the lower hub only.
13. Connection is internal between C and 25 or C and 50, controlled by SLP-25 (left side of card) or SLP-50 (right side of card).
14. If suppress print is in use, either the N or the X switch must be wired—the N switch to suppress NX cards, the X switch to suppress X cards.
15. Non-suppress switch is operative only when proof is installed.
16. This is to be used as an entry only for X-0 split impulses or control X read impulses.
17. These hubs emit any card impulse accepted by the next hub to the left in print entry. If any digit 1 through 9 is read, the zero print-control upper hub also emits the "hot zero" (zero print impulse).
18. These hubs accept the "hot zero" (zero print impulse) if no impulse 1 through 9 is received by the corresponding print entry hub, and there is a significant digit to the left in print entry.

Normal Exit | Other Exit | Normal Entries | Other Entries

HUBS	LOCATION	TIMING FROM	TIMING TO	NOTES
Asterisk Control (Left)	AH-AK 21-22	192°	192°	1,2
CC Switch (Left)	AG-21-22	227°	240°	2
Column Splits	C-H 21,22			
Interpret 11-12		189°	24°	
0-9		24°	189°	
Proof 11-12		188°	48°	
0-9		48°	188°	
Comparing	A-B 27-31			
ALTN	A-B 31	112°	162°	3
ISUP	A-B 29	207°	232°	4
STOP	A-B 27	112° 207°	169° 232°	
SUP	A-B 28	112° 207°	169° 232°	
UNEQ	A-B 30	144°	169°	
Compare Entry	T 1-20	5°	159°	
Control X Read	C, 1-20	198°	210°	
Digit Selector Pickup	A-B 11-18			5
Interpret Emitter	W-X, 1-22 Y-Z 21-22	5°	169°	6
Interpret Read	D-L 1-20	358°	273°	7
Plug to Print	U 1-20	358°	273°	
Posting	AB-AC 23-35, AE-AF 23-34	96°	248°	
Print Entry 1 and 2	M-S 1-20			8
Print Entry Zero Selector	Y-AA 23-34			9
Print Line	AD 23-35 AG 23-34	96°	248°	
Proof Entry 1 and 2	M-S 23-42	30.5°	181.5°	
Proof Emitter	W-X, 23-44 Y-Z, 43-44			
Proof Reading	D-L 23-42	358°	273°	10
Repeat Print	J-K, 21-22 L-M -21			11
Control X		198°	210°	
Proof X		42.5°	46.5°	
X Switch (upper)		0°	360°	12
Selectors	Y-AD, 1-20			
T(Interpret Read)		29°	187°	
T(Proof Read)		54.5°	187°	
SLP 25	AA-AC 21-22			
DCPL	AC 21-22	96°	248°	
OFLO	AB 21-22	96°	248°	
ON	AA 21-22	0°	360°	
SLP 50	AD-AF 21-22			
LLCTL	AF 21-22	96°	248°	
OFLO	AE 21-22	96°	248°	
ON	AD 21-22	0°	360°	
SLP Selector	AE-AG 35			13
C	AG 35	0°	360°	
25	AF 35	0°	360°	
50	AE 35	0°	360°	
Stacker	A-C 23-26			
Comp	A-C 26	152°	159°	
Ctrl X	A-C 23	198°	210°	
IMM PK	A-C 24	0°	360°	
Int Br	A-C 25	5°	146°	
Suppress Print	N-S 21-22			
Interpret X		5° 17°	12° 24°	
N Switch (Upper)		204°	254°	12,14
Non-Suppress Switch (Left)		204°	254°	2,15
Proof X		42.5°	46.5°	
X Switch (upper)		206°	254°	12,14
X-O Split	A-B, 1-2			
Interpret		24°	187°	
Proof		46.5°	187°	
X-O Split or Control X Selector Pick-up	A-B, 2-10	198° 24°	210° 187°	16
Zero Print Control	AE-AK 1-20			
Upper		358°	273°	17
				18
Lower				



78.3X

Figure 6-24.—Timing chart.

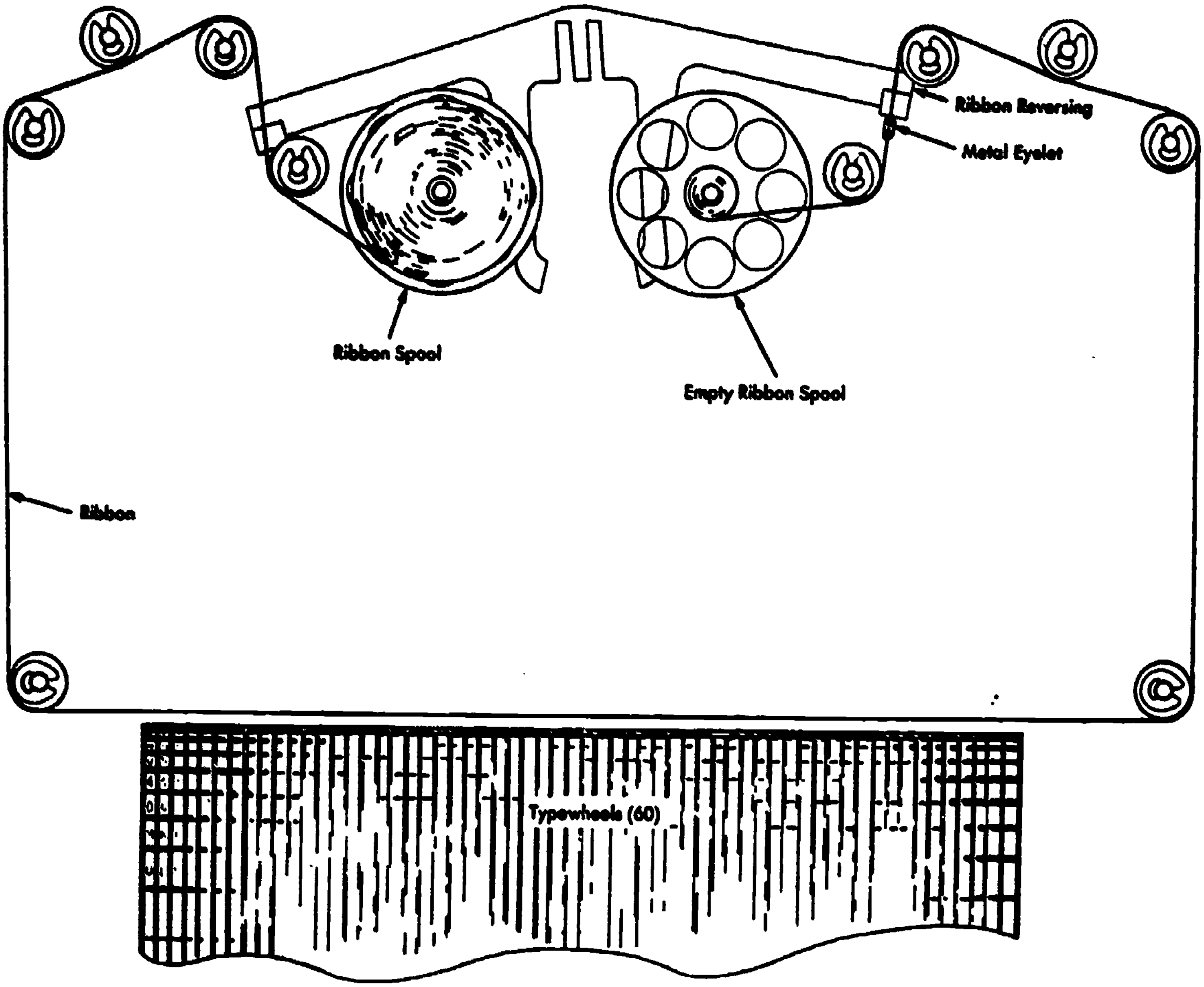


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Figure 6-25.—Type 557 ribbon feed schematic.

Ribbon

On each print cycle the ribbon feeds from one spool to the other approximately one-fourth inch. A metal eyelet near the end of the ribbon reverses it automatically when it strikes the reversing lever. When a new ribbon is installed, it should be threaded around the guide rollers as shown in figure 6-25.

CHAPTER 7

AUTOMATIC PUNCHES

One characteristic of record keeping is repetition. Records made on the same day must be dated identically. Records prepared at the same source contain identical location information. Likewise, information used at one place may be needed at another, requiring duplication of the same basic records. In some cases, partial changes to the original records must be made on a continuing basis, in order to keep the records up-to-date. At times, entire files must be partially changed or duplicated.

When records are maintained in punched card form, these repetitious operations can be performed automatically by automatic punches. The operations to be discussed in this chapter are described in general in the following paragraphs.

1. REPRODUCING. All or any part of the data contained in one set of cards can be punched into another set. Accuracy of punching can be verified at the same time by the comparing feature. For example, if you have a file of personnel status cards in which rate abbreviation and rate code must be changed, you can reproduce the original cards, leaving out rate abbreviation and rate code. Then you can reproduce the new rate abbreviation and code from a set of matching change cards into the reproduced personnel status cards. The reproduced cards then become the up-to-date personnel status card file.

2. GANGPUNCHING. Information contained in a master card can be transferred to each succeeding detail card which requires the same information. This application reduces the coding and keypunching required of source documents in those cases where one item of data relates to another. For example, it would not be necessary to code and keypunch rate code from the personnel diary, since a master rate code deck, containing rate code for each rate, can be used to gangpunch the code into the appropriate change cards.

3. DOUBLE PUNCH AND BLANK COLUMN DETECTION. Double punches or blank columns can be detected by a special device. This feature may be used to ensure that certain fields in a card are punched in all positions and that each column in the field contains only one punch.

4. EMITTING. The gangpunch emitter is a special device which supplies punching impulses identical to the punches which may be placed in a card. Repetitive punching without the use of a master card can be accomplished by wiring the hubs of the gangpunch emitter directly to punch. Emitting can be performed in conjunction with any other operation. By emitting data common to all cards, the need for keypunching or duplicating this data during the keypunch operation is eliminated.

All operations described in this chapter occur at the rate of 100 cards per minute.

This chapter discusses the two most widely used automatic punches; the IBM type 514 reproducing punch and the IBM type 519 document originating machine. While both machines are similar in appearance, operation, and functions, their control panels differ considerably in design and method of wiring. For this reason, each machine will be discussed separately.

REPRODUCING PUNCH, TYPE 514

The type 514 reproducing punch, pictured in figure 7-1, contains two feed units; the reading unit and the punching unit. Cards may be fed from either or both units depending upon the

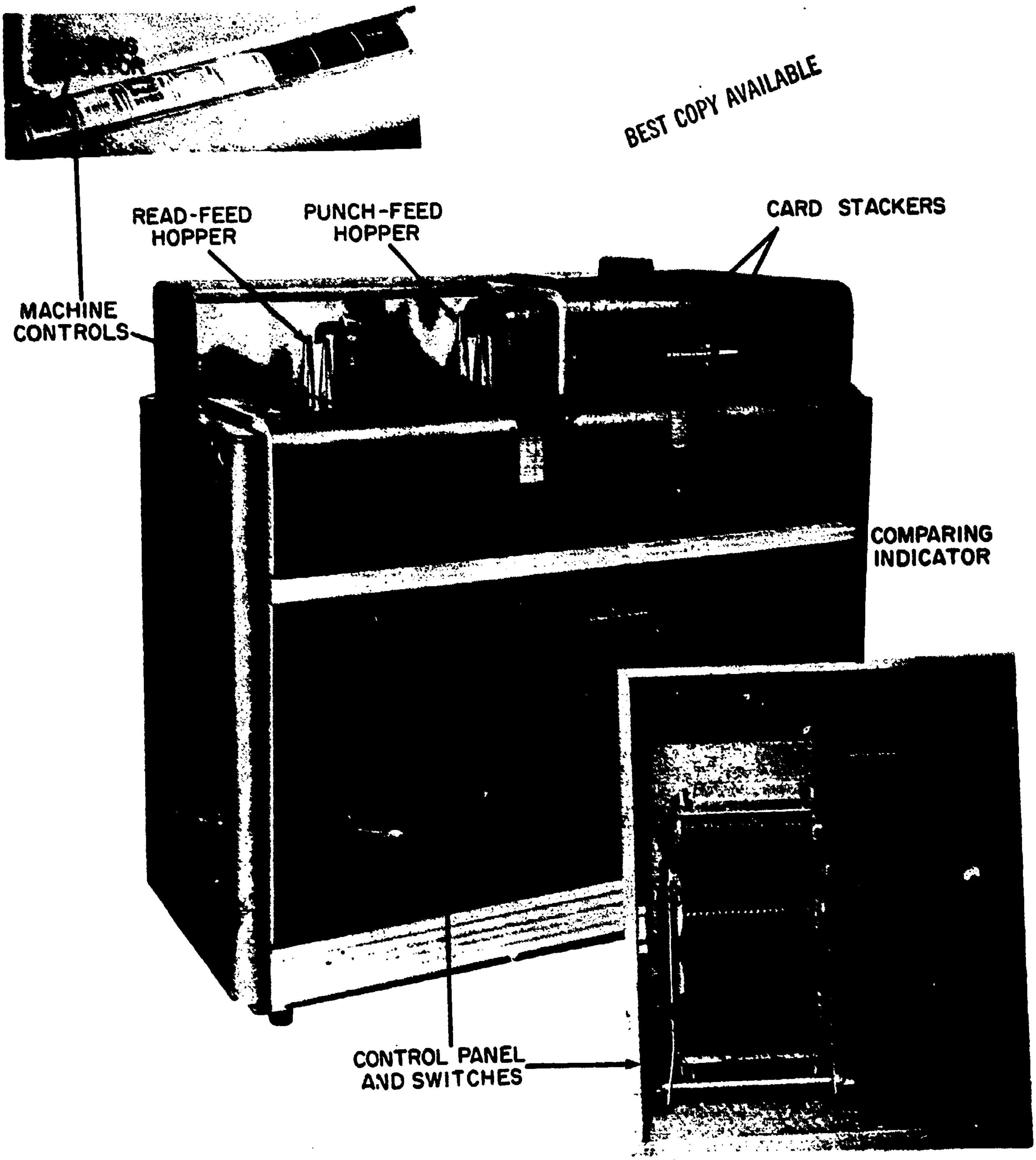

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Figure 7-1.—IBM type 514 reproducing punch.

job being performed. Each unit holds approximately 800 cards. For normal operations, cards are placed in the hoppers face down, with the 12 edge toward the throat. Once card feeding is started, it continues automatically until a hopper becomes empty, a card fails to feed, an error is signalled by the comparing unit, or a stacker becomes filled.

OPERATING FEATURES

The MAIN LINE SWITCH, located on the right end, provides power to the machine and must be ON for all machine operations. Other switches, keys, and lights that control card feeding and machine operation are located on the front as illustrated in figure 7-1. The START KEY must be depressed to start card feeding, and the STOP KEY must be depressed to stop card feeding. The DOUBLE PUNCH AND BLANK COLUMN LIGHT goes on and the machine stops whenever a double punch or blank column has been detected. The RESET KEY must be depressed to reset the double punch and blank column detection circuits and to put out the DP&BC light. The COMPARE LIGHT signals an error in card comparison and causes the machine to stop.

CARD FEEDING

The 514 is the first machine discussed in this manual that is capable of working with two separate card feeds (figure 7-1). Each feed hopper is an entry to its own feed unit with three stations and a respective stacker.

By changing the functional switch settings the feeds can be synchronized (timed to work together) or work independently of each other.

The feed unit on the left is called the READING UNIT or read unit. This unit contains only reading brushes.

The feed unit on the right is called the PUNCHING UNIT or punch unit. The unit contains reading brushes and punching dies.

Reading Unit

Refer to the schematic diagram in figure 7-2. Notice that as cards feed through the reading unit, they first pass the five read X (RX) brushes (figure 7-3). These brushes can be set to read any desired columns of the card in order to control the reading of other data from the card. These brushes must be set at least two columns apart.

The following station contains 80 reproducing brushes, which read the 80 columns of the card. These brushes may be wired to the punch magnets to reproduce data into a card passing through the punching unit, or they may be wired to the comparing unit to compare cards that have been gangpunched in the punching unit.

After cards pass the reproducing brushes, they are read by 80 comparing brushes. These brushes may be wired to the comparing unit to compare the card reproduced on the preceding cycle, or to check the accuracy of a gangpunching operation.

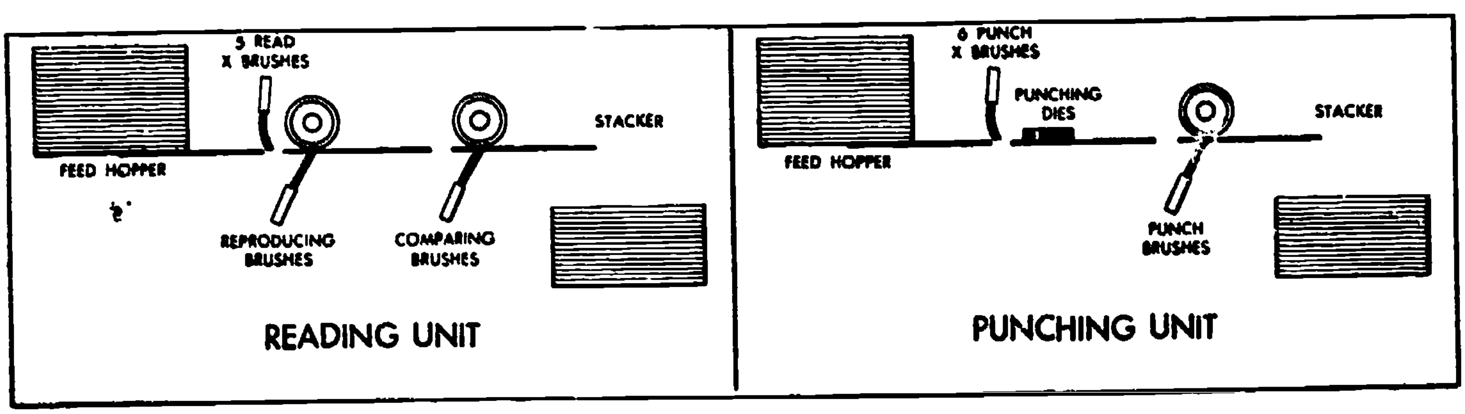

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Figure 7-2.—Card feed schematic diagram.

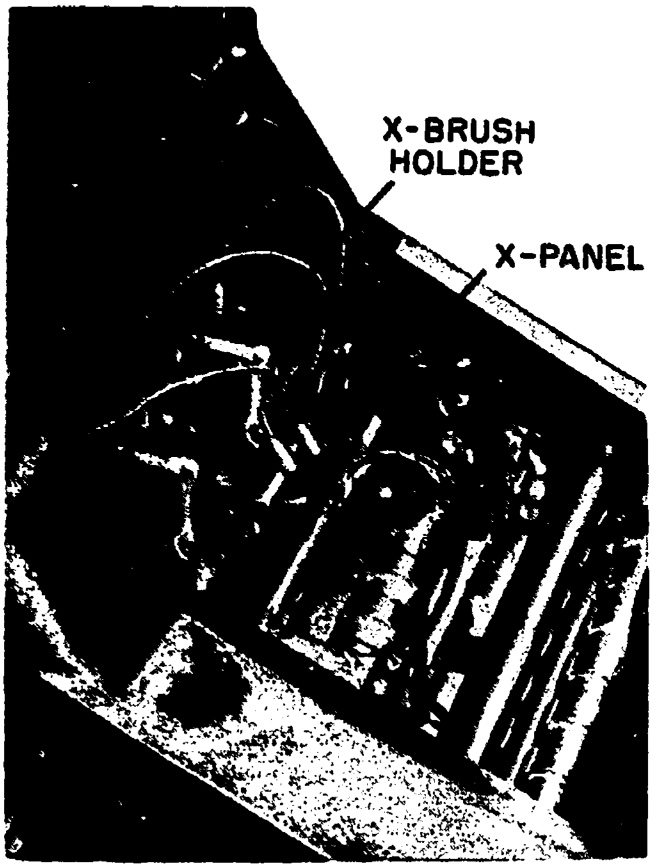

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Figure 7-3.—RX brush station.

Punching Unit

A schematic diagram of the punching unit also is included in figure 7-2. Cards feeding through the punching unit first pass the six punch X (PX) brushes. These brushes can be set to read any columns of the card in order to control the reading of other data. These brushes must be set at least two columns apart.

The next station contains the punching mechanism, consisting of 80 punch magnets and supporting dies. Each punch magnet may be actuated at either or all of the 12 punching positions in a column as a card moves past this station.

After a card passes the punching station, it is read by 80 punch brushes. These brushes may be wired to the comparing unit to compare the card reproduced on the preceding cycle with the original card, or they may be wired to the punch magnets to cause punching during a gangpunching operation.

Synchronized Feeding

During a reproducing operation the reading and punching units are synchronized. When the feed units are synchronized, cards pass their respective stations in unison. A card passes the RX brush station at the same time one passes the PX brush. A card passes the reproducing brushes at the same time one passes the punching dies. A card passes the comparing brushes at the same time one passes the punch brushes.

Separate Unit Feeding

When the controls are set to allow each feed to work independently, the operations for each unit are limited. The read unit consists solely of reading stations. This limits the read unit to comparing operations.

The punch unit has only the one full read station and a punch station. This limits the punch unit to an operation called gangpunching.

Even though the units accomplish two different functions, they may do them simultaneously. This means that while gangpunching is occurring in the punch unit, comparing for a different file may take place in the read unit. One board is wired to accomplish both jobs.

Comparing Unit

The comparing feature provides for comparing the punching in two cards to see if punching is identical. Comparison may be made between one card in the reading unit and another in the punching unit, or between two cards in the reading unit. When the punching in the two cards being compared is different, the compare light goes on and the machine stops. The comparing indicator, shown in figure 7-4, points out the comparing position containing the error. In order to reset the comparing indicator and turn out the compare light, the restoring lever on the comparing indicator unit must be reset.

Comparing is performed by control panel wiring of read brushes to comparing magnets. (Review of reproducer type comparing in chapter 5 is recommended.)

Always remember that a comparing unit does not distinguish where its impulses come from.

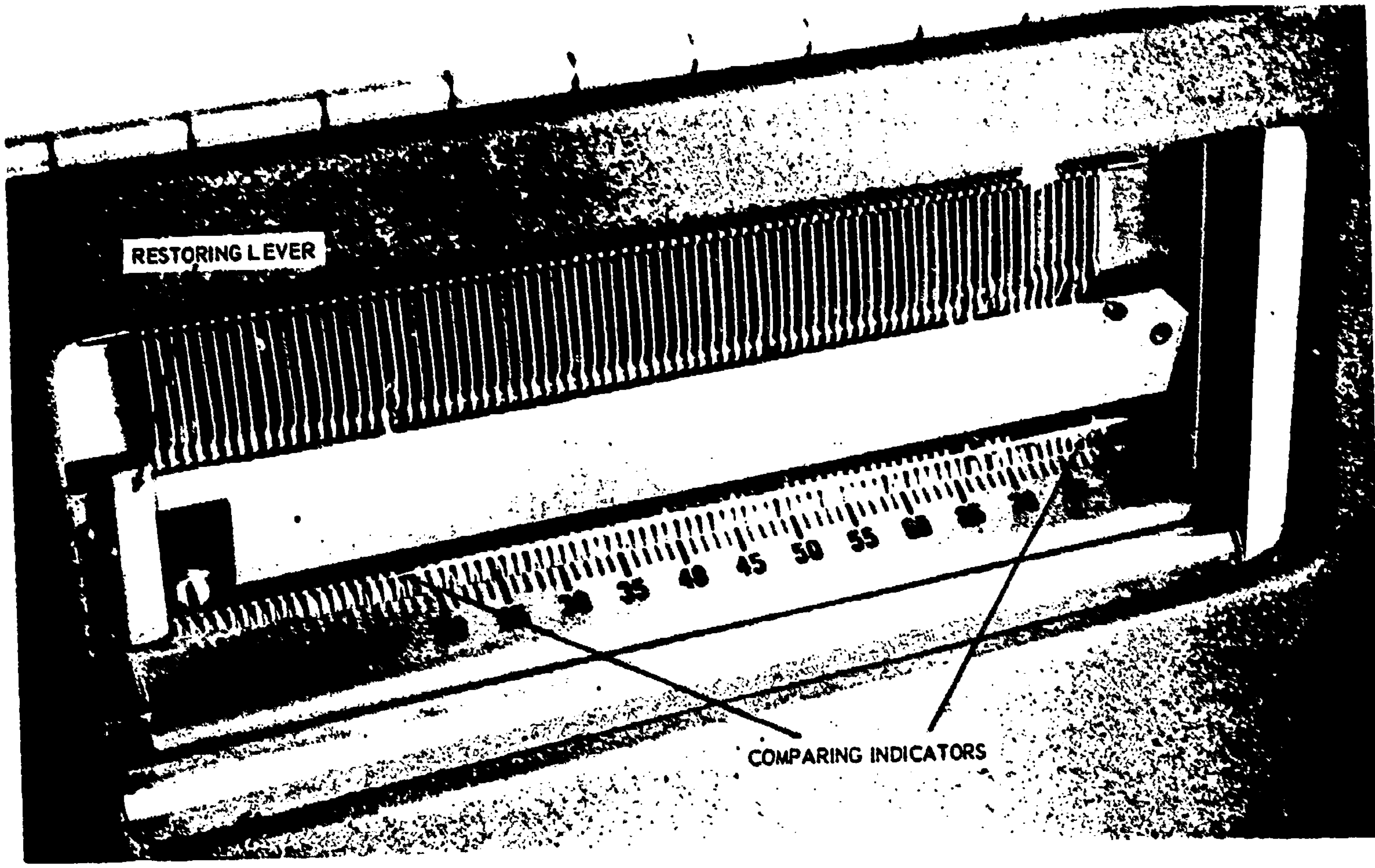

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Figure 7-4.–Comparing indicator unit.

The comparing unit is simply a device that indicates when two impulses are different.

One entry to the magnet may be wired from the reproducing brushes while the other is wired from the punch brushes. One entry may be wired from the punch brushes while the other is wired from the comparing brushes. It all depends on which stations you, the operator, want compared.

CONTROL PANEL

Use figure 7-5 for location of the following hubs. Use figure 7-2 for location of the brush and punch stations.

REPRODUCING BRUSHES. A1 through D20. This group consists of 80 exit hubs from the first set of 80 read brushes in the read unit.

D.P. & BL. COL. DETECTION (Double punch and blank column detection). E1-10 and F1-10. This group consists of 20 entry hubs to the DP & BL COL detection device. These hubs are normally wired from the punch brushes.

COLUMN SPLITS. E11-20, F11-20 and G11-20 This group consists of 10 column split posit.

G. P. EMITTER (Gangpunch emitter). G1-10, H1 and H2. These hubs are exit hubs. They emit their own timed impulses. They are normally wired to the punch magnets.

D.P.D. (Double punch detection). H3, 4 and J3, 4. These hubs control the double punch detection of X or NX cards. The pickup hub is normally wired from a RX brush or a PX brush. If the two hubs labeled X are connected, only X punched cards are checked. If the X hubs ar not wired, only NX cards are checked.

RX (read X). H5 and 6. This is a common entry hub for control of the comparing unit. When a controlling impulse is delivered to this hub, the comparing unit is inoperative for one card cycle.

RD (read delay). H7. This hub emits an impulse one card cycle after the RX hub receives an impulse. The RD hub is normally used to control a selector.

PX (punch X). H8 and 9. This is a common entry hub for control of the punch magnets, read unit feeding and comparing unit. (This is explained in detail later in the chapter.)

PD (punch delay). H10. This hub emits an impulse one card cycle after the PX hub receives an impulse. This is normally used to control a selector.

0 & X (zero and X (11) impulse emitter). J1-2. This is a common exit. These hubs emit two impulses each, the numeric zero and the 11. The impulses are emitted at the same time as those from hubs H1 and G10.

READ X BR (read X brushes). J5-9. These are exit hubs from the five possible read brushes wired to the X-panel (figure 7-3).

PUNCH MAGNETS. K1 through N20. This group consists of 80 entry hubs to the punching mechanism.

P.X. BR (punch X brushes). P1-P6. These are exit hubs from the six possible X brushes wired to an X-panel in the punch unit.

PUNCH BRUSHES. Q1-T20. This group consists of 80 exit hubs from the set of 80 read brushes in the punch unit.

SELECTOR 1 and 2. U1 through W20. These hubs comprise two 10 position selectors. The U1 row labeled X is the same as T (transferred) on other control panels.

R and P (read and punch selector pickup hubs). X1 and 2. When either of these two hubs is correctly impulsed, selector 1 transfers.

X18 and 19. When either of these two hubs is correctly impulsed, selector 2 transfers.

The R hub is normally wired from the RD hub. The P hub is normally wired from the PD hub.

T. X3 and X20. Advanced.

SUM. XPCH. CTRL OR M.S. BRUSHES. X4-17. Advanced.

COMP. MAG. FROM PUNCH BRUSHES (Comparing magnets from punch brushes). Y1-AB20. This group consists of 80 entry hubs to one side of 80 comparing magnets. They are normally wired from the punch brushes (hence, the name).

Rows AA and AB are triple purpose and are so labeled. These secondary functions, as labeled—OR CTR. TOT. EXIT OR M.S. IN, are for the advanced DP technician.

COMP. MAG. FROM COMPARING BRUSHES (comparing magnets from comparing brushes). AC1-AF20. This group consists of 80 entry hubs to the 80 comparing magnets. They are normally wired from the comparing brushes. What is entered here is compared against what is wired to the same relative hub of the other comparing magnet entries.

Rows AE and AF are triple purpose, and again, the secondary functions are only for the advanced DP technician.

COMPARING BRUSHES. AG1-AK20. This group consists of 80 exit hubs from the second set of 80 read brushes in the read unit.

Insertion

Before any control panel is inserted into a machine, certain checks should be done as part of the operator's routine.

The contact points on the machine should be checked to ensure:

1. No contact points are bent
2. No contact points are broken off
3. No foreign material is on the contact points (brush hairs, paper clips, etc.)

The board should be checked to ensure:

1. No wire tips are bent
2. No wire tips are stripped
3. No foreign material is lodged between the wire tips.
4. The boards edge is smooth. No loose screws, jutting screw heads, gouged edges or tape repairs. These could all prevent proper seating of the control panel and/or cause possible electrical shorting.

Never force the panel door shut. On faulty doors there are release levers that can be manually tripped.

FUNCTIONAL SWITCHES

Before any job can be processed correctly, the functional control switches must be properly

set. These switches are located inside the control panel compartment (see inset of figure 7-1).

These switches are described in the following paragraphs. The settings required for each job are given in the discussion of each job.

Reproducing Switch

Although this is referred to as one switch, it is actually three toggle switches joined together to work as one. This switch synchronizes the reading and punching units so that they work together when reproducing information from one deck of cards onto another. When this switch is OFF, each unit may be used independently to perform separate operations.

Sel Repd and GP Compare Switch

This single switch allows continuous feeding in the reading unit. It should be ON only when performing selective reproducing or a gangpunching and comparing operation.

Detail-Master Switch

The detail-master switch (2 toggles) controls the handling of X and NX cards. This switch should be set to master when the master card has the controlling punch for gangpunching or when reproducing from the NX cards is desired. The switch should be set to detail when the detail cards have the controlling punch or when reproducing from the X cards is desired.

REPRODUCING AND COMPARING

In reference to automatic punches the word reproducing is associated with the following wiring and operator standards:

The feed units will always be synchronized.

The read unit will contain the source cards to be reproduced.

The reproducing brushes will read the card to be reproduced.

The word comparing (when associated with reproducing) implies the following standards:

The punch brushes and comparing brushes will be used to read the new and old card respectively for comparing.

A comparing error indication will be for the first cards to enter the stackers after the comparing unit is reset.

Straight Reproducing and Comparing

Straight reproducing means that specific columns of each card passing the reproducing brushes are to be duplicated into a set of cards in the punch unit. This may be a column for column reproduction (columns 1-8 into 1-8), or the field(s) may be offset (columns in the read unit reproduced into any column but their counterpart in the punch unit) as shown in figure 7-5.

For an offset field it is important to remember that the punched field is compared with the originally read field. Locating the stations in the schematic (figure 7-2) and mentally following cards through their respective unit will help you understand the following explanation of figure 7-5.

1. As a source card passes the reproducing brushes, all columns are read by the brushes, and impulses representing digits punched are available at the reproducing brush hubs on the control panel. These impulses, when wired to the punch magnet hubs, cause punching to occur in the card passing the punching station in the punching unit.

2. Both cards then feed simultaneously past the next station in their respective unit. At this point, the source card is read by the comparing brushes, and impulses representing digits punched are directed to the comparing magnets by wiring the comparing brush hubs of the field being reproduced to one side of the comparing unit. At the same time, the reproduced card will be read by the punch brushes, and impulses representing digits punched are directed to the corresponding magnets by wiring the punch brush hubs of the reproduced field to the other side of the comparing unit. Thus, if the two impulses received by a particular comparing position are the same, reproducing has been performed satisfactorily. If the impulses differ, or if only one magnet in a comparing position has received an impulse, an error is indicated. The machine stops and the comparing position

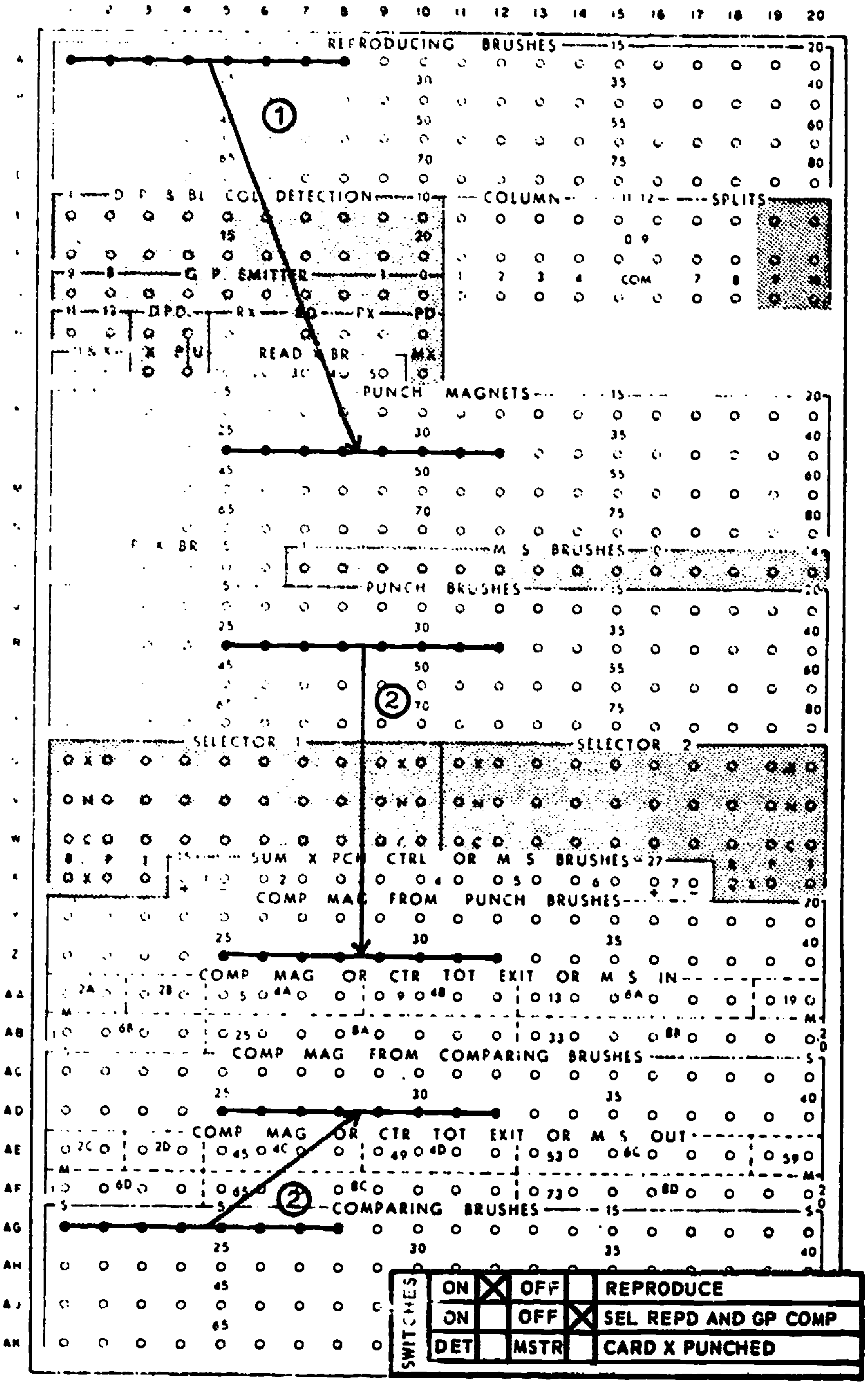

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Figure 7-5.—Straight reproducing and comparing.

in which the error is located is identified by the comparing indicator.

Any comparing position can be used to verify punching in any given column, but the positions corresponding to the columns in the reproduced card are generally used. This provides for ease in wiring, as well as simplifying the process of finding the error column.

Selective Reproducing and Comparing

Selective reproducing is the process whereby only one type of card, X or NX, will be reproduced. The reproducing switch and the selective reproducing GP and compare switch must be turned on. There will be a blank card in the reproduced deck for each source card which is not reproduced. Wiring for this operation is shown in figure 7-6.

1. The wiring for punching and comparing is the same as for straight reproducing.
2. In order to identify the X cards, a read X brush is set to read the column containing the X punch, and the corresponding read X brush hub on the control panel is wired to the PX hub. The PX circuit then sets up the conditions under which reproducing and comparing can be performed, in conjunction with the detail-master switch, as follows:

a. When the detail-master switch is set to MASTER, punching is suspended when X punched cards pass the reproducing brushes. All NX cards will be reproduced. Comparing is suspended when the X punched cards pass the comparing brushes. NX cards will be compared.
b. When the detail-master switch is set to DETAIL, punching is suspended when NX cards pass the reproducing brushes, and all X punched cards will be reproduced. Comparing is suspended when NX cards pass the comparing brushes, and all X punched cards will be compared.

X ELIMINATION OR TRANSFER

Column splits operate on the same principle as those in the type 557 interpreter. They allow the reading of a column to be divided between the zero and 11 punching positions in order to separate the reading of control punches from digit punches, or to combine these punches from different columns into one column. Figure 7-7 shows three uses for column splits.

1. If an 11 or 12 control punch is not to be reproduced, the reproducing brush hub for the column containing the control punch is wired to common of a column split. The 0-9 hub is then wired to the desired punch magnet. The control punch may be wired from the 11-12 hub to any other punch magnet, if desired. The comparing brush must be wired through a column split in the same manner in order to avoid a false error light during comparison.
2. The column split may also be used for combining punches. The reproducing brush hub representing the control punch is wired to the 11-12 hub, and the digit punch from another column is wired to the 0-9 hub. The common hub is then wired to a punch magnet, where the two punches from different columns are punched into one column. The comparing brushes for both columns of the source card must be wired through a column split to the comparing unit to avoid false comparison.
3. In some instances you may wish to punch an X in all cards passing through the punching unit, or add zeros to increase the size of a field. This can be accomplished by wiring the 0 and X hubs through a column split to the punch magnets. These hubs emit both a zero and an X impulse each card cycle. In order to punch all cards with an X, a zero and X hub is wired to common of a column split and from the 11-12 hub to a punch magnet. Zero impulses are available from the 0-9 hub of the same column split, and may be wired to a punch magnet to punch a single zero, or split wired to several punch magnets for punching two or more zeros.

GANGPUNCHING AND COMPARING

Gangpunching is an operation that is performed solely in the punch unit. Information is read from one card (master) by the punch brushes and punched into the following card (detail) at the punch magnets. When the gang-

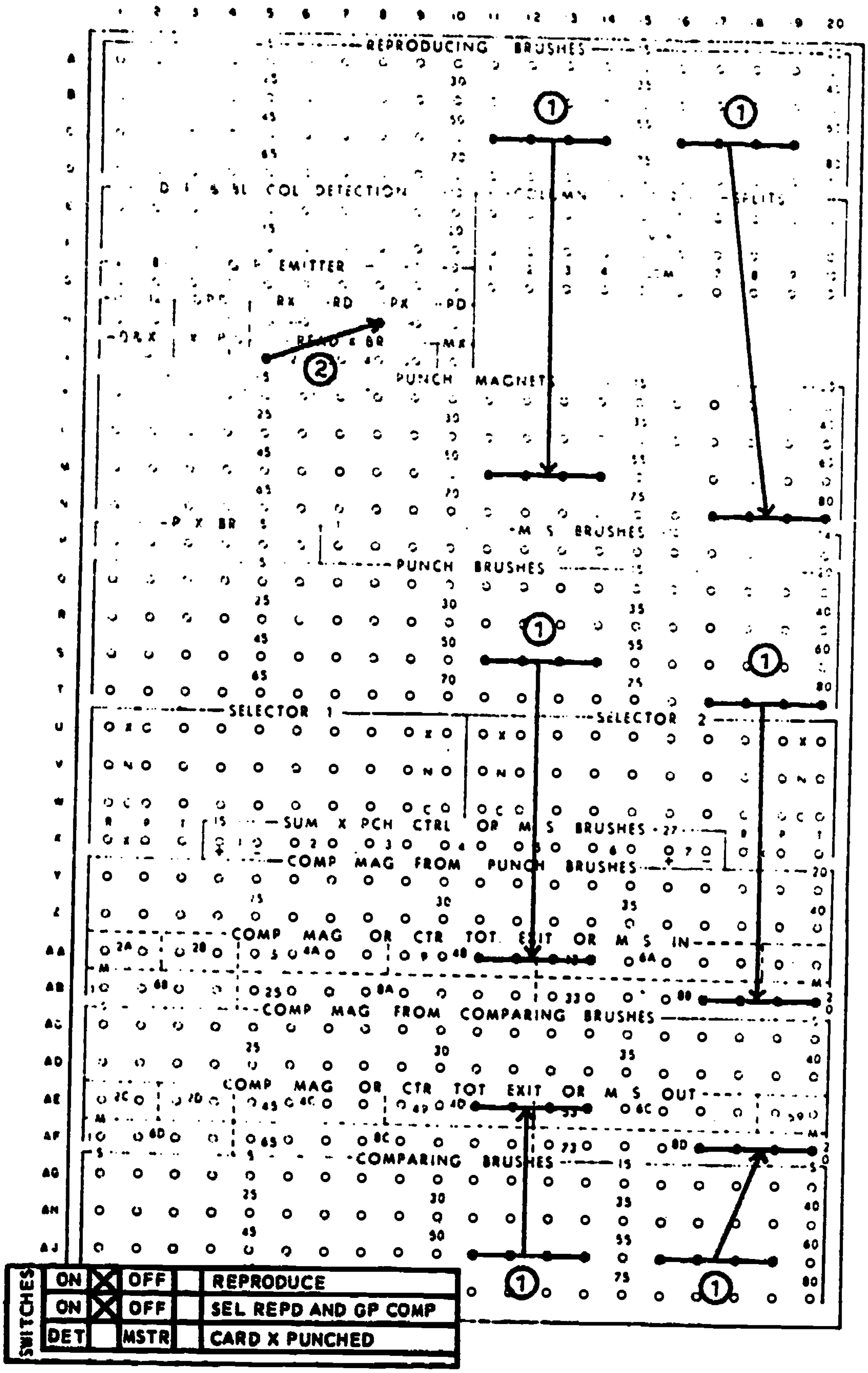

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Figure 7-6.—Selective reproducing and comparing.

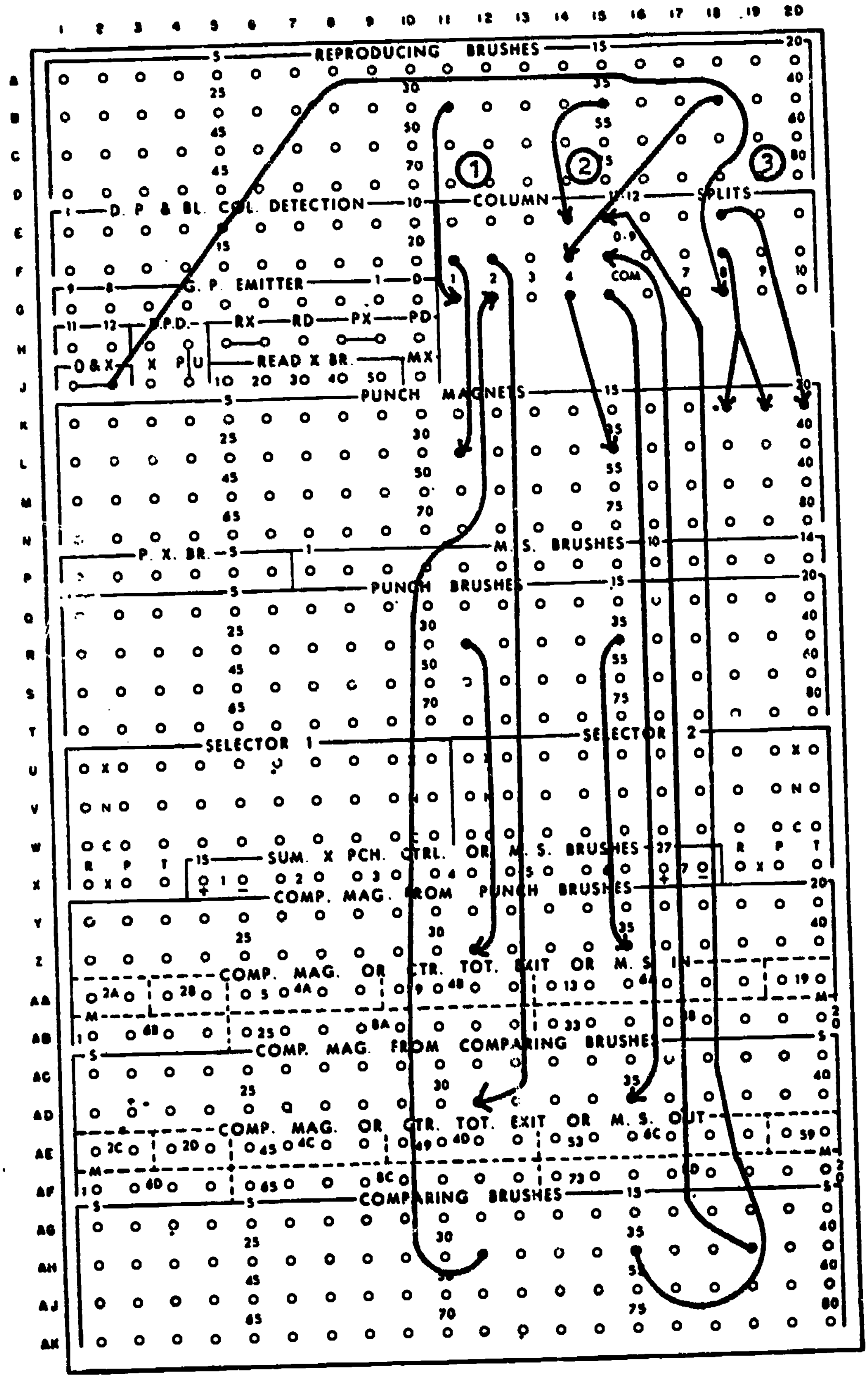

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Figure 7-7.—Using the column splits.

punched detail reaches the punch brushes, it is read and causes punching in the next detail card. This process continues until another master card is detected or the end of file is reached.

The comparing of gangpunched cards can be accomplished in either of two ways. If only one master card is utilized, it is sight checked with the last card punched. If more than one master card is utilized, the file is fed through the read unit for machine comparing.

When each feed is used for a different function, the reproducing switch must be OFF to allow the units to work independently.

The SR and GP COMP switch must be ON to allow correct control of the read unit during comparing of files with more than one master card (interspersed master cards).

For interspersed files the detail/master switch is set to master or detail, depending on which card type has the controlling X punch.

Single Master Card Gangpunching

If a file of cards is required to have identical information on each card (date, activity number, job number, etc.), it may be done by gangpunching from a single prepunched card (master). The master card is punched with the information in the required card columns. The board will have wiring only from punch brushes to punch magnets, as illustrated in the circled 1 portion of figure 7-8. No other wiring is required.

The detail/master switch is set to master as all cards are to be punched. This sets up a NX detail circuitry which allows punching when no impulse reaches the PX hub.

The SR and GP COMP switch can be ON or OFF as there is no wiring for a control punch.

A master card may not even be required. If the information to be gangpunched is short and numeric (date) gangpunching may be accomplished by using the emitter vice a punched master card.

Interspersed Master Card Gangpunching and Comparing

Where information to be gangpunched changes from one group of cards to the next, interspersed gangpunching may be employed. This could be in the form of straight or offset gangpunching. A different master card is placed in front of each group of detail cards. Gangpunching and comparing are then controlled by the presence of a control punch in either the master or the detail cards.

Cards to be gangpunched are placed in the punching unit. After a handful has been punched, they may be compared for accuracy of gangpunching by placing them in the reading unit. Figure 7-8 illustrates the wiring for interspersed master card gangpunching and comparing.

1. Information to be gangpunched is wired from the punch brushes to the punch magnets. This permits each card to pass the punched information to the following card. The punch brushes must be wired to the corresponding punch magnets, column for column.

2. A punch X brush is set to read the column containing the control X, and the corresponding PX brush hub on the control panel is wired to the PX hub. This causes either X punched cards or NX punched cards to be gangpunched, depending upon the setting of the detail-master switch. If master cards contain the control X, the detail-master switch must be set to MASTER. If detail cards contain the control X, the detail-master switch must be set to DETAIL. Punching is then controlled by the detail-master switch as follows:

a. When set to MASTER, punching is suspended when X punched master cards are passing under the punch magnets. This prevents a master card from being punched with information contained in the last detail card of the preceding group. All NX detail cards are gangpunched with information from their own X master card.

b. When set to DETAIL, punching is suspended when NX master cards are passing under the punch magnets. This prevents a master card from being punched from the preceding detail card. All X punched detail cards are gangpunched from their own NX master card.

3. In order to compare the gangpunched cards, the comparing brushes are wired to one

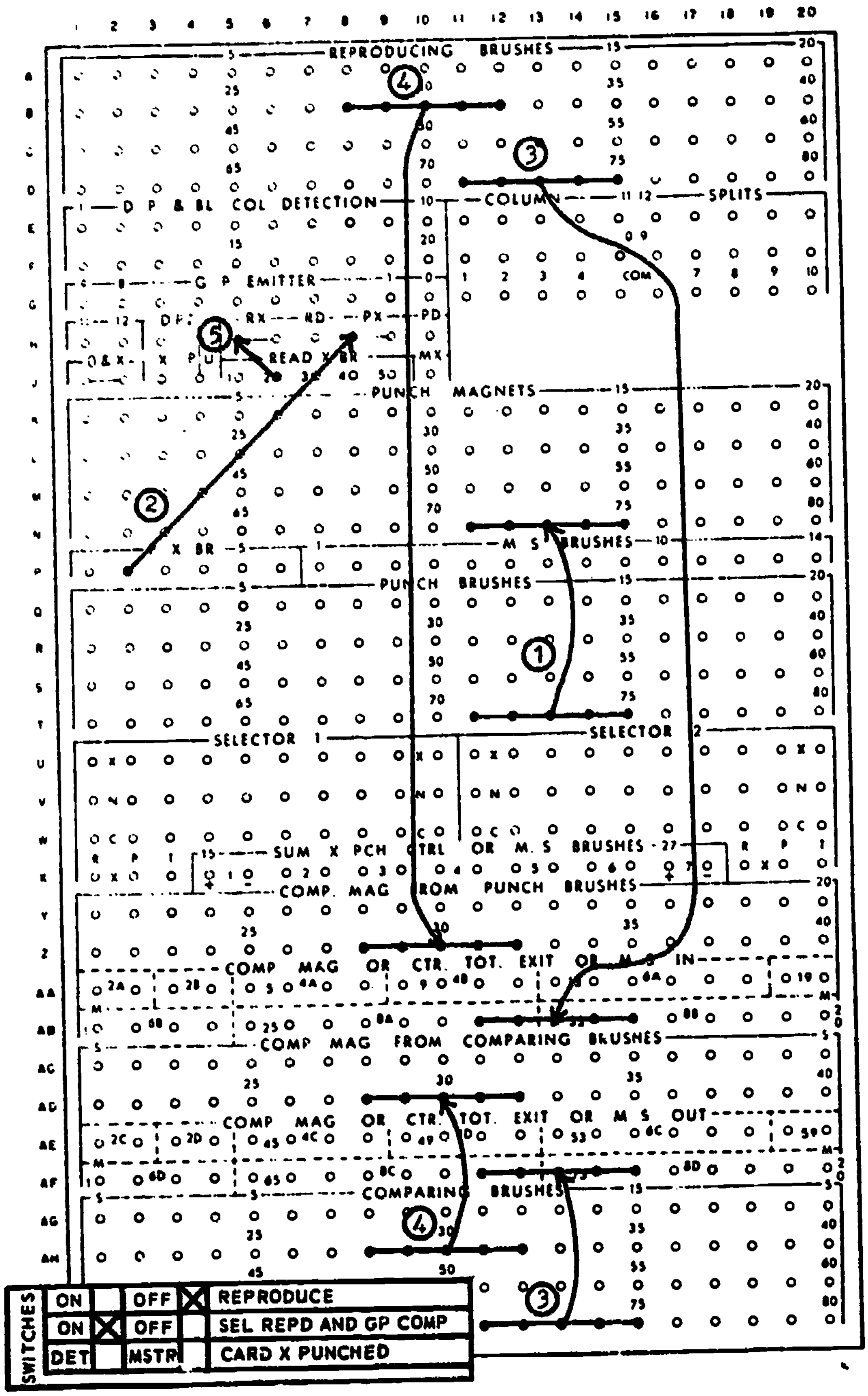

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Figure 7-8.—Interspersed master card gangpunching and comparing.

side of the comparing unit and the reproducing brushes to the other side. The wiring allows information punched in one card to be compared with the information in the following card. If the punching differs, the machine stops and the comparing indicator points out the comparing position in which the error was detected. Any comparing positions can be used, but the positions which correspond to the columns being punched should be used for ease in locating an error.

4. The control field is wired for comparing to ensure that the appropriate detail cards follow their respective master card. If a master card is missing, or if a detail card has been misfiled or punched with the wrong control data, an error will be signalled.

If time permits, this should be done before the gangpunching operation to ensure a correctly sequenced file. This requires only a couple of minutes more machine time than with the double wired board. The cards are processed as follows:

a. The cards are placed in read unit for control field comparing.

b. When a sufficient number have compared correctly, the machine is stopped, and cards from the read stacker are placed in the punch hopper.

c. The machine is restarted, and gangpunching and comparing occur.

d. The punched cards are stacked until all control field comparing is accomplished.

e. The punched cards are then sent through the read unit to ensure that proper gangpunching took place.

5. A read X brush is set to read the column containing the control X, and the corresponding read X brush hub is wired to the RX hub. This causes comparing to be performed under the control of the detail-master switch, as follows:

a. If the control X is punched in the master cards and the detail-master switch is set to MASTER, comparing is suspended when the X punched master cards are passing the reproducing brushes. This prevents a master card from being compared with the last detail card of the preceding group. All NX detail cards are compared.

b. If the control X is punched in the detail cards and the detail-master switch is set to DETAIL, comparing is suspended when the NX master cards are passing the reproducing brushes. This prevents a master card from being compared with the preceding detail card. All X punched detail cards are compared.

DOUBLE PUNCH AND BLANK COLUMN DETECTION

The double punch and blank column device does just what its name implies. Up to 20 hubs can be activated for entries into the device. When any of these hubs is wired from a read station, detection of two or more punches in a column and/or a blank column will cause the machine to stop and the DP & BC DETECT indicator to light.

Toggle switches are installed when the device is installed. There is one switch for each active hub. These switches are normally located near the functional switches (figure 7-9).

When the hubs are wired, detection of double punches is automatic. The additional detection of blank columns is optional, and the operator must set each toggle switch to ON for those desired positions. Detection for blank column only is not possible.

Double Punch Reset Key

This key (figure 7-9) resets the machine after a double punch or blank column error has been recognized. The start key must be pressed to resume machine operation.

OPERATING SUGGESTIONS

The following suggestions aid in obtaining the most efficient operation of reproducing punches.

1. Consult your procedure book for the job you are running. Prewired panel numbers are indicated, switch settings are documented, placement of RX and PX brushes is indicated and all other requirements for the reproducing or gangpunching step are included.

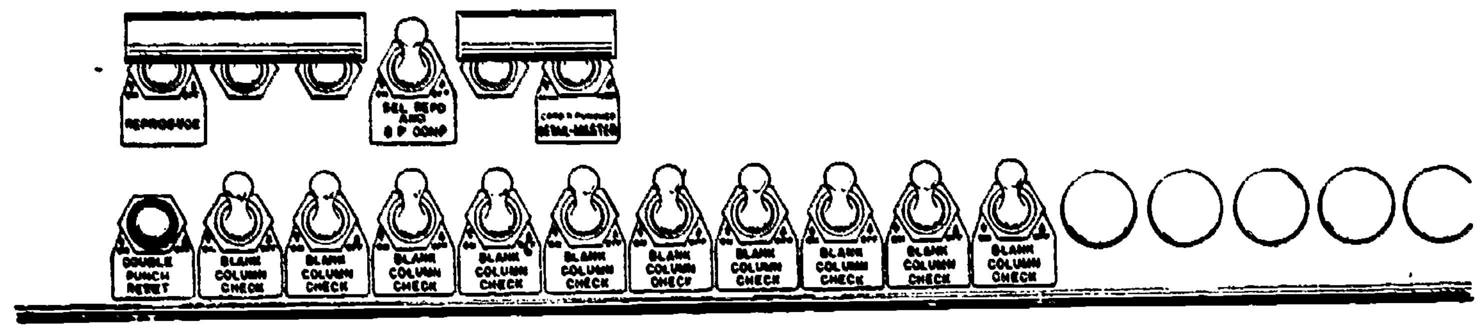

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Figure 7-9.–DP & BC switches.

If any job requires that you wire a board, a wiring diagram should be included in the procedure book.

2. When the stackers must be emptied, stop the machine and remove cards from both stackers before resuming the operation. Failure to stop the machine may result in a card jam.

3. If cards still remain in the punch feed unit when the reproducing operation is finished unload the punch feed hopper. Depress the start key and hold it down for three feed cycles in order to allow all cards remaining in both units to feed into the stackers.

4. The alignment of punching should be checked with a card gauge at the start of each job, and periodically during the job.

5. In many instances a card jam will require removal of the brushes. Your supervisor will demonstrate the proper procedure for removing and replacing brushes, and removing the damaged cards. After your supervisor has finished the demonstration, practice this operation several times. The operation must be carefully performed, and can be learned only through personal instruction, repeated practice and experience.

6. Always leave a control panel in the machine, even when the machine is not in use. This will guard against damage to the prongs in the machine.

7. If the comparing unit signals an error while verifying a gangpunch operation, empty the reading unit stacker and reset the comparing unit. Operate the machine for two feed cycles. Compare the error card, which will be the second card that moves into the reading unit stacker, with the card immediately preceding it.

8. Whenever the comparing indicator signals an error during a reproducing operation, mentally note the error column or columns and reset the comparing unit. Operate the machine for one card feed cycle, and remove cards from both stackers. The top cards removed from the stackers will not agree.

DOCUMENT ORIGINATING MACHINE, TYPE 519

The type 519 document originating machine, similar in appearance to the type 514 reproducing punch, is designed to perform all functions previously described for the type 514. In addition, a print unit provides for printing as many as eight digits across the end of a card as it passes through the punch unit. If the information is printed from punches in the same card, it is referred to as INTERPRETING. If printed from a card in the read unit, it is called TRANSCRIBING.

Notice in figure 7-10 that the paths of cards through the reading and punching units are the same as for the type 514. The only difference is in the terminology associated with some of the brushes, six read X brushes instead of five, and addition of the print unit. The print units function will not he discussed in this manual.

The two additional lights provided operate as follows:

Print Light

The print light comes on when the print unit is engaged and ready to print. When the print

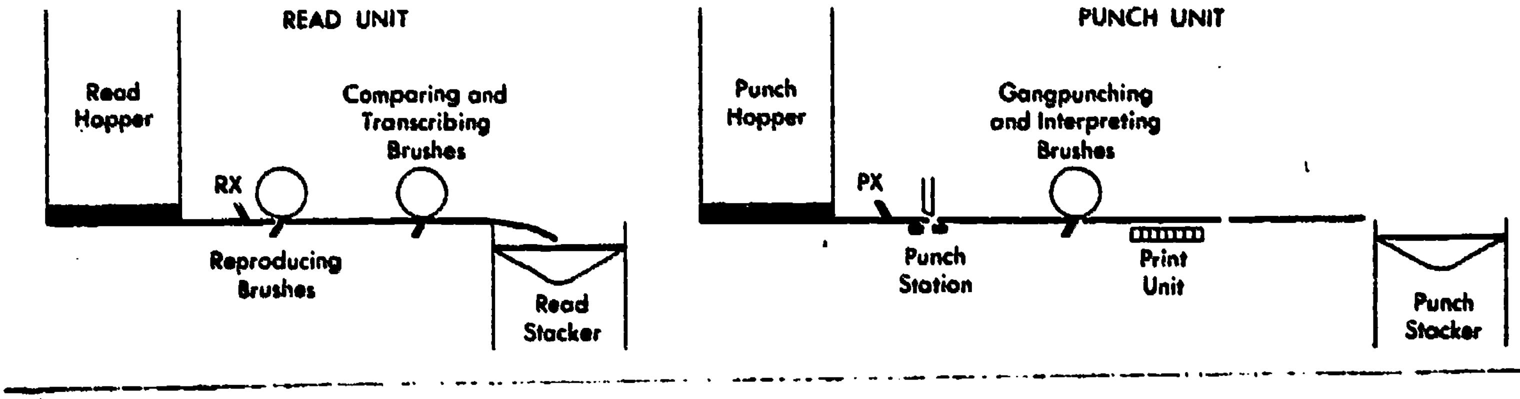

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Figure 7-10.—Card feed schematic diagram.

unit is not being used, it should be disengaged to minimize wear on the unit and the ribbon. The light goes off when the unit is disengaged.

Chip Box Light

When the chip box is full, the chip box light comes on and the machine stops. The 519 cannot be restarted while the chip box is removed.

CONTROL PANEL

The appearance of complexity of the 519 control panel (figure 7-12) is deceiving. It contains nothing with which you have not already been familiarized, although labeling is different. The panel is congested rather than complex.

All the control hubs appear on the left of the panel. These include the RX and PX hubs, selector pickup hubs, X and NX control hubs for punching and comparing, and control hubs rather than functional switches for feed synchronization.

The reading, punching and comparing hubs are located at H through AA. The first 40 of each are located from H through Q and the last 40 from T through AA.

Each line of hubs is labeled to indicate all the functions connected with their wiring. An example is row H labeled PUNCH NORMAL NX & GP. The hubs in this row are the first 40 entries to the punch magnets through a path called PUNCH NORMAL. They are wired into for punching during reproducing for the NX cards. They are also wired into when performing gangpunching (GP).

Some hubs have arrows indicated (H and J5, P and Q22, etc.) and appear to be switches. They are not switches. These arrows appear only to assist the operator in board wiring. The arrow from J5 to H5, for example, indicates that normally row J is wired to row H for gangpunching (GP). The abbreviations appear with the arrows for explanation. GP means gangpunching; GP CH means gangpunch comparing; RPD means reproducing.

PUNCH SELECTOR ENTRIES AND CONTROL HUBS

There are three separate entries to the punch magnets. These entries are labeled PUNCH NORMAL, PUNCH DIRECT and PUNCH TRANSFER.

Selection of one or more entries is controlled by wiring the pickup hubs for punch direct and/or punch transfer. These controls are located at H, J and K3 and 4 for punch direct (P DIR) and Q3 and 4 for punch transfer (P TFR). The pickups are normally wired from the RX or PX hubs.

Figure 7-11 shows the schematic for the three entries and the P TFR control. As is shown, punch direct and punch normal are direct lines to the punch magnets when no controls are utilized. When the P DIR controls are utilized, however, all three punch entries may be suspended from reaching the punch magnets.

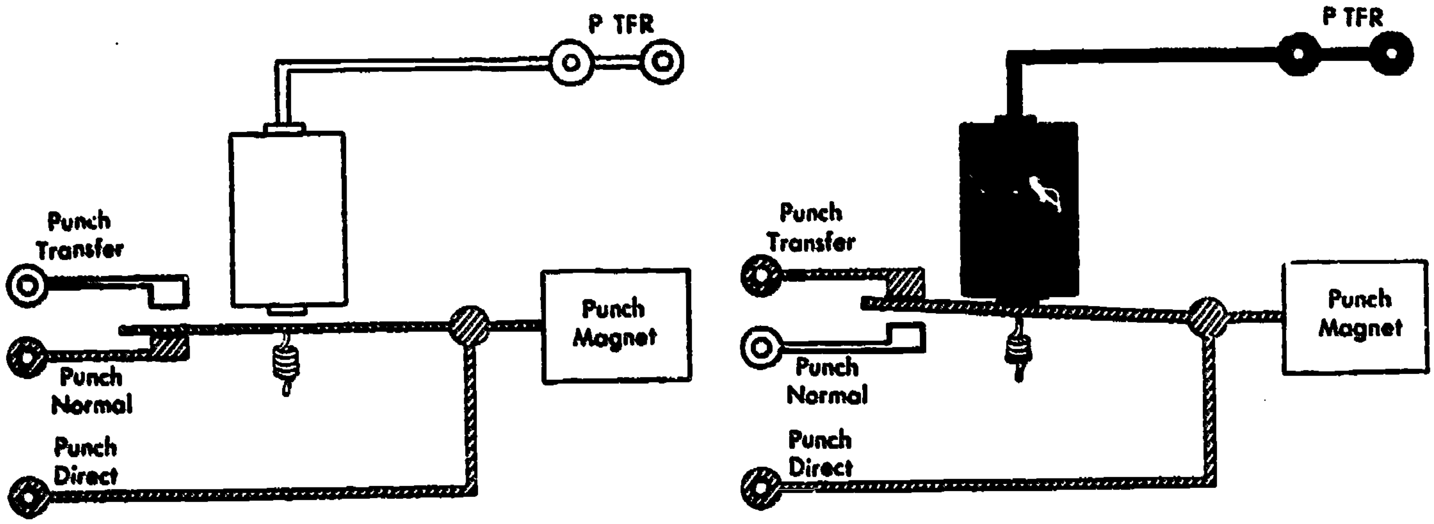

Figure 7-11.–Schematic of the punch entires to punch magnets.

The P TFR pickup controls only the selection between the entries of punch normal and punch transfer. When the pickup is impulsed, the armature changes connections, and what is wired to punch normal does not punch.

With this type of control it is possible to punch constant data through punch direct and select, for X or NX cards, either punch normal or punch transfer for additional information.

If only one type (X or NX) card is to be punched, two ways are available.

Punch Direct Method

Wire into punch direct and control the punching by use of the P DIR hubs. If only X cards are to be reproduced, wire the appropriate RX hub to P DIR pickup and jackplug the X hubs. This conditions the machine to punch only when an X timed impulse is delivered to the PU.

If only NX cards are to be reproduced, wire the pickup and jackplug the N or leave both the X and N unwired. Remember, when the pickup is wired and the X jackplugged, an impulse reaching the pickup causes punching. Therefore, if the X is not jackplugged (the N jackplugged or not), the machine is conditioned to punch only when an impulse does not reach the pickup.

Punch Transfer Method

Wire the P TFR pickup and then simply wire into the punch entry for the type of card to be punched. Punch normal for punching NX cards or punch transfer for punching X cards.

Note: Ensure that the X hubs of P DIR are unwired; otherwise all three entries will be disconnected from the punch magnets.

PRINCIPLES OF CONTROL PANEL WIRING

All operations of the type 519 machine are directed by control panel wiring. Machine controls are located on the left side of the control panel, while the remainder of the panel is used for position wiring.

REPRODUCING

The reading and punching units work together when performing a reproducing operation. In order to synchronize these two units, the reproducing switch (REP) located in the top left corner of the control panel must be wired ON. This switch may be disregarded or wired OFF for all other operations.

Figure 7-12 illustrates the wiring necessary for normal reproducing and comparing of all cards.

1. The reproducing switch is wired ON in order to cause both feed units to operate together.
2. The reproducing brushes are wired to punch direct. All cards will be reproduced, since

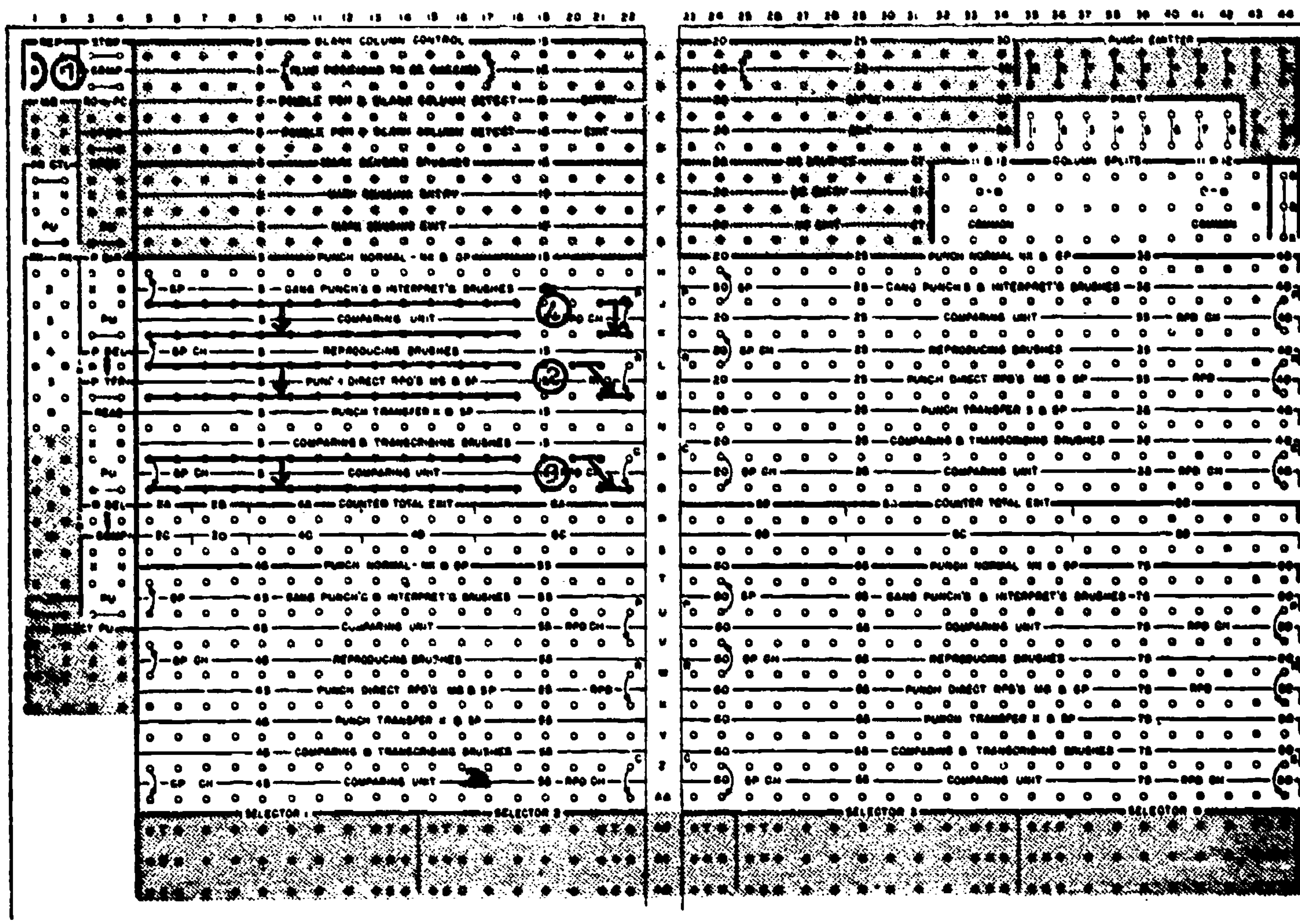

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Figure 7-12.—Normal reproducing and comparing.

no control punch is used to impulse the punch direct pickup hub. Punch normal could be used just as well.

3. The comparing brushes read the source card and send the readings to one side of the comparing unit.

4. The gangpunching brushes read the reproduced card, and send the readings to the other side of the comparing unit. When an error in punching is detected by the comparing unit, the machine stops, the comparing light comes on, and the comparing indicator points out the comparing position containing the error. The comparing unit can be restored by lifting the lever at the left of the unit.

Punching can be controlled so that only one type of card, X or NX, will be reproduced. Figure 7-13 illustrates the punch transfer method for selective reproducing and comparing.

1. The reproducing switch is wired ON.

2. In order to identify the X cards, a read X brush is set to read the column containing the X punch, and the corresponding RX brush hub on the control panel is wired to the punch transfer pickup hub.

3. The reproducing brushes are wired to punch transfer. When an X punched card is read, the punch transfer hubs are activated, thus allowing X punched cards to be reproduced. If NX cards were to be reproduced, the reproducing brushes would be wired to punch normal in place of punch transfer.

4. Comparing takes place on the following card cycle. The RX brush is wired through the common punch transfer pickup hub to the read

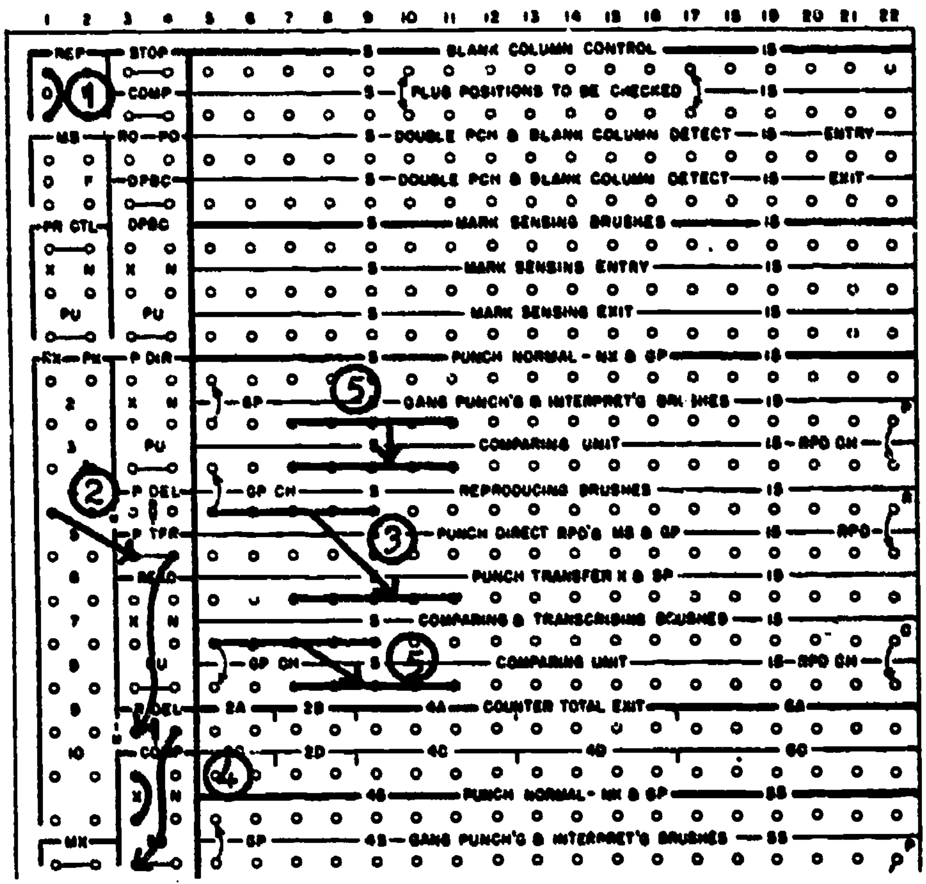

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Figure 7-13.–Selective reproducing and comparing.

delay entry hub. This causes an impulse to become available from the read delay exit hub one cycle later, just before the X card reaches the comparing brushes. The read delay exit impulse is then wired to the comparing switch pickup hub to control comparing of X or NX cards. If the X hubs in the comparing switch are jackplugged, comparing is effective for X cards only. If the pickup alone is wired, or if the pickup is wired and the N hubs are jackplugged, comparing would be effective for NX cards only.

5. The comparing unit is wired the same as for normal reproducing.

Another method of selective reproducing would be to wire the reproducing brushes to punch direct, and wire the RX hub to the punch direct pickup hub. Then, if X cards were to be reproduced, the X hubs would be jackplugged, and punching would be suspended for NX cards. If NX cards were to be reproduced, the N hubs would be jackplugged and punching would be suspended for X cards. Comparing would be controlled in the same manner as shown in figure 7-13.

GANGPUNCHING

Gangpunching from a single master card may be performed by wiring the gangpunching brushes to either punch normal or punch direct, since either entry provides a path to the punch magnets if no punch entry pickup has been impulsed. Interspersed gangpunching can be accomplished by either of two methods, punch direct or punch transfer.

The punch direct method causes suspension of all punching when the X or NX cards are under the punch magnets, depending upon whether the X control punch is in the master or detail cards. The gangpunched field cannot be wired to end print or to double punch and blank column detection when this method is used.

The punch transfer method uses an internal selector system for gangpunching. The punch normal hubs are considered to be the normal side of the selector, and the punch transfer hubs the transferred side. Thus, when the punch transfer pickup hub receives an impulse, the punch transfer hubs become active, and provide a path to the punch magnets. At all other times, entrance to the punch magnets is provided through punch normal. This method must be used when the gangpunched field is also wired to some other entry, such as end print or double punch and blank column detection.

Comparing is performed in the same manner for both methods. When an X punched card is recognized, comparing is either effective or suspended, depending upon the type of card which contains the control X.

In figure 7-14 the punch direct method of interspersed gangpunching is used to punch X detail cards.

1. The gangpunching brushes are wired to punch direct. Punch normal could be used just as well.

2. A PX brush is set to read the control X punched in the detail cards, and the corresponding PX brush hub is wired to the punch direct pickup hub.

3. Because the X detail cards are to be punched, the punch direct X hubs are jackplugged. This causes punching to be suspended whenever NX master cards are under the punch magnets. If the master cards contain the control X punch, the punch direct N hubs would be jackplugged or left unwired to cause punching to be suspended for X master cards.

4. Comparing is performed by wiring the reproducing brushes to one side of the comparing unit and the comparing brushes to the other side.

5. An RX brush is set to read the control X punched in the detail cards, and the corresponding RX brush hub is wired to the comparing switch pickup hub.

6. Since comparing is to be suspended whenever NX master cards are under the reproducing brushes, the comparing switch X hub is jackplugged. If the master cards contain the control

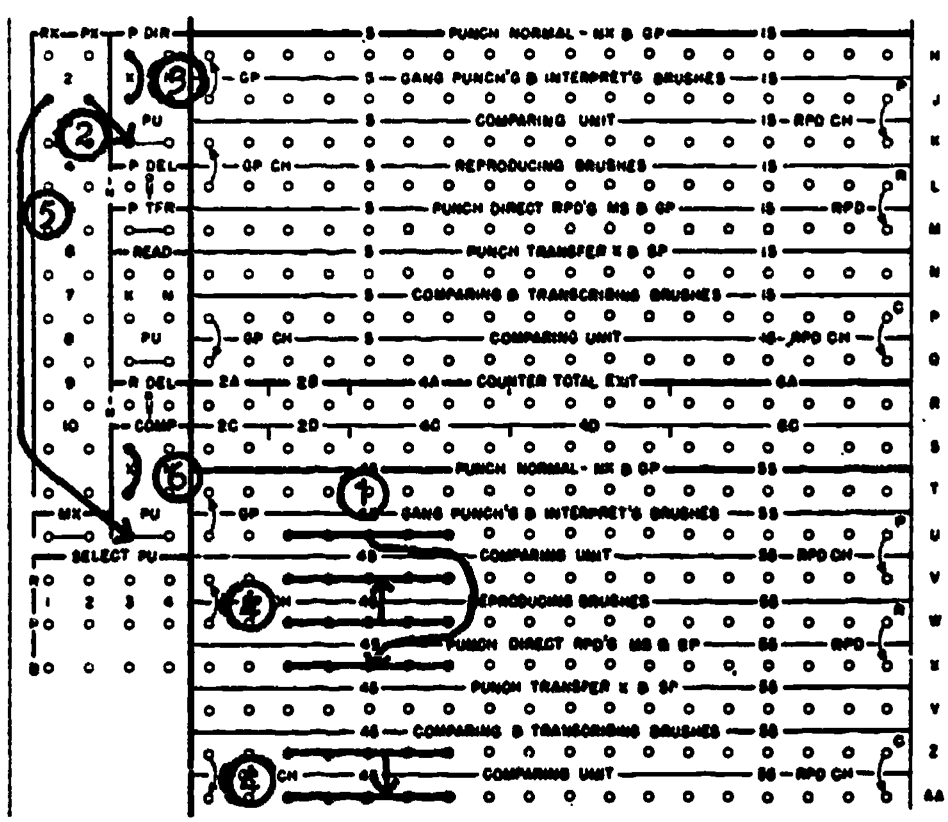

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Figure 7-14.—Interspersed gangpunching, punch direct.

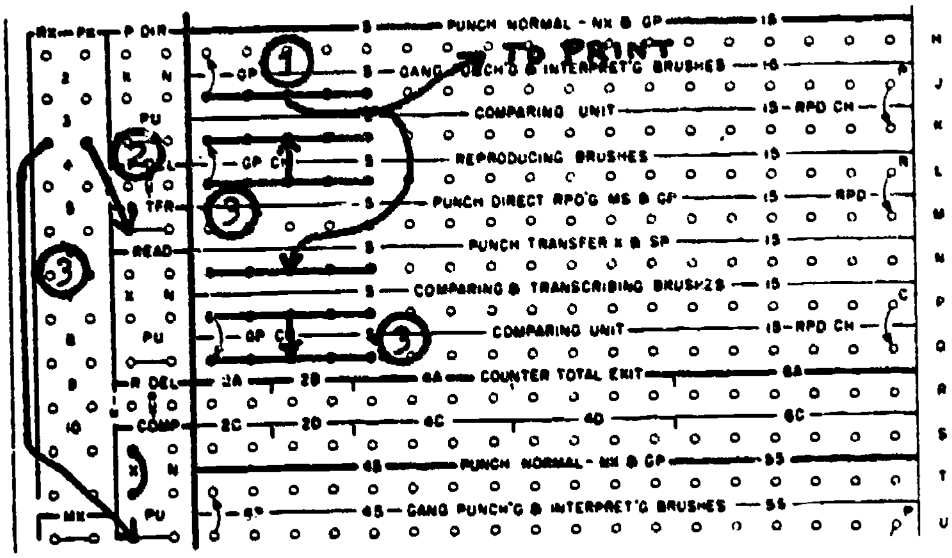

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Figure 7-15.–Interspersed gangpunching, punch transfer.

X, the comparing switch N hubs would be jackplugged or left unwired.

The wiring for interspersed gangpunching using the punch transfer method is illustrated in figure 7-15. X punched detail cards are to be punched and all cards are to be end printed.

1. The gangpunching brushes are wired to both punch transfer and the print hubs. If master cards were to contain the control X, punch normal would be wired in place of punch transfer.

2. The PX hub is wired to the punch transfer pickup hub. This causes the field which is to be gangpunched to reach the punch magnets through the punch transfer hubs when X punched detail cards are sensed by the PX brush.

3. Comparing is controlled in the same manner as previously described for the punch direct method.

OPERATING SUGGESTIONS

The first seven suggestions listed under the type 514 reproducing punch apply equally to the type 519. Suggestion number 8 must be modified to allow for the extra printing station in the punch unit of the type 519. The machine must be operated for two feed cycles after the comparing unit has been reset before removing cards from the stackers. The top card from the punch stacker and the next-to-top card from the read stacker will not agree.

CHAPTER 8

COLLATORS

INTRODUCTION

We know that one of the basic requirements for preparing any type of report from punched cards is to have the cards in some kind of sequence. We also know that the original card arrangement is performed on the sorter. Now suppose you wish to combine two files of cards already in sequence to prepare a report. One method would be to place both files together and sort them again as one file. This method would work, provided you had the time to do it, and further provided that all cards in both files are to be used in the report. But suppose you wish to use only those cards from one file that contain the same control numbers as the cards in the other file. Now you have a problem that the sorter cannot solve. What you need is a machine that will merge the two files of cards without disturbing their original sequence, and at the same time, will select the cards you do not wish to use. The collator is designed to do just this sort of job, along with various other functions as explained later.

Operations which can be performed on the collator fall into five general categories as follows:

1. CHECKING SEQUENCE. After a file of cards has been sorted into a desired sequence, the file should be machine checked in the collator to ensure the proper sequence is throughout the file. The collator performs this job in one feed unit by comparing each card with the one ahead of it. If any cards are found to be out of sequence, the machine can be directed by control panel wiring to stop and turn on the error light, or select the cards that are out of sequence.

2. MERGING. This is the operation in which two files of cards already in sequence are combined into one file. Feeding from two different feed units is controlled by comparing the cards from one feed with the cards from the other. The card that contains the lower (or higher, depending on the sequence) control number will be fed first, providing the control panel is wired correctly. The result will be one combined file in proper order.

3. MATCHING. Suppose that instead of merging two files of cards, you want only to see if the cards in one file match those in the other. For this type operation two feeds and four pockets are used. Two of the pockets receive the matching cards (one for each file), and two pockets receive those cards from each file that do not match.

4. MERGING WITH SELECTION. This operation is not merging as explained in category two. This is the same operation as matching except that the matched cards from each file are allowed to merge into one pocket. The unmatched cards from each file are again selected to separate pockets. At the end of this job there will be three groups of cards, one group of match-merged cards and two groups of unmatched cards.

5. CARD SELECTION. Particular types of cards can be selected from a file without disturbing the sequence of the others. The type selected may be an X or NX card, the first card of a group, the last card of a group, a single-card group, a zero balance card, a card with a particular number, or cards with numbers between two control numbers. Single cards or groups of cards out of sequence can be selected also. The type of card or cards selected depends upon the operation being performed and control panel wiring.

COLLATOR GROUPS

Collators can be classified in two general groups–numerical and alphabetic. Numerical collators, such as the IBM types 77, 85, and 88, can process numerical data only, unless a special alphabetic collating device is installed; whereas alphabetic collators, such as the IBM types 87, and 188, can process either numerical or alphabetic data. The types 77, 85, and 87 collators are designed along the same lines, both in operation and control panel wiring. Therefore, an understanding of the collating principles involved for the type 85 as presented in this chapter should enable you to adapt your knowledge to the types 77 and 87 if you should be required to operate either of those machines. Since the types 88 and 188 collators differ considerably from the previous generations, they will be discussed separately.

COLLATOR, TYPE 85

The type 85 collator (fig. 8-1), is designed to perform all the functions previously mentioned. In addition, it has the capacity for checking blank columns in cards fed from either hopper. Blank column detection can be performed separately or can be combined with any of the other operations.

OPERATING FEATURES

The MAIN LINE SWITCH, located on the right side of the machine, controls the power supply, and must be ON for all machine operations. The operating keys and lights, located above the stackers, are illustrated in figure 8-2.

Depression of the START KEY starts card feeding, while the STOP KEY is used to stop card feeding. When the last card has been fed from either hopper, the machine stops. The RUNOUT KEY must then be held down until the cards from the depleted hopper, remaining in the machine, have been moved into the stackers. Whenever the machine stops because of an error or blank column detection, the RESET KEY must be depressed before the operation can be resumed.

The READY LIGHT signals that the machine is ready to be operated. This light goes off when cards are passing through the machine, or when the main line switch is turned off. The ERROR LIGHT comes on when an error condition is recognized by the machine through control panel wiring, such as a card out of sequence. The BCD 1 LIGHT comes on whenever a blank column is detected in a field wired to blank column detection entry 1. The BCD 2 LIGHT comes on if the blank column is detected in a field wired to blank column detection entry 2.

Card Feed Units

The two feed units in the collator are called the PRIMARY FEED and the SECONDARY FEED. Cards placed in the primary feed are referred to as primary cards, and those placed in the secondary feed are called secondary cards. Cards are placed in the hoppers face down, with the 9 edge toward the throat. Either feed unit can feed cards at the rate of 240 cards per minute. When using both feeds, the number of cards fed per minute will range between 240 and 480, depending upon control panel wiring and the job being performed.

As cards feed from the primary feed hopper, they pass the sequence reading station and then the primary reading station. Each station consists of 80 reading brushes, which completely read the cards one row at a time. Cards fed from the secondary feed hopper pass the secondary reading station, consisting of 80 reading brushes.

Pockets

After cards are read by the brushes, they are directed to one of four pockets, or stackers, by control panel wiring. From right to left, these pockets are known as pocket 1, pocket 2, pocket 3, and pocket 4. Cards fed from either hopper will always stack in pocket 2 unless directed to one of the other pockets by control panel wiring. Primary cards can be selected into pocket 1 and secondary cards can be selected into pockets 3 and 4. Under no circumstances can primary cards be selected into pockets 3 and 4 nor secondary cards into pocket 1.

PRINCIPLES OF OPERATION

Most collating operations require that two numbers be compared. For example, when

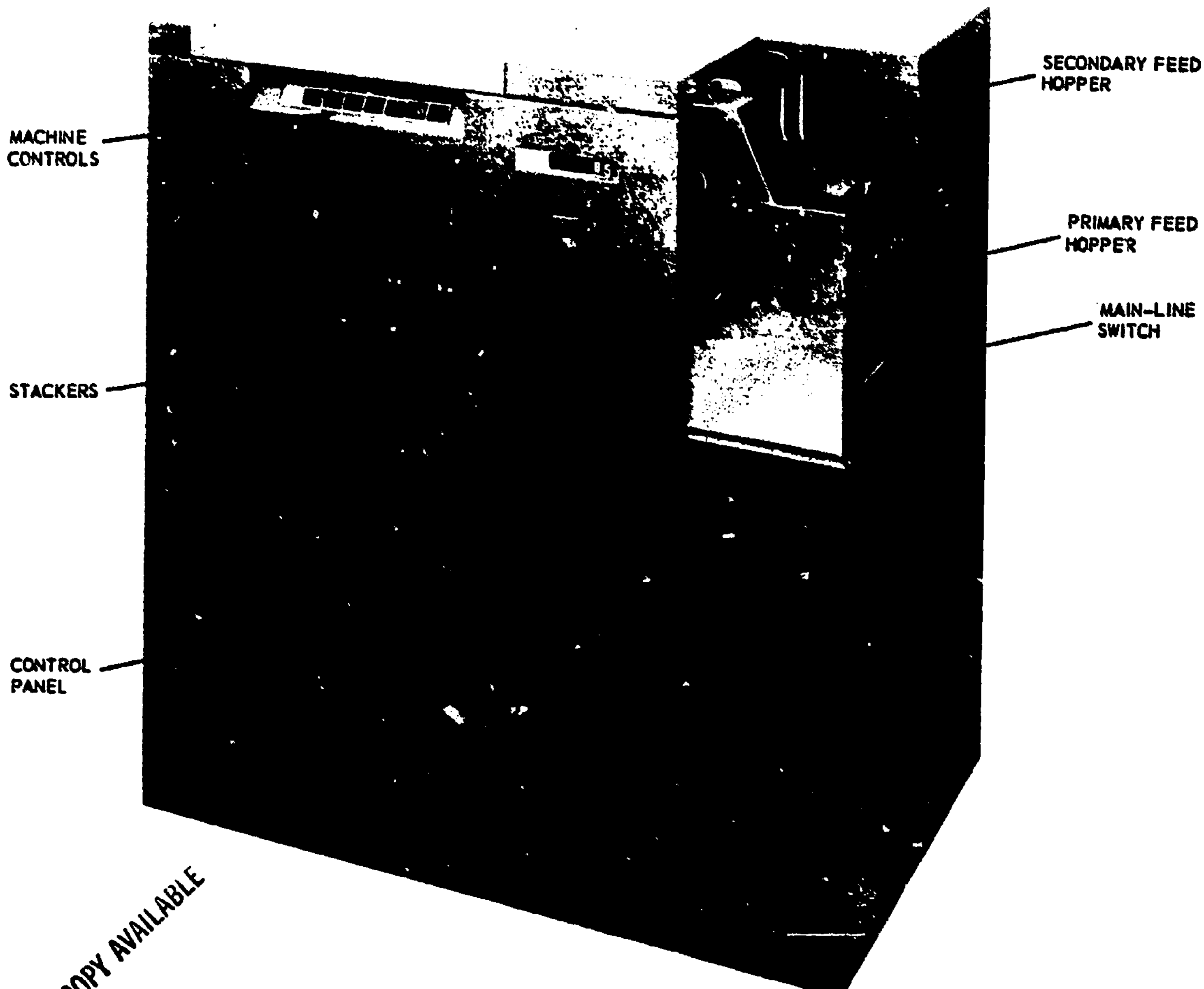

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Figure 8-1.—IBM type 85 collator.

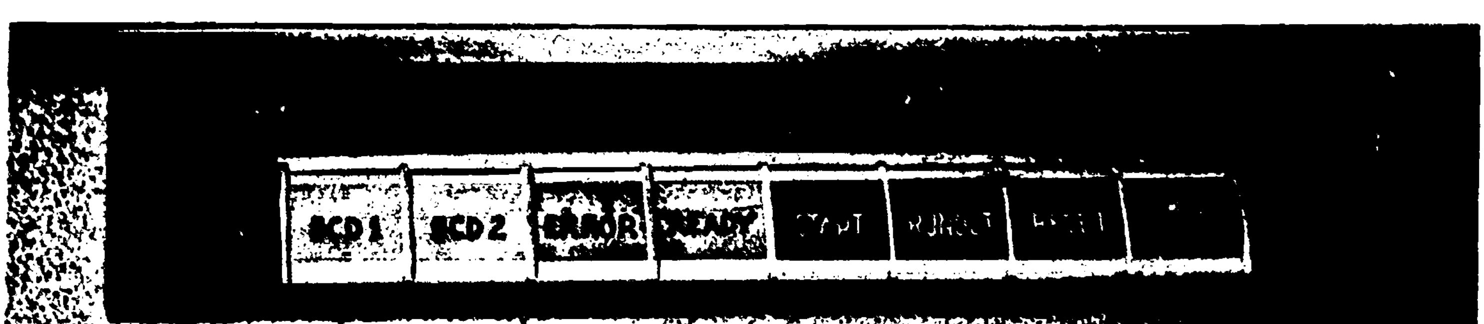

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Figure 8-2.—Machine Controls.

checking sequence, the number in one card must be compared with the number in the preceding card (in the same feed) to see if the cards are in the proper order. When merging, the number in a card in one feed unit must be compared with a number in a card in the other feed unit to see which card is to be fed first. When one card is compared with another, one of three possible conditions may exist; it may be lower, equal to, or higher than the other card.

Correct feed unit selection for card feeding and pocket control for card selection are accomplished by proper wiring of control panel comparing unit exit hubs to the feed and pocket selection control hubs. The collator can be thought of as one big comparing unit as most all of the operations are controlled by comparison results.

Schematic Diagram

Refer to figure 8-3. This gives you a look inside the machine to see how card feeding and brush reading occur. Notice that the primary cards pass two sets of brushes while the secondary cards pass only one set. The readings from the two sets of brushes in the primary feed unit can be compared with each other or with readings from the secondary brushes. Since the secondary feed unit contains only one set of brushes, readings from the secondary brushes can normally be used only for comparing with readings from the primary brushes.

Comparing is performed in either or both of two comparing units, the sequence unit and the selector unit. Each unit has two sides or entrances and consists of 16 comparing positions. The sequence unit is normally used for checking sequence by comparing the readings from the two sets of brushes in the primary feed unit, while the selector unit is used for merging or matching by comparing a card in the secondary feed unit with one in the primary feed unit. However, both comparing units operate in the same manner and may be used interchangeably if desired.

Control Panel Hubs

Figure 8-4 represents the entire control panel. The hubs on the left side of the panel are used for position wiring while the hubs on the right side are used for control. A basic understanding of the standard hubs will help you to understand the principles involved in wiring the control panel for a particular application. Refer to figure 8-4 and locate the particular hubs as they are described. The timing chart (figure 8-5) is provided to help you in better understanding the hubs and for operations explained later in the chapter.

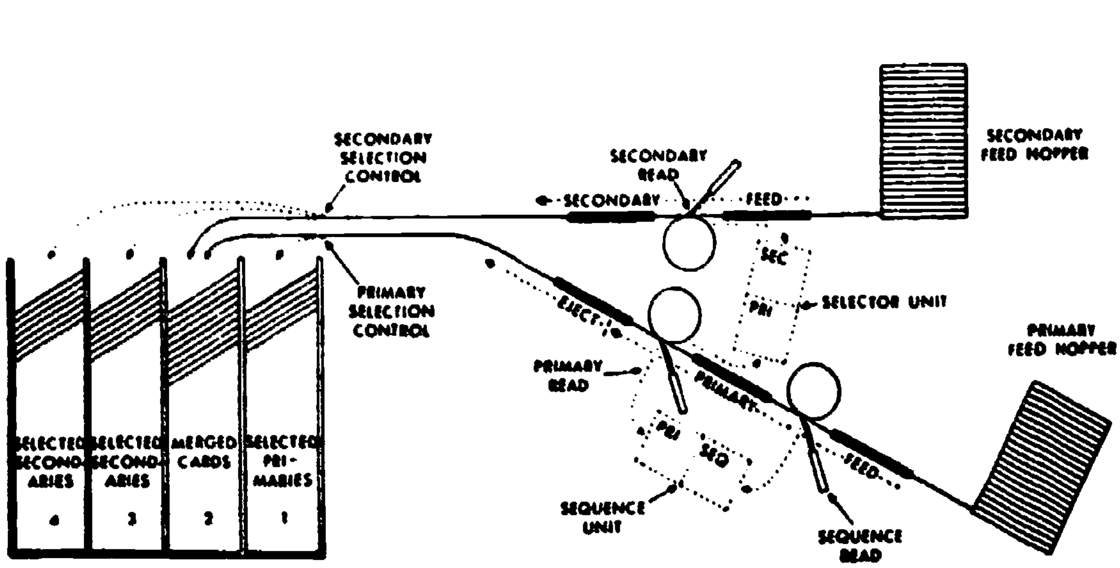

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Figure 8-3.—Card Feed Schematic Diagram.

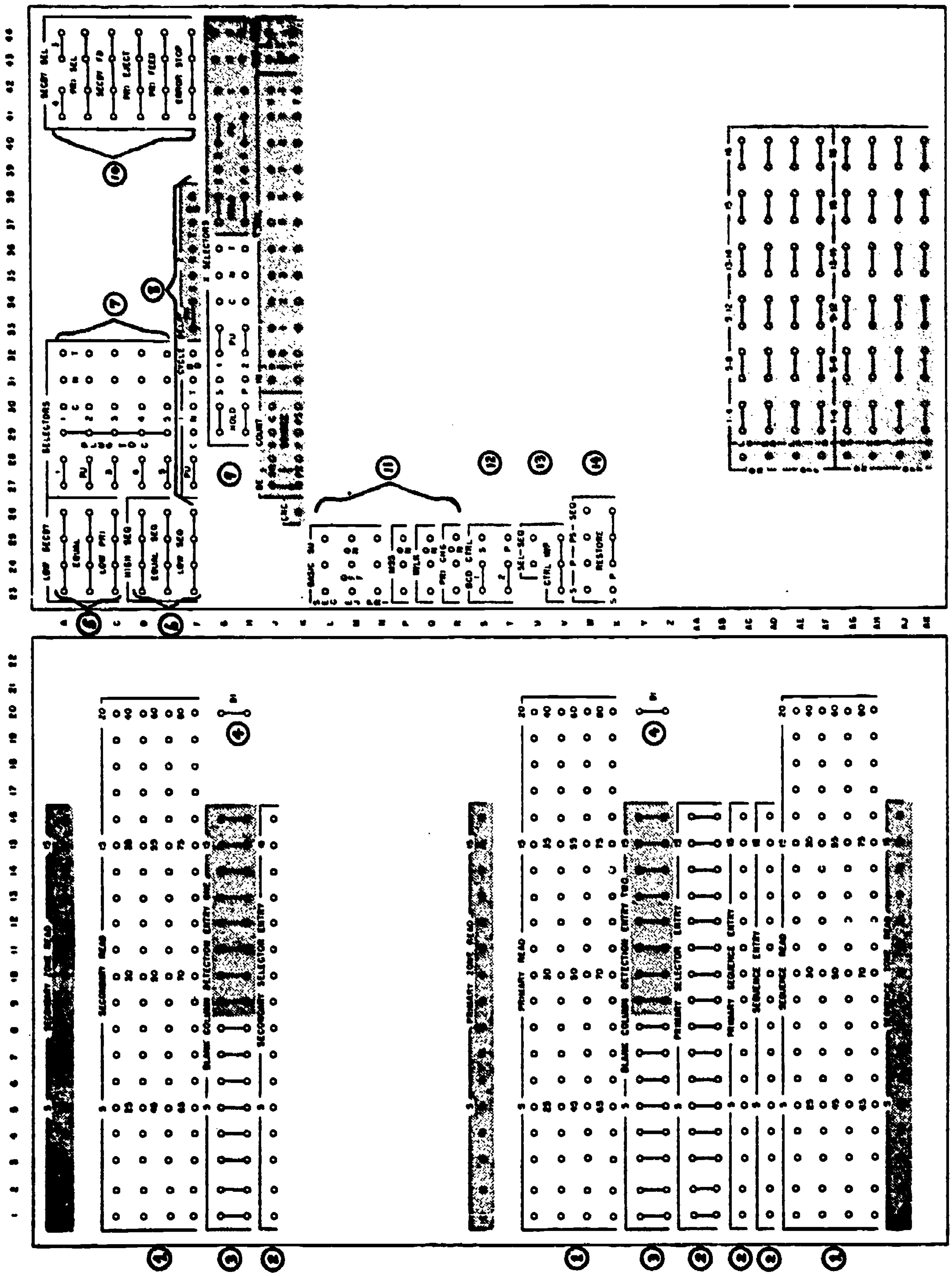

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Figure 8-4.—Type 85 Control Panel.

85 COLLATOR TIMING CHART

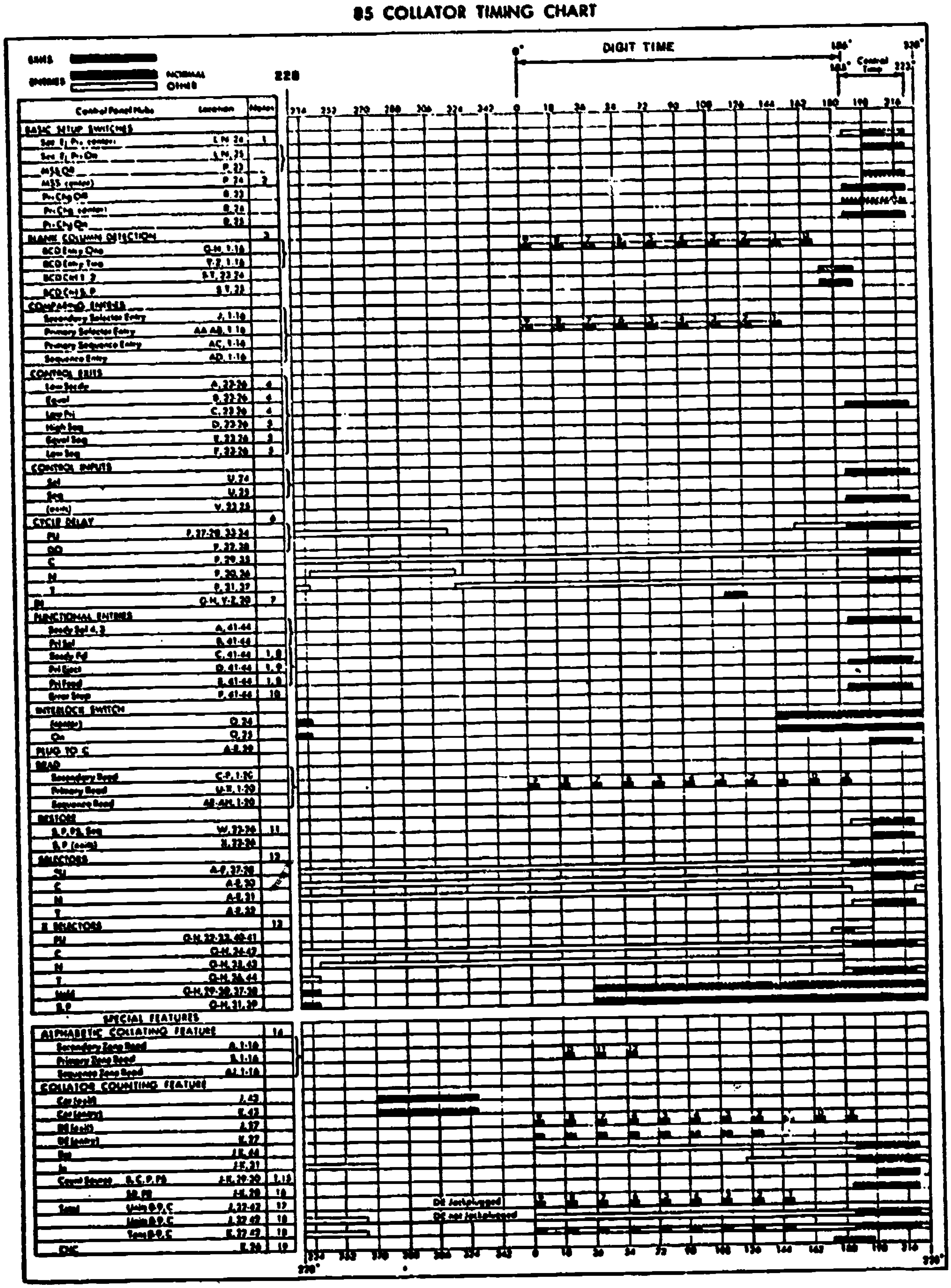

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Figure 8-5.—Timing Chart—IBM 85.

1. READ. These three sets of hubs represent outlets from the corresponding set of reading brushes.

2. COMPARING ENTRIES. These hubs provide entrance to the comparing units and are normally wired from the read hubs. The selector unit compares two numbers by wiring one number to secondary selector entry and the other number to the corresponding positions of primary selector entry The sequence unit compares two numbers by wiring one number to primary sequence entry and the other number to the corresponding positions of sequence entry.

3. BLANK COLUMN DETECTION. Flexibility is provided in the blank column detection units to allow for checking up to eight blank columns from each feed during the same operation or up to 16 columns when checking cards from one feed only. Operation of these units is controlled by the way the BCD control hubs are wired.

4. DIRECT IMPULSE. The DI hubs emit an impulse each machine cycle, which corresponds essentially to a 2-punch in a card. A direct impulse must be wired to unused blank column detection entry hubs when checking for blank columns in order to deactivate these unused hubs and prevent false blank column indication.

5. SELECTOR UNIT CONTROL EXITS. These hubs emit impulses whenever a high, low, or equal condition exists in the selector unit. If the secondary reading is lower than the primary, LOW SECONDARY emits an impulse. If the primary reading is lower than the secondary, LOW PRIMARY emits an impulse. If both readings are the same, EQUAL emits an impulse. They are normally wired to the functional entry hubs or to selector pickup hubs to control card feeding and selection.

6. SEQUENCE UNIT CONTROL EXITS. These hubs emit impulses resulting from a high, low, or equal comparison in the sequence unit. If the sequence reading is higher than the primary reading, HIGH SEQUENCE emits an impulse. If the sequence reading is lower than the primary reading, LOW SEQUENCE emits an impulse. If both readings are the same, EQUAL SEQUENCE emits an impulse. The high sequence and equal sequence exits are normally wired to the functional entry hubs or to selector pickup hubs to control card feeding and selection. Low sequence exit is usually wired to ERROR STOP to cause card feeding to stop and the error light to turn on when a step-down in sequence is detected.

7. SELECTORS. Card feeding and selection can be controlled by proper wiring of the selectors. The pickup hubs are normally wired from the control exit hubs. They cannot be wired from a reading station. Five common PLUG TO C hubs, located immediately to the right of the selector pickup hubs, emit an impulse each card feed cycle. They are normally wired to functional entry hubs, either directly or through the normal or transferred sides of the selectors to the functional entry hubs, to cause card feeding or selection as required. A selector will transfer immediately when the pickup hub receives and impulse, and will return to normal at the end of the controlling impulse.

8. CYCLE DELAY. This unit operates in a manner similar to the selectors, but with two notable exceptions. First, the cycle delay unit does not transfer until the cycle following that on which the pickup impulse is received. Second, once the cycle delay unit is transferred, it remains transferred until an impulse is received by the DROPOUT (DO) hub. When DO is impulsed, the unit returns to normal for the following card cycle unless another pickup impulse is received.

9. X SELECTORS. Feeding and selection of X or NX cards can be controlled through the use of X selectors. Either selector may be controlled to operate with either the primary or secondary feed by wiring the selector HOLD hub from either P (primary) or S (secondary). The P hub emits an impulse when cards are fed from the primary feed, and the S hub emits an impulse whenever secondary cards are fed. The pickup hubs may be wired from primary read when X or NX primary cards are to be selected, or from secondary read when the selection of X or NX secondary cards is desired. A Plug to C, wired through the selectors to the functional entry hubs, causes feeding or selection of the desired type of cards.

10. FUNCTIONAL ENTRIES. These hubs accept impulses to control feeding and selection of cards. They are usually wired from control exits or Plug to C. Each hub, when impulsed, will cause the following to occur; SECONDARY

SELECT 4 directs a secondary card to pocket 4 while SECONDARY SELECT 3 directs a secondary card to feed or select into pocket 3. If both 4 and 3 are impulsed at the same time, pocket 4 will take precedence over pocket 3. PRIMARY SELECT directs a primary card to pocket 1. SECONDARY FEED causes a card to be fed from the secondary feed hopper. PRIMARY EJECT causes a card to move from the eject station in the primary feed unit without causing a primary feed cycle. PRIMARY FEED causes a primary card to be fed from the primary feed hopper. ERROR STOP causes card feeding to stop and the error light to turn on. It is normally wired from low sequence. A Plug to C impulse must NEVER be wired to error stop, since this would result in a card jam without stopping card feeding.

11. BASIC SETUP SWITCHES. It is possible to control card feeding for most operations by using the basic setup switches in place of wiring the control exits and functional entries. However, you should first have a complete understanding of how functional wiring is accomplished in order to fully realize the relationship between these switches and functional wiring, and the role that each switch plays in performing a given operation. Therefore, a detailed discussion of the basic setup switches is reserved for later in this chapter.

12. BLANK COLUMN DETECTION CONTROL. These hubs control the use of the blank column detection units. Each unit may be controlled to operate with either the primary or secondary feed by wiring the control entry hub from P (primary) or S (secondary). Primary card feeding causes the P hub to emit an impulse while the S hub emits an impulse during a secondary card feed cycle.

13. CONTROL INPUTS. These hubs allow test impulses to enter the comparing units for the purpose of determining whether a low, equal or high condition exists. The hubs labeled CTRL INP are exits which emit impulses every card feed cycle. They are normally wired to SEQ (sequence) and SEL (selector) to test comparisons in the sequence and selector units.

A control input hub wired to SEL allows an impulse to travel internally through the selector unit, where it tests the comparing positions wired. This impulse then becomes available from one of the selector control exits depending upon the condition found in the selector unit.

A control input hub wired to SEQ allows an impulse to test the sequence unit in the same manner as the selector unit is tested. This impulse is then available from one of the sequence control exits depending upon the condition found in the sequence unit.

The test impulse in each unit travels from left to right, so that the high order position of the control field is tested first, and continues toward the units position until an unequal condition is found or, in the case of an equal condition, until the last position in the unit is reached.

In multi-field operations, (major, intermediate, minor) the major field should be wired to the leftmost position of the comparing entries, then the intermediate, then minor.

14. RESTORE. The sides of comparing units wired from brushes in the primary feed unit are usually cleared each primary card feed cycle to allow new readings to enter from the next primary card. Likewise, sides of comparing units wired from the secondary feed brushes are usually cleared each secondary card feed cycle to allow new readings to enter from the next secondary card. The single hub, labeled S in the lower row emits an impulse every secondary card feed cycle, and is normally wired to the restore S hub directly above it to cause the secondary side of the selector unit to clear, or restore, each time a secondary card is fed. Each of the three common P hubs in the lower row emits an impulse each time a primary card is fed. These hubs usually are wired to the restore hubs directly above to cause both sides of the sequence unit (PS and SEQ) and the primary side of the selector unit (P) to restore on each primary card feed cycle.

PRINCIPLES OF CONTROL PANEL WIRING

For simplicity and uniform explanation of operations and control panel wiring in this chapter certain standards are set.

The majority of installations utilizing a collator require, when merging files of cards, that the master cards precede the detail cards in the

merged file. This is most easily accomplished by ensuring that the master card file or the one of primary importance is placed in the primary feed. The basic setup switches are designed to operate under this assumption. Although functional wiring is as versatile as the amount of experience of the board wirer, the following operations will be explained with the understanding that the primary feed always holds the file of primary importance (the master cards or the cards to be compared against).

For wiring in this chapter the following additional standards are set:

1. The secondary selector entries are always wired from the secondary read.
2. The primary selector entries are always wired from the primary read.
3. The primary sequence entries are always wired from the primary read (directly or continued from the common primary selector entry hubs).
4. The sequence entries are always wired from the sequence read.

These standards are for this manual only. Deviance from the wiring methods presented can be successfully accomplished but should only be attempted by an experienced DP.

Sequence Checking

Sequence checking is a simple operation requiring only the use of the primary feed unit. The field containing the control number is wired from both sets of read brushes to the two entries of the sequence unit (see figures 8-3 and 8-6). This allows readings of a card at the primary read to be compared with the readings from a card at the sequence read.

The sequence desired (ascending or descending) is then checked by utilizing the results of this comparison in the sequence unit. (As the majority of files are in ascending sequence, all figures and explanations in this chapter will deal with ascending order. Descending order would reverse most functional feed controls.)

In ascending sequence any time a reading is lower at the sequence read than at the primary read an error (stepdown) condition is present.

In the functional control wiring of figure 8-6, a plug to C wired to primary feed causes continuous card feeding from the primary feed unit. Whenever a stepdown in sequence is detected, an impulse wired from low sequence to error stop causes the machine to stop and the error light to come on.

The functions of the wired control at locations Q, U, V, W and X are explained in detail under the section on control panel hubs. The restore controls are necessary to ensure that each new card reading is accepted by the comparing unit. The control input directs a testing impulse through the comparing units. The interlock control provides for proper control during runout of the last few cards. These controls may not be shown on the partial diagrams in this chapter but are required for all jobs.

What has happened inside the machine? Examine the analysis charts in figure 8-7. In chart A, cards punched with 3 and 4 were found to be in sequence, and were stacked in pocket 2. The 5 card has just been read by the primary read brushes and the reading has been entered into the primary side of the sequence unit. The following card has just been read by the sequence read brushes, resulting in a 7 being placed in the sequence side of the sequence unit. Since 7 is higher than 5, a high sequence condition exists indicating that the cards are in order.

In chart B, the 5 card has been stacked and the following cards have moved up. In this case, the 7 card is followed by another 7 card, so an equal condition exists, indicating that the cards are still in order.

In chart C, the first 7 has stacked, the second 7 has moved up, and a 6 card has been read into the sequence side. Since 6 is lower than 7, a low sequence condition is indicated. The machine stops and the error light comes on when low sequence is wired to error stop.

Merging

When two files are to be combined into one, it is an operation of merging. Basically, there are two types of merging, straight merging and merging with selection.

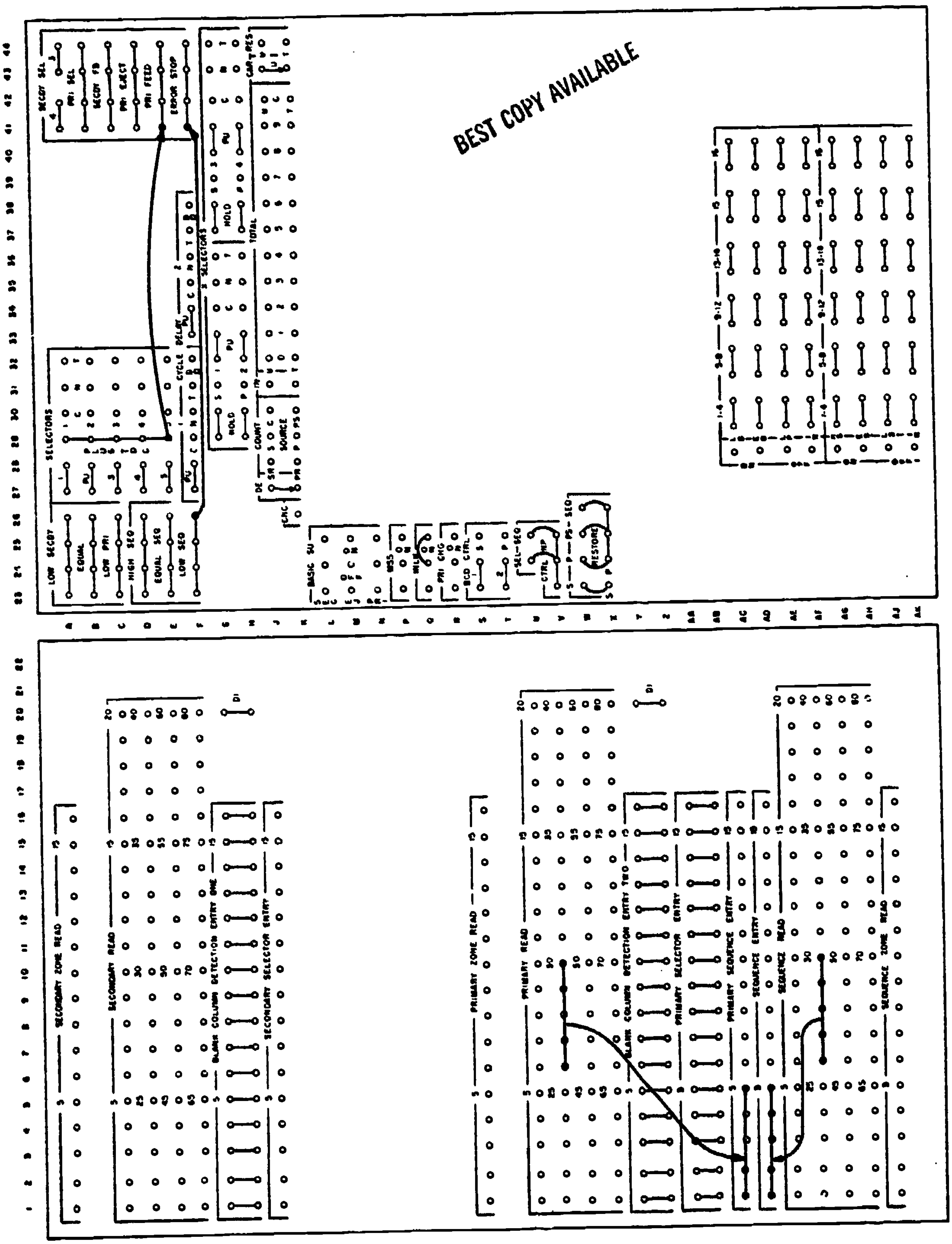

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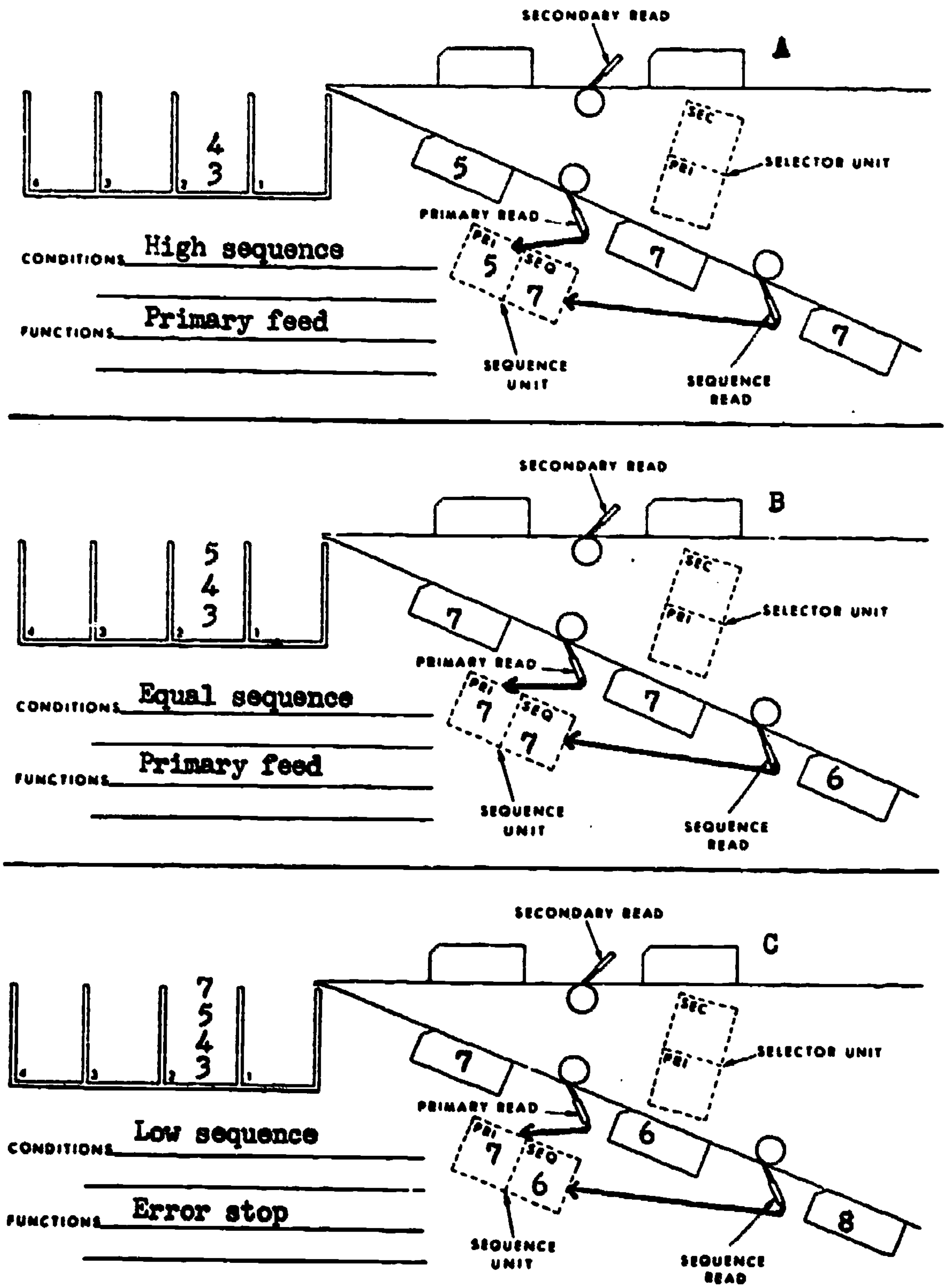
Figure 8-6.—Sequence Checking.



49.58

Figure 8-7.—Checking Sequence, Analysis Chart.

Straight merging combines the files with no requirements other than all like control numbers be combined into one group and the entire combined file be in sequence. This means that if the primary file contains the control numbers 1,2,2,4,5,6, and the secondary file contains control numbers 1,1,2,3,3,5, the result will be a combined file with control numbers 1,1,1,2,2,2,3,3,4,5,5, and 6.

Straight merging can be accomplished in two ways using the functional wiring methods. Figure 8-8 illustrates the functional wiring required

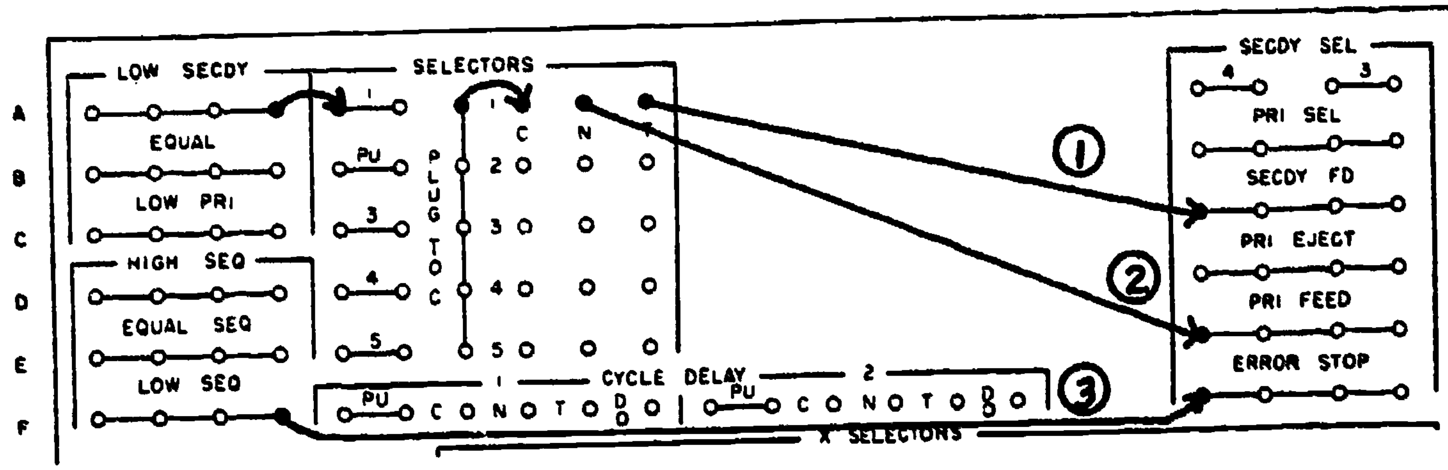


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Figure 8-8.—Merging, feeding from one feed at a time.

for one method. (Wiring diagrams for this chapter may not always show the wiring required for the left side of the control panel. Reference to the schematic (figure 8-3) provides station nomenclature for relation to required hub wiring.)

The following is an explanation of figure 8-8.

1. Low secondary is wired to the pickup hub of selector 1. A Plug to C, wired through the transferred side of selector 1 to secondary feed causes a secondary card to feed when it is lower than the primary.

2. The normal side of selector 1 is wired to primary feed. This wiring causes a primary feed when the primary card is equal to or lower than the secondary card, since selector 1 is transferred only when a low secondary condition exists.

3. Primary cards can be sequence checked by adding a wire from low sequence to error stop.

Now follow what is happening in the machine by referring to the analysis charts in figure 8-9. The analysis charts show three different comparisons made in the selector unit.

In chart A the primary card is lower than the secondary thus requiring a primary feed.

In chart B the situation is reversed so that the secondary card is lower than the primary. This calls for a secondary feed.

In chart C the primary and secondary cards are equal. Because it is customary to file equal primaries ahead of equal secondaries, a primary feed cycle is desired.

A second method of wiring for merging is not more acceptable than the first. It does, however, make better use of machine time. The first method causes a card to be fed from only one feed unit at a time. The speed of a merging operation can be increased by causing both feed units to operate at the same time whenever possible. For example, whenever the primary and secondary cards are equal one feed cycle can be eliminated by causing both feed units to operate at the same time. However, when multiple primary cards are involved and all equal primaries are to be filed ahead of equal secondaries, the secondary feed must be delayed until all but the last equal primary card has been fed.

The analysis charts in figure 8-10 show how the sequence unit is used in conjunction with the selector unit to control card feeding.

In charts A and B card feeding is controlled by a low primary or low secondary condition in the selector unit and the reading in the sequence unit is ignored.

In chart C the primary and secondary cards are equal and the primary card is followed by an equal primary. If all equal primaries are to be filed ahead of equal secondaries, a primary feed only is desired.

In chart D the selector unit contains an equal reading while the reading in the sequence unit is unequal. This indicates that the last multiple primary card has been reached and feeding from

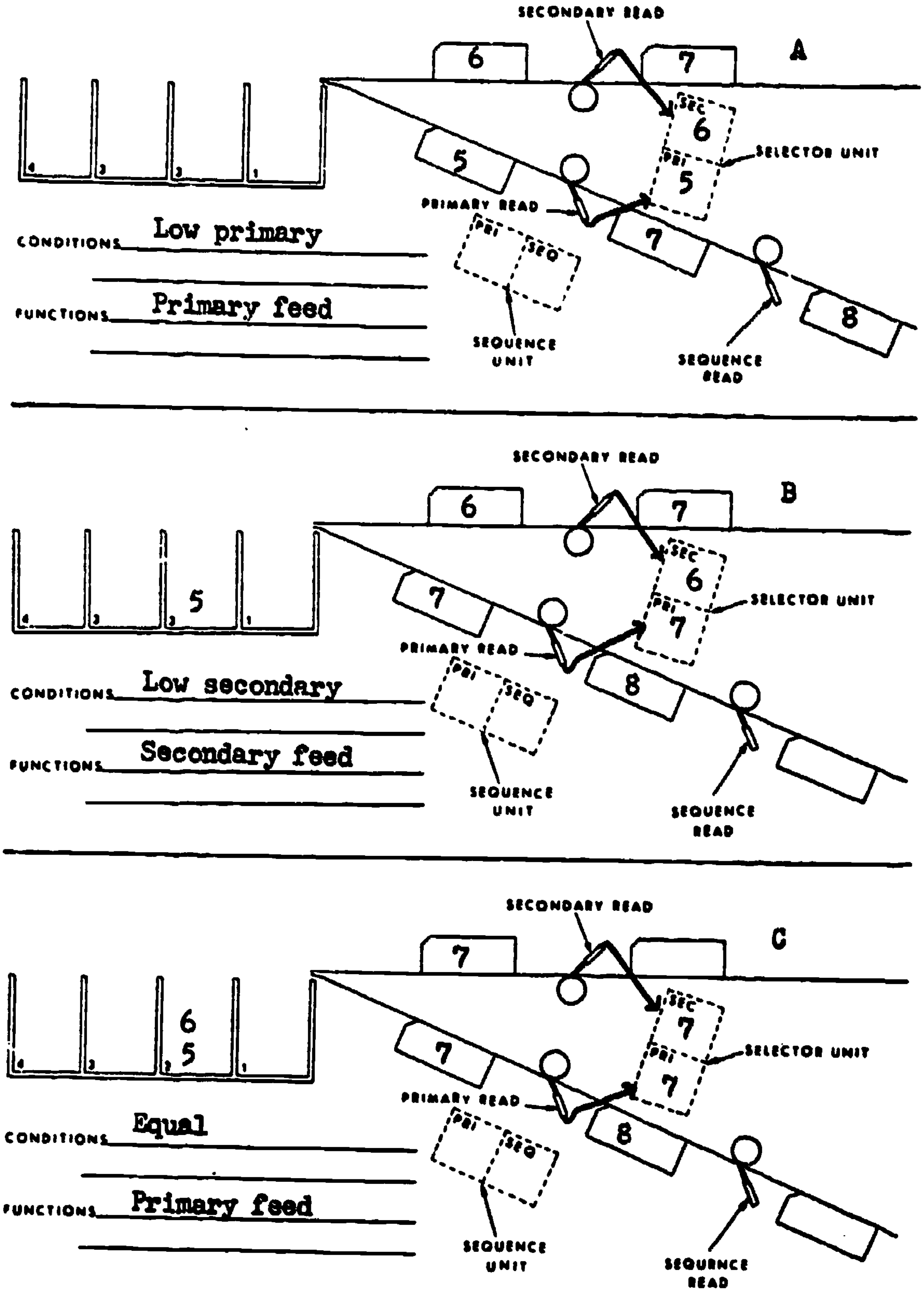

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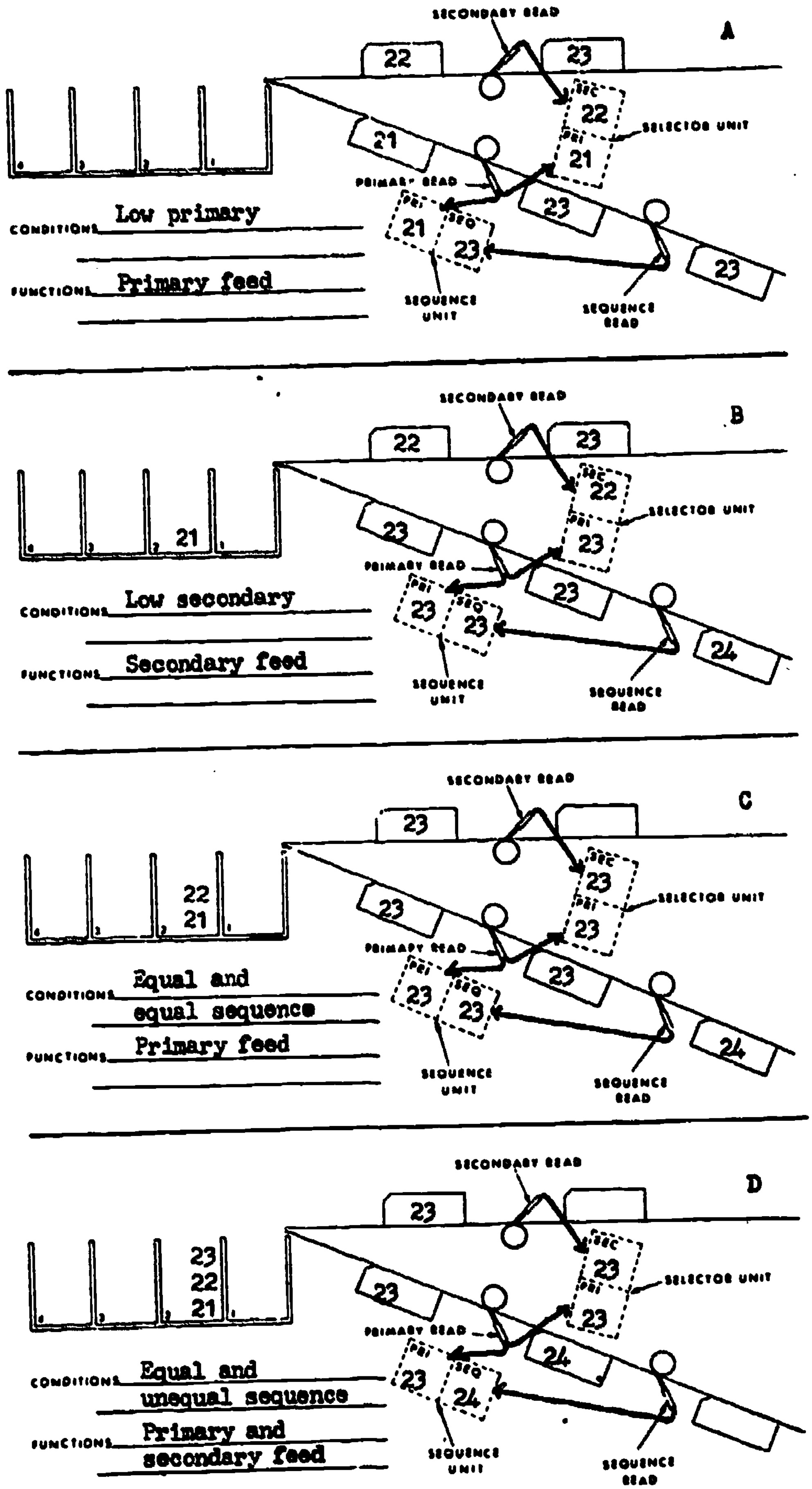
Figure 8-9.—Merging, feeding from one feed at a time.



49.61

Figure 8-10.--Merging, feeding from both feeds simultaneously.

both the primary and secondary feed units can be accomplished. If there are multiple secondary cards, the remaining equal secondaries will be treated as low secondaries.

Functional wiring for simultaneous feeding is illustrated in figure 8-11.

1. Low secondary is wired to the pickup hub of selector 1, and a plug to C is wired through the normal side of the selector to primary feed. This causes a primary feed on an equal or low primary condition in the selector unit, since the selector transfers only on a low secondary condition.

2. Plug to C is wired through the transferred side of selector 1 to secondary feed. This causes a secondary feed on a low secondary condition in the selector unit.

3. Feeding of an equal secondary card is dependent upon the reading in the sequence unit. Therefore, two selectors must be used. Equal is wired to the pickup of selector 2 and high sequence is wired to the pickup of selector 3. Plug to C is wired through the transferred sides of selectors 2 and 3 to secondary feed. This causes a secondary card to feed on an equal condition in the selector unit only if an unequal condition is present in the sequence unit.

4. Primary cards may be sequence checked by wiring low sequence to error stop.

BASIC SETUP SWITCHES

Some other jobs that may be wired by functional wiring are:

1. Matching
2. Card selection
3. Merging with selection, single secondaries
4. Merging with selection, multiple secondaries

The above jobs are listed in order of increasing complexity in board wiring. The most complex of these is a merging with selection (multiple secondaries) job that requires the wiring in figure 8-12.

Functional wiring can accomplish the job, but it is not the simplest method. By use of five basic setup switches to provide proper feed control the functional wiring is reduced to mainly pocket control.

In figure 8-13 the basic conditions which cause card feeding are wired functionally as shown by the dotted lines. The following numbered paragraphs explain how the basic setup switches are used to replace the functional wiring.

1. SEC (Secondary Feed). When this switch is wired ON a secondary card is fed on a low secondary condition, thus replacing wire 1. This switch has no effect when wired OFF. Secondary feeding is further controlled by the primary change switch, as explained later.

2. EJ (Primary Eject). When wired ON, this switch causes a primary eject on an equal or low primary condition, thus replacing wire 2. When wired OFF, it has no effect.

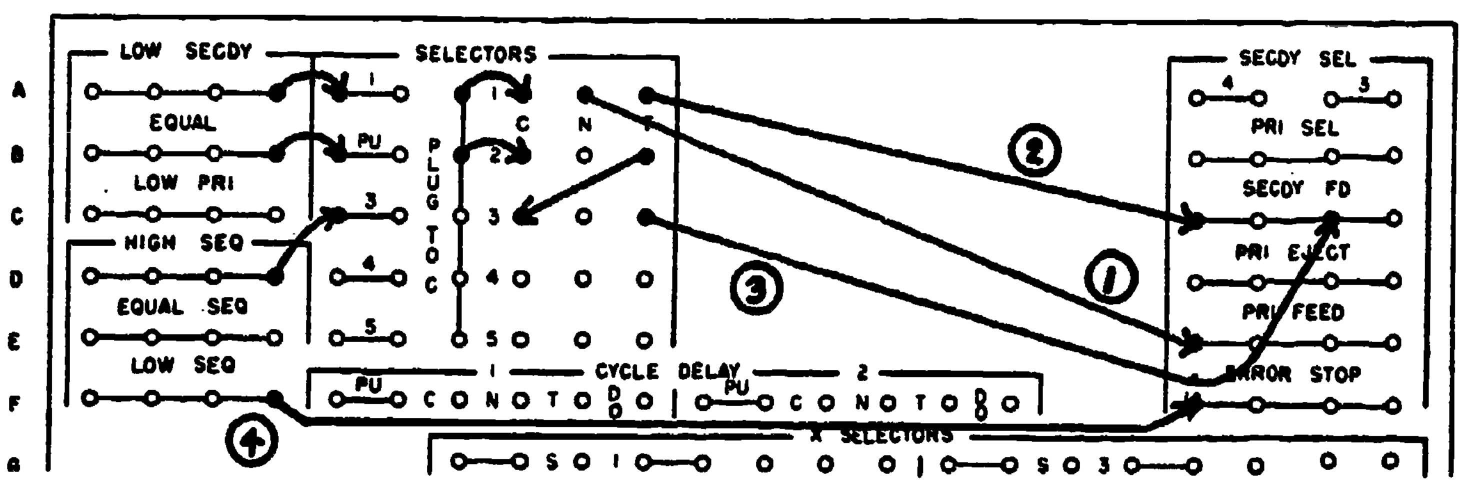


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Figure 8-11.—Merging, feeding from both feeds simultaneously.

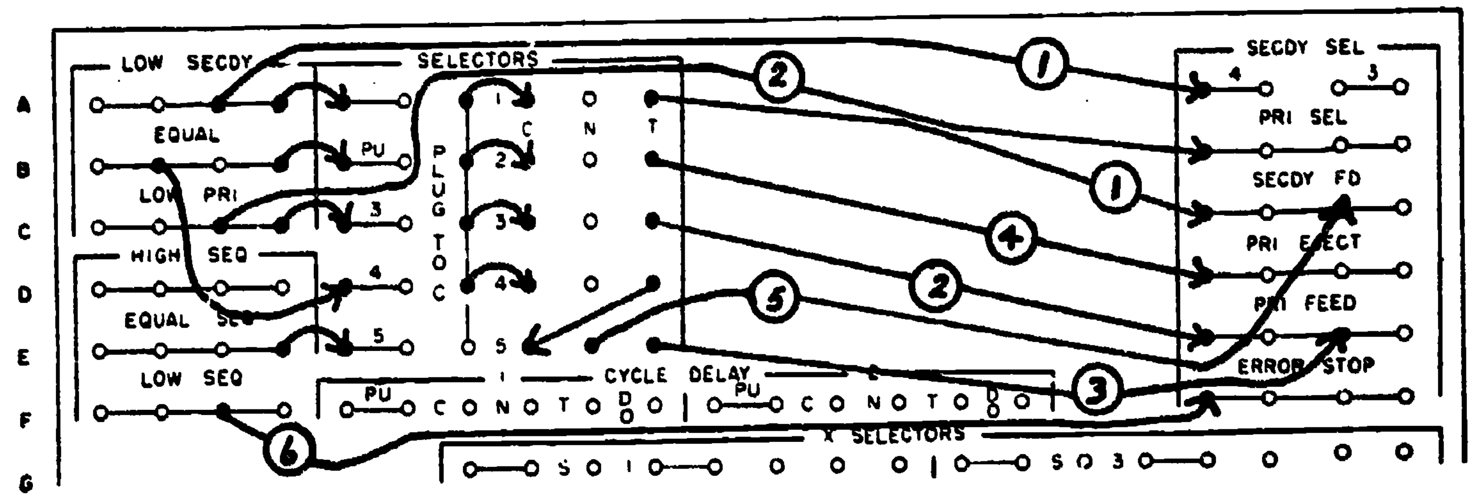

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Figure 8-12.—Merging with selection, multiple secondaries.

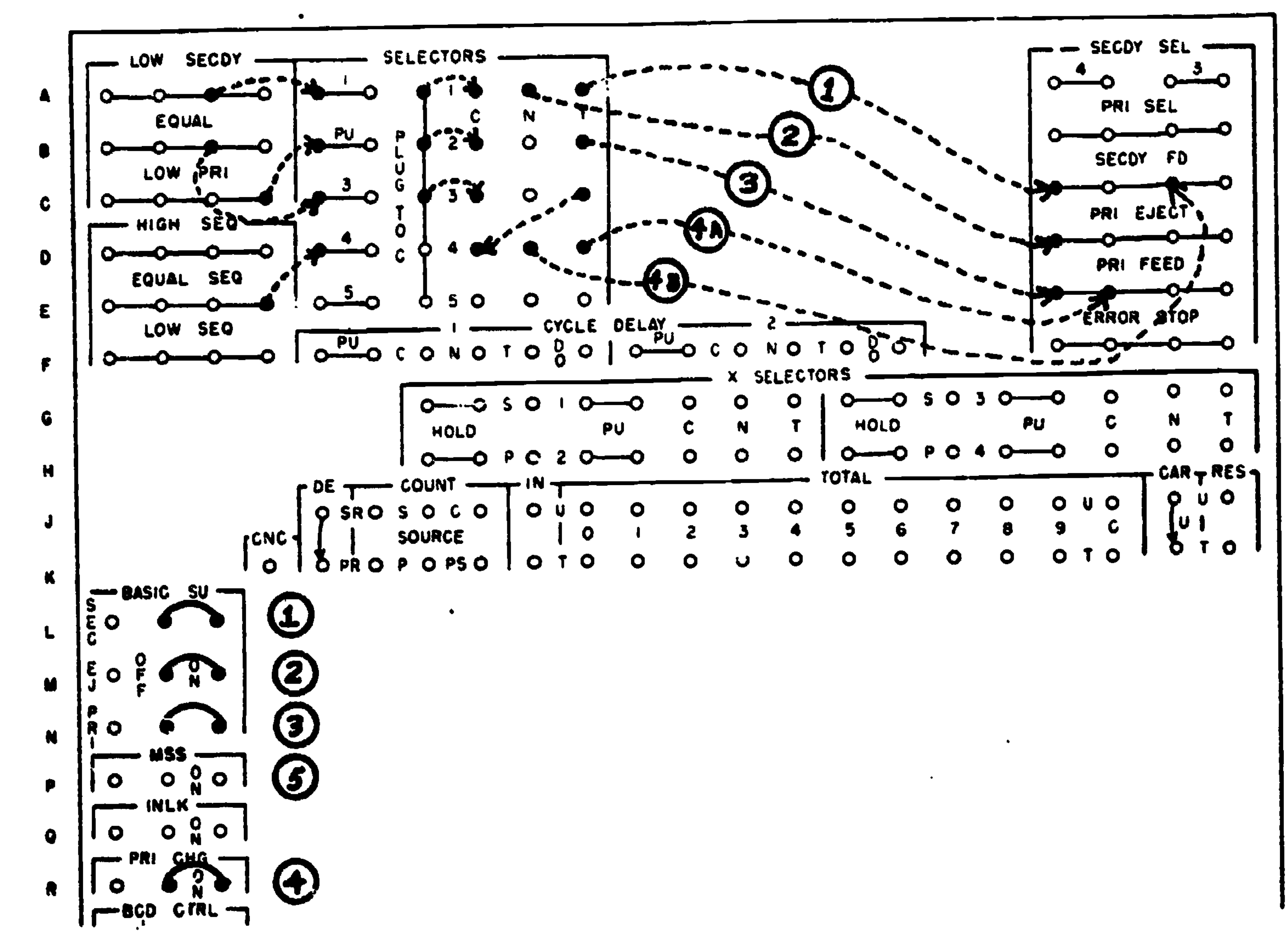

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Figure 8-13.—Basic setup.

3. PRI (Primary Feed). The basic function of this switch, when wired ON, is to cause a primary feed on a low primary condition, thus replacing wire 3. It has no function when wired OFF. Primary feeding is further controlled by the setting of the multiple secondaries and selection switch, and the primary change switch, as explained later.

4. PRI CHG (Primary Change). This switch is used to condition the primary and secondary feed switches, depending on a control change in the primary cards.

When wired ON, primary feeding occurs on an equal reading in the selector unit together with an equal reading in the sequence unit, provided the multiple secondaries and selection switch is also wired ON, thus eliminating wire 4A.

When wired ON, secondary feeding will occur on an equal reading in the selector unit together with an unequal reading in the sequence unit, thus replacing wire 4B.

When wired OFF, primary feeding will occur on an equal reading in the selector unit regardless of the reading in the sequence unit.

5. MSS (Multiple Secondaries and Selection). This switch conditions the primary feed switch. When MSS is wired ON or not wired primary feeding occurs on an equal reading in the selector unit together with an equal reading in the sequence unit, provided the primary change switch is wired ON. When the MSS is wired OFF a primary feed occurs on an equal reading in the selector unit regardless of the reading in the sequence unit.

Basically, what happens is that when the switches are wired ON, the machine operates on the principle that the cards in the primary feed unit take precedence and must be fed first. As this principle is correct for the majority of installations' requirements, all five switches are wired on for all jobs in this chapter with the exception of one. That job is merging with selection when there is only one matching secondary card for a primary card. This will be explained later.

BASIC SETUP WIRING

For this manual the wiring for hubs located at L 23, 24 and 25 through X 23, 24, 25 and 26 in figure 8-14 is standard for the operations of merging, merging with selection (multiple secondaries), and matching. The only wiring differences between the operations are shown in the functional wiring for pocket control and are explained in the following paragraphs.

Merging

The only functional wiring required for merging is the dotted line in figure 8-14. This wiring is for detection of a sequence error. If the file in the primary feed has already been sequence checked, even this is not necessary. With basic setup switches the merging is done by feeding from both feeds simultaneously. The basic setup, therefore, takes the place of all the wiring shown in figure 8-11.

Merging with Selection (Multiple Secondaries)

Merging with selection is actually a process of merging all cards from two files that have identical (matching) control numbers. Those numbers that do not have a match are either low primaries or low secondaries and are to be selected. This selection is accomplished by the functional wiring labeled with a circled 1 in figure 8-14.

Matching

Matching involves stacking the matched cards from both files separately rather than combining them into one file. All other aspects of matching are the same as merging with selection.

For functional control of pocket selection one wire is required in addition to those for a merging with selection operation. The additional wiring is labeled with a circled 2 in figure 8-14. This wire selects the matched secondary card to pocket 3, thereby disallowing the merge action to pocket 2.

Merging with Selection (Single Secondaries)

If a master file is to be merged with a detail file and the detail card file has ONLY ONE card

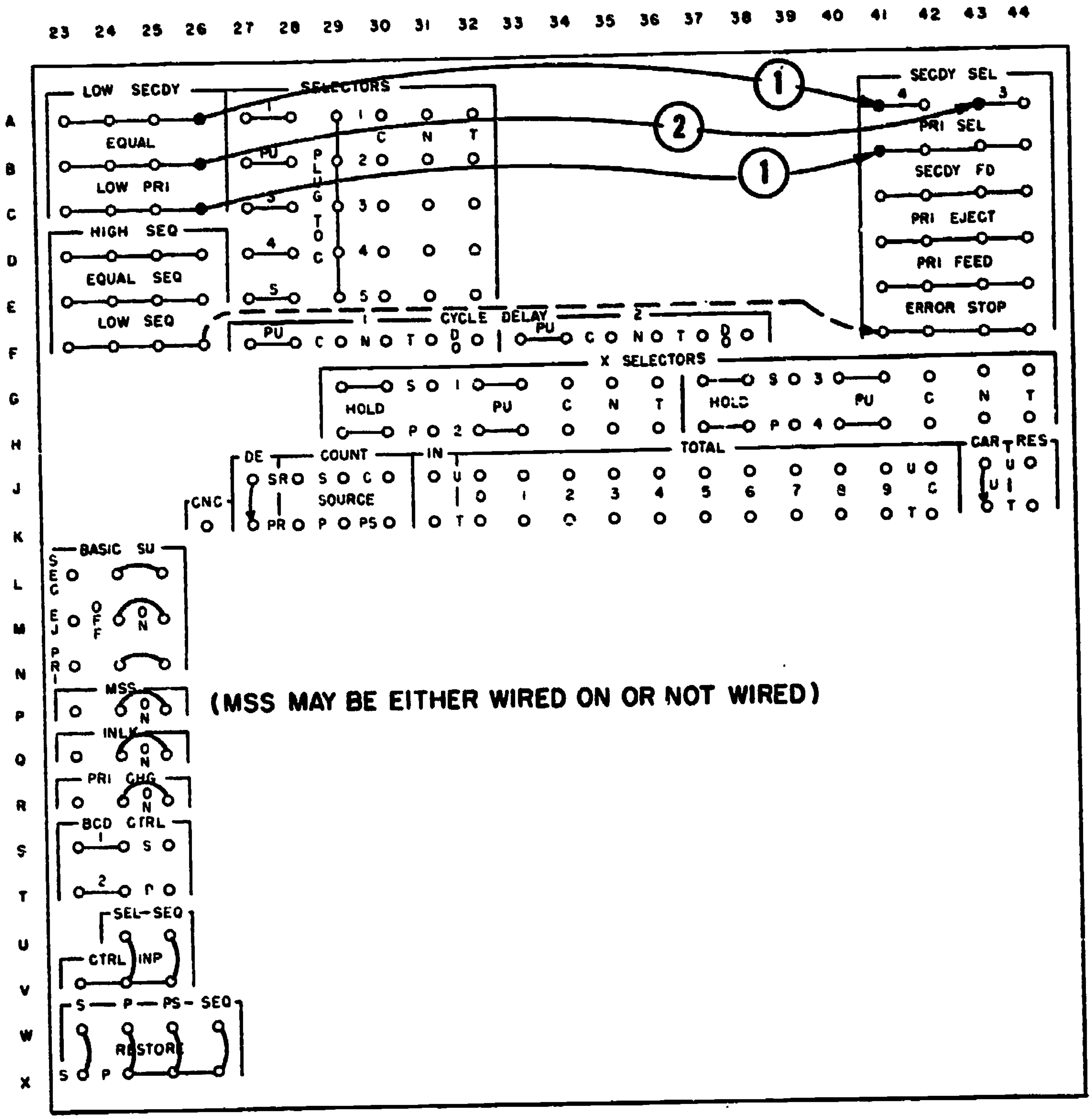

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Figure 8-14.—Basic setup diagram for multiple operations.

for each control number, the operation can be speeded up by wiring the MSS switch OFF.

In merging with selection involving multiple secondaries, the primary equals are all fed before the matching secondaries (equal selector and equal sequence condition). When the last equal primary of each of the groups is detected (equal selector and unequal sequence condition) it is ejected, no primary feed occurs and the reading in the PRI side of the selector unit remains until

all secondary equals are fed. When the secondary control number changes, the comparing unit restores and normal reading resumes.

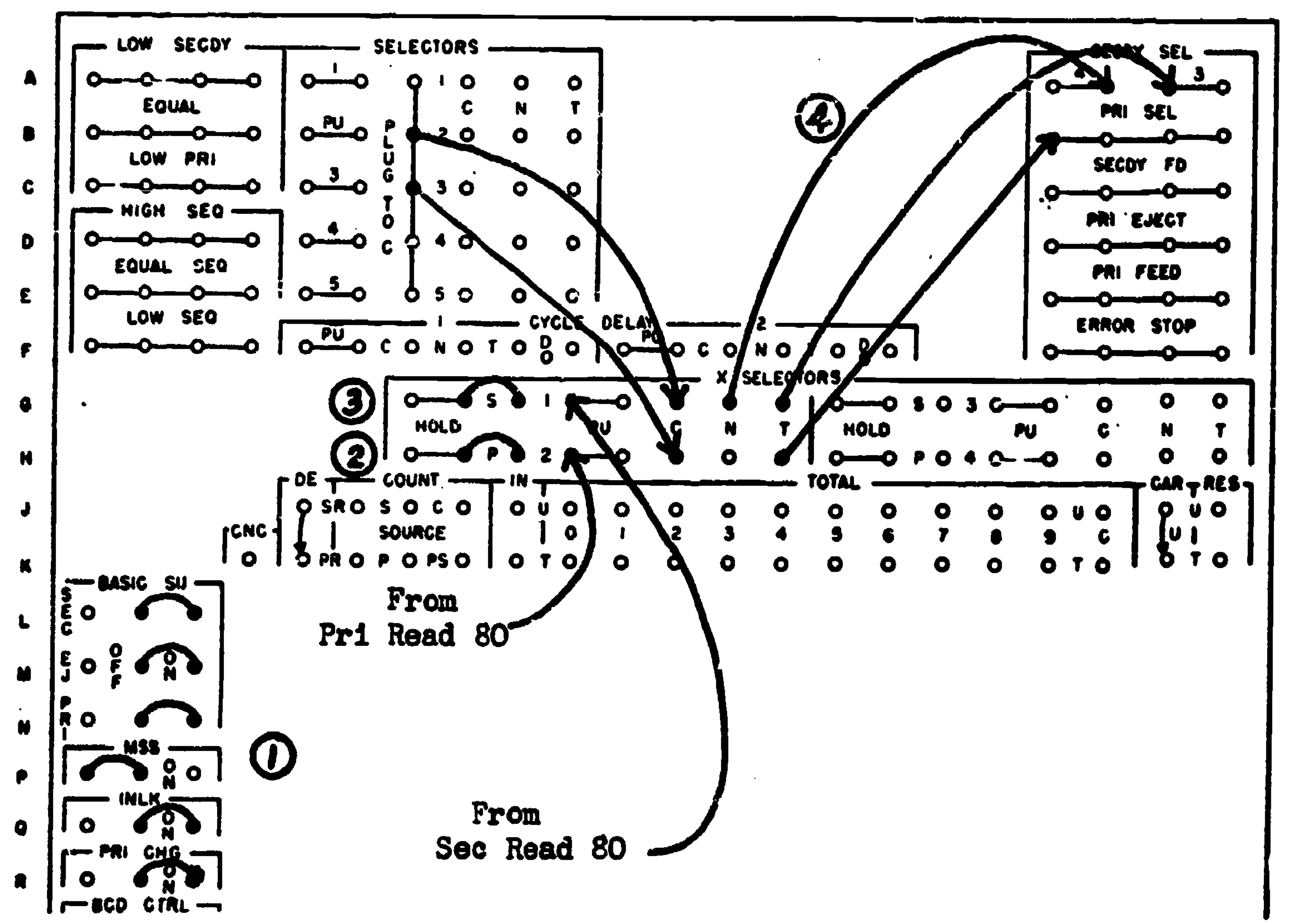
All of this control is required because there are multiple equal secondary cards and they must be allowed to merge.

When there is only one secondary card for a primary control number the primary feed does not have to be halted. Therefore, the operation can be speeded up. This is accomplished by simply wiring the MSS switch OFF; all other basic setup switches remain wired ON.

Card Selection

In the discussion on merging with selection you saw how the selection of cards from either feed was dependent upon the cards in the opposite feed. It is possible also to select certain cards from either feed independently of the other. In this respect, card selection can be generally divided into two categories; selection of X or NX punched cards from either feed, and selection of certain cards from the primary feed depending upon the condition in the sequence unit.

X SELECTION.—All X or NX cards can be selected from both feeds as a separate operation or during another operation. Suppose you were required to merge two files of cards and select all cards containing a control X. This could be accomplished by the wiring illustrated in figure 8-15.



49.68

Figure 8-15.—X Selection.

1. The basic setup switches are wired to control card feeding.

2. X selector 2 is controlled to operate with the primary feed by wiring the P hub to the selector HOLD hub. The P hub emits an impulse each primary feed cycle, thus causing the selector to hold for the feeding of each primary card. X-80 primary cards are selected by wiring primary read 80 to the pickup hub of X selector 2. When an X punch is read the selector transfers immediately and remains transferred for the duration of the pickup impulse. A plub to C is wired through the transferred side of the selector to primary select. All X-80 primary cards will stack in pocket 1 and NX-80 primary cards will stack into pocket 2.

3. X selector 1 is controlled to operate with the secondary feed by wiring the S hub to the selector HOLD hub. The S hub emits an impulse each secondary feed cycle causing the selector to hold for the feeding of each secondary card. X-80 secondary cards are selected by wiring secondary read 80 to the pickup hub of X selector 1, and wiring a plug to C through the transferred side of the selector to secondary select 3. All X-80 secondary cards will stack in pocket 3.

4. Plug to C is wired through the normal side of X selector 1 to secondary select 4 so that all NX cards in the secondary feed will fall in pocket 4. If this wire were omitted NX secondary cards would merge with NX primary cards in pocket 2

The use of the S and P hubs is not restricted to the selector with which they seem to appear. They emit an impulse on the corresponding card feed cycle and may be used to hold either or both selectors. For this reason, one selector may be used to select secondary cards which contain one control X, while the other is used to select secondary cards with another control X. By the same token, both selectors can be used to select two different X punched primary cards.

SEQUENCE SELECTION.–Various types of cards, such as the last card of a group, the first card of a group, or single card groups, can be selected under certain conditions existing in the sequence unit. As you can see by the analysis chart in figure 8-16, the LAST card of a group is at the eject station when a control change occurs, and can be selected by wiring high sequence to primary select.

Now refer to the analysis chart in figure 8-17. Notice that the FIRST card of a group is one station away from the eject station when a high sequence condition is recognized. Therefore, selection of this card must be delayed for one card cycle in order for the proper card to be selected. This is done by using the cycle delay unit. Operation of the cycle delay unit differs from other selectors in the collator in two respects. First, when picked up, it does not transfer until the following cycle. Second, once transferred, it remains transferred until returned to normal by an impulse received by the

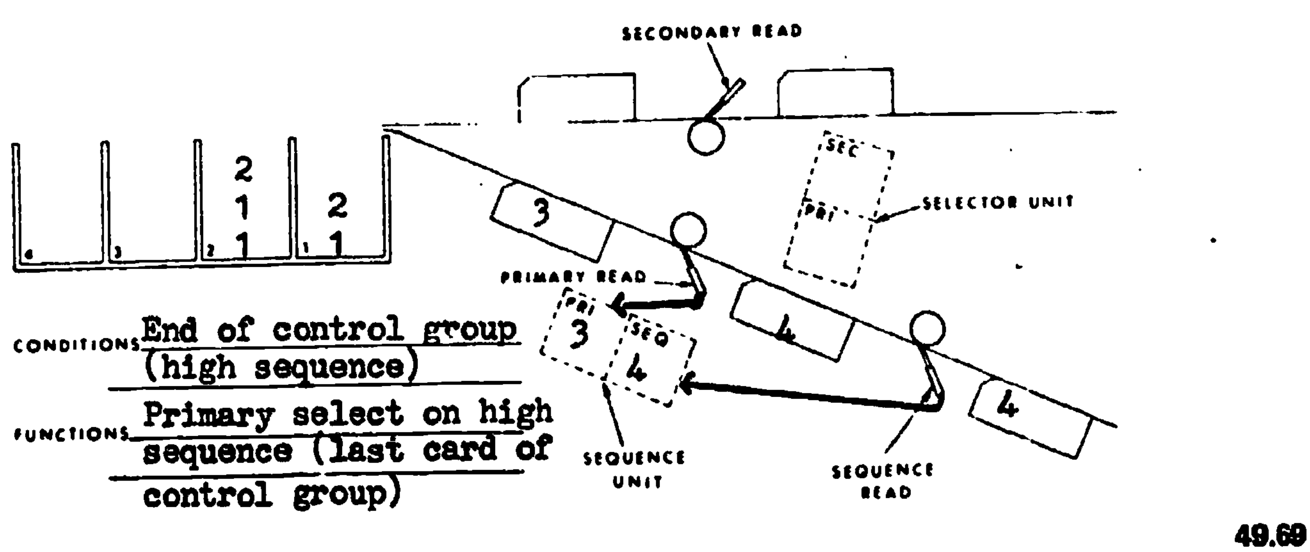


Figure 8-16.–Selecting the last card of a group.

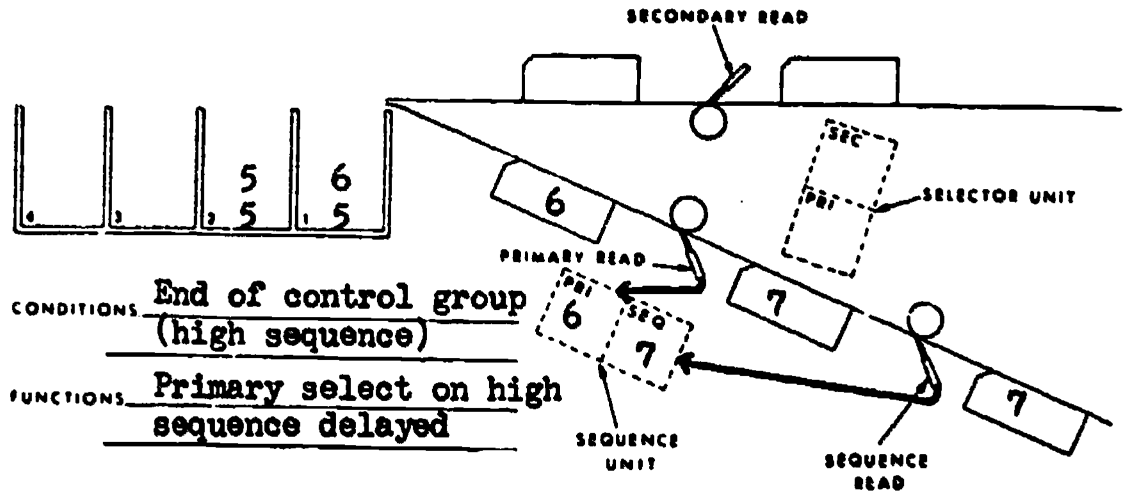


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Figure 8-17.—Selecting the first card of a group.

DROPOUT (DO) hub. When the DO is impulsed, the cycle delay unit will be normal on the following card cycle, unless the pickup hub has again been impulsed.

The first card of a group can be selected by the wiring shown in figure 8-18.

1. A high sequence impulse is wired to the pickup hub of the cycle delay unit. The unit will be transferred one cycle later, when the high sequence card reaches the eject station.

2. A plug to C, wired through the transferred side of the cycle delay unit to primary select, causes the high sequence card to be selected into pocket 1.

3. The cycle delay unit is returned to normal on each card feed cycle by wiring a plug to C to DO.

Single card groups are recognized by a high sequence followed by a high sequence. As seen in analysis chart A in figure 8-19, card 4, which is the first card of a new control group, has caused a high sequence reading in the sequence unit. Is this a single card group? The machine must wait one card cycle to find out. In chart B

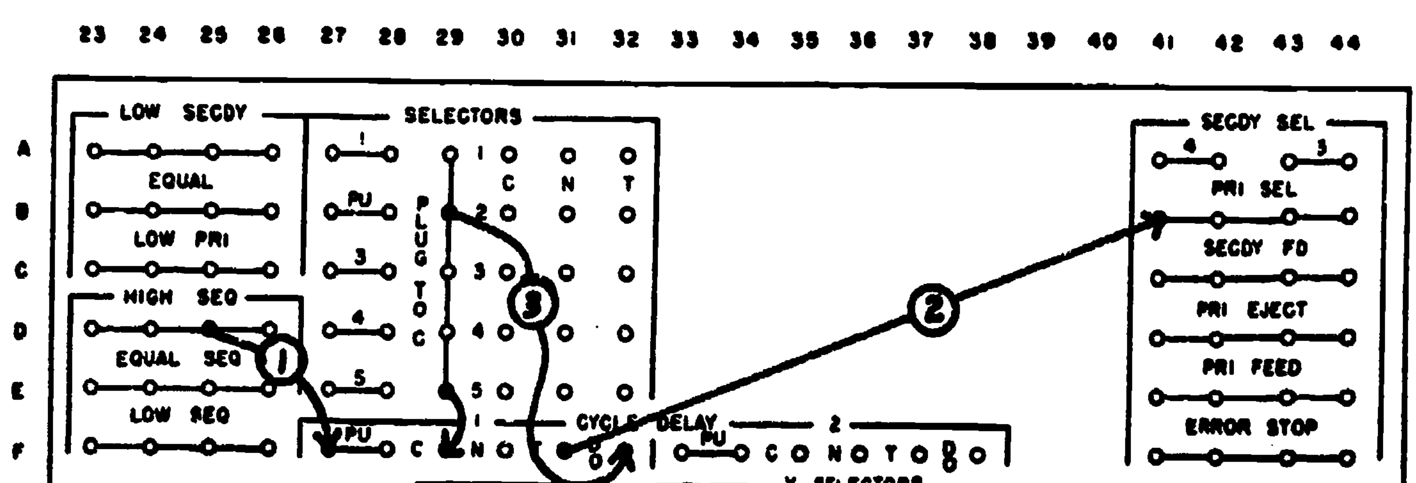

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Figure 8-18.—Selecting the first card of group.

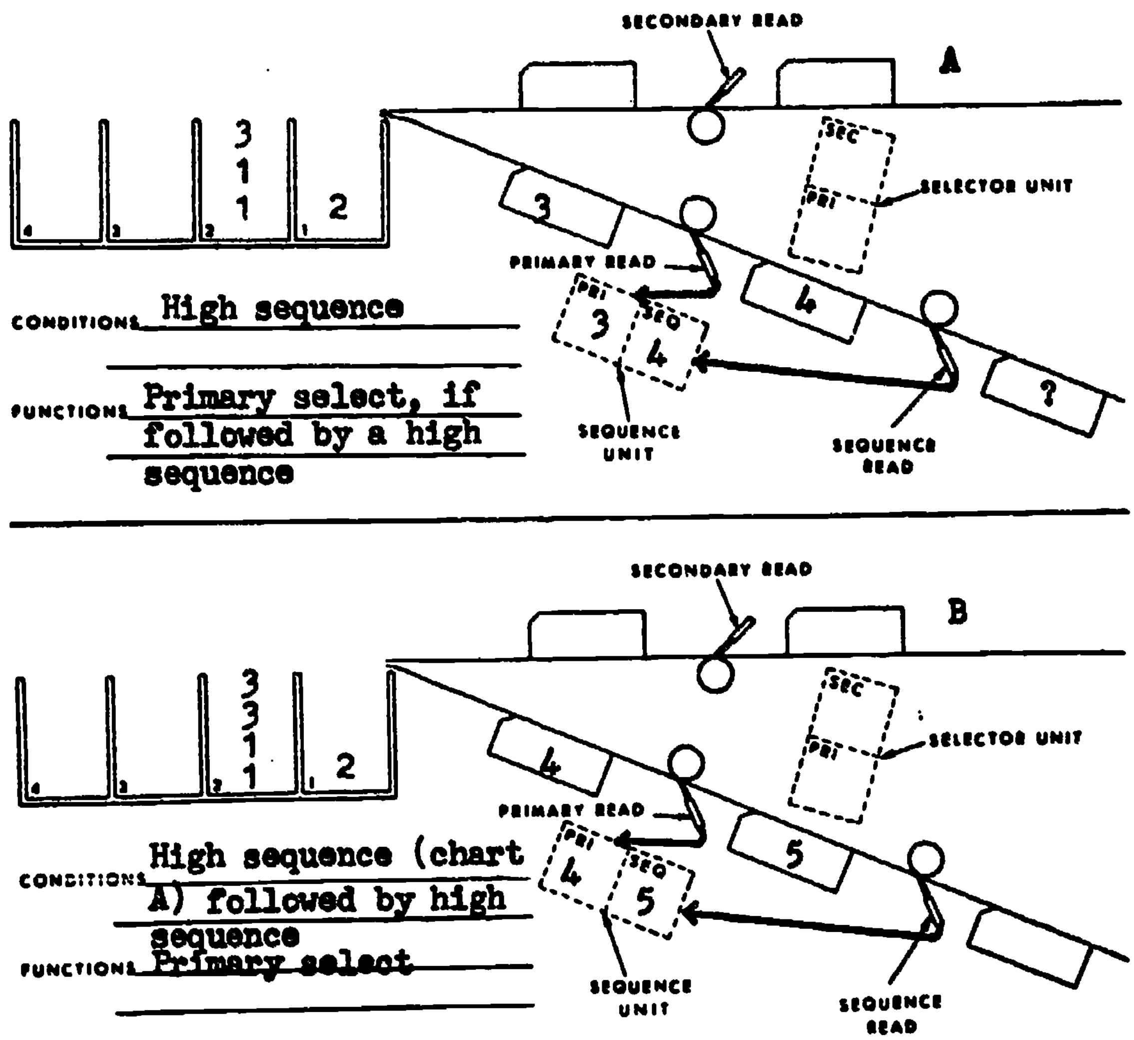

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Figure 8-19.–Selecting single card groups.

card 4 is followed by card 5, thereby causing two consecutive high sequence conditions. Card 4 is then recognized as a single card group and can be selected. If card 4 had been followed by another 4, the requirement that a high sequence be followed by a high sequence would not be met, and selection would not occur.

Wiring for selection of single card groups is illustrated in figure 8-20.

1. When a high sequence condition in the sequence unit is recognized, a high sequence impulse wired to the pickup of the cycle delay unit causes the unit to be transferred for the following card cycle.

2. If a high sequence condition still exists on the following cycle, a second high sequence impulse, wired through the transferred side of the cycle delay unit to primary select, causes a card to be selected. Multiple card groups will be stacked automatically in pocket 2.

3. Plug to C is wired to the dropout hub. This causes the cycle delay unit to be normal for the next card cycle unless another high sequence condition has been recognized.

Blank Column Detection

Two blank column detection units provide for blank column checking as cards feed through the collator, either as a separate operation or in conjunction with other operations. A maximum of eight columns can be checked in each card when detection is required in both feeds, or 16

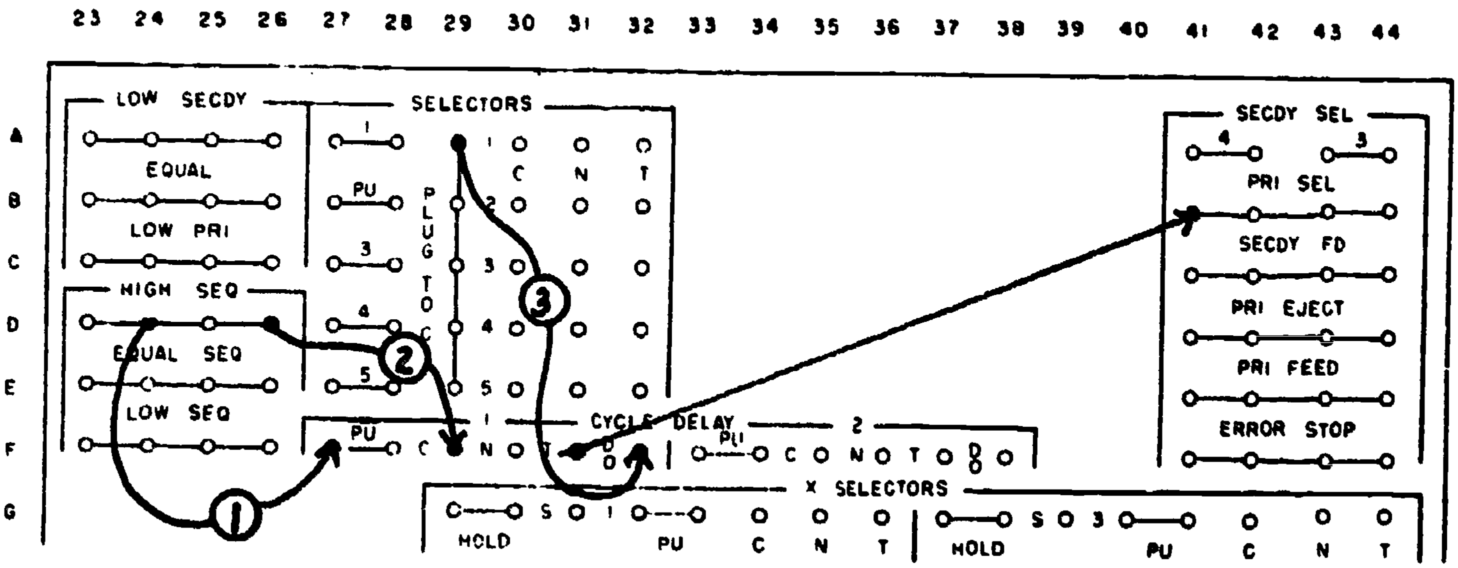

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Figure 8-20.—Selecting single card groups.

columns can be checked when detection is required in one feed only. Card feeding stops when a blank column is detected, and the blank column detection light (BCD1 or BCD2) corresponding to the unit in which the error is detected comes on. The reset key must be depressed in order to turn off the BCD light. Card feeding may then be resumed by depressing the start key. The next card stacked from the feed in which the error was detected will be the error card.

Each blank column detection unit can be used with either feed, or both units can be wired to operate with one feed. The S and P hubs, located to the right of the blank column detection pickup hubs, emit an impulse each secondary and primary feed cycle, respectively. The S hub can be wired to a BCD pickup hub to hold that unit between secondary feed cycles, or the P hub can be wired to the BCD pickup hub to hold that unit between primary feed cycles.

In figure 8-21 columns 26-37 of the primary cards are checked for blank columns during a merging operation.

1. Primary and secondary cards are merged on columns 1-5.
2. Card feeding is controlled by the basic setup switches.
3. Control input test the sequence and selector units in order for card feeding to be controlled.
4. The secondary side of the selector unit is restored each secondary card feed cycle, while the primary side of the selector unit and both sides of the sequence unit are restored each primary card feed cycle, to allow new readings to enter the comparing units on the next secondary or primary feed cycle, as appropriate.
5. Primary cards are checked for sequence.
6. Columns 26 through 37 in the primary cards are to be checked for blank columns. Columns 26-33 are wired to BCD entry 1, and columns 34-37 are wired to BCD entry 2.
7. The pickup hubs of both BCD units are wired from P in order to hold both units between primary feed cycles.
8. A direct impulse (DI) is wired to the remaining positions in BCD entry 2 in order to prevent false indication of a blank column.

OPERATING SUGGESTIONS

A successful collating operation is dependent primarily upon proper control panel wiring and an understanding of the operation to be performed. While it is impossible to describe all the situations that you may encounter while

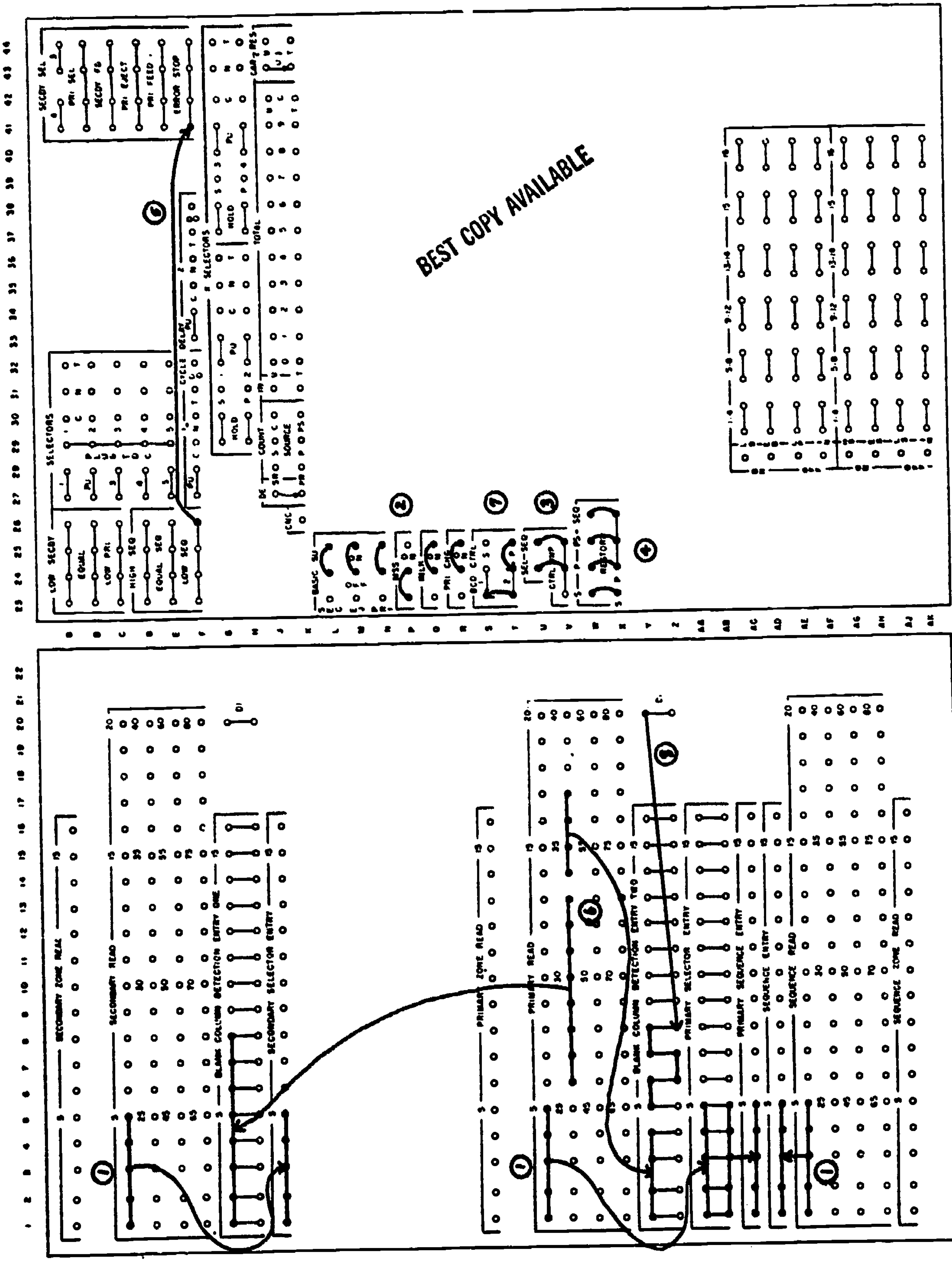

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Figure 8-21.—Merging and blank column detection.

collating, the following guidelines apply to all operations.

1. Always joggle cards into perfect alignment before placing them in the feed hoppers. Particular care must be observed when placing cards in the primary feed hopper because this hopper is placed at an angle on the machine.

2. In any collating operation involving both feeds no errors should exist in the numerical sequence of either file. Both files should be checked for sequence to avoid misfiled cards. The secondary file can be sequence checked as a separate operation, and the primary file can be checked during the merging operation.

3. Any operation involving sequence checking should be tested at the beginning of the job. Insert several blank cards throughout the first 300 or 400 cards to be checked. The blank cards will break the continuity of any series of numbers causing the machine to stop when the blank cards feed through. If the blank cards fail to stop card feeding, either the control panel has not been wired correctly or the machine is not operating properly.

4. Always depress the stop key to stop card feeding. Never turn off the main line switch while the machine is in operation.

5. In case of a card jam depress the stop key immediately and tell your supervisor. Removal of a card jam can best be learned by personal instruction. All damaged cards must be repunched or duplicated and manually filed in their proper sequence.

6. The collator automatically stops when either feed hopper runs out of cards. The runout key must de depressed and held to move the cards remaining in the machine to the pockets. When one hopper becomes empty during a merging or matching operation, the runout key must be held down until all cards from the empty feed have been stacked. Card feeding will be performed automatically until the remaining hopper becomes empty. The runout key must be depressed again and held until all cards are stacked.

COLLATOR, TYPE 87

The IBM type 87 collator is essentially like the 85 in design, features, and operation. The major difference lies in the fact that while the standard 85 can process numerical data only, the 87 can process numerical, alphabetic, and special character data.

The type of data which can be processed through the type 87 is arranged in ascending sequence (low to high) as follows:

1. Blank column
2. Special characters in the following order:

CODE	CHARACTER
12-3-8	.
12-4-8	¤
12	&
11-3-8	$
11-4-8	*
11	-
0-1	/
0-3-8	,
0-4-8	%
3-8	#
4-8	@

3. Letters A through Z.
4. Digits 0 through 9.

The type 87 control panel is illustrated in figure 8-22. Shaded areas represent optional features. Wiring is the same as for the type 85 with the following exceptions:

1. The primary sequence side of the sequence unit is wired internally to the primary side of the selector. Thus, any reading which enters primary selector entry is automatically read into the primary sequence entry. There are 19 positions of comparing available in both the sequence and selector units.

2. The function of the primary change switch is performed through internal wiring. The ZONE SWITCH, when wired ON, allows both comparing units to recognize zone punches as well as numerical punches, making it possible to compare alphabetic and special character data in addition to numerical data. When the zone switch is wired OFF, numerical punches only are recognized.

3. Conditions existing in the comparing units are tested by internal wiring, thus eliminating the control input hubs.

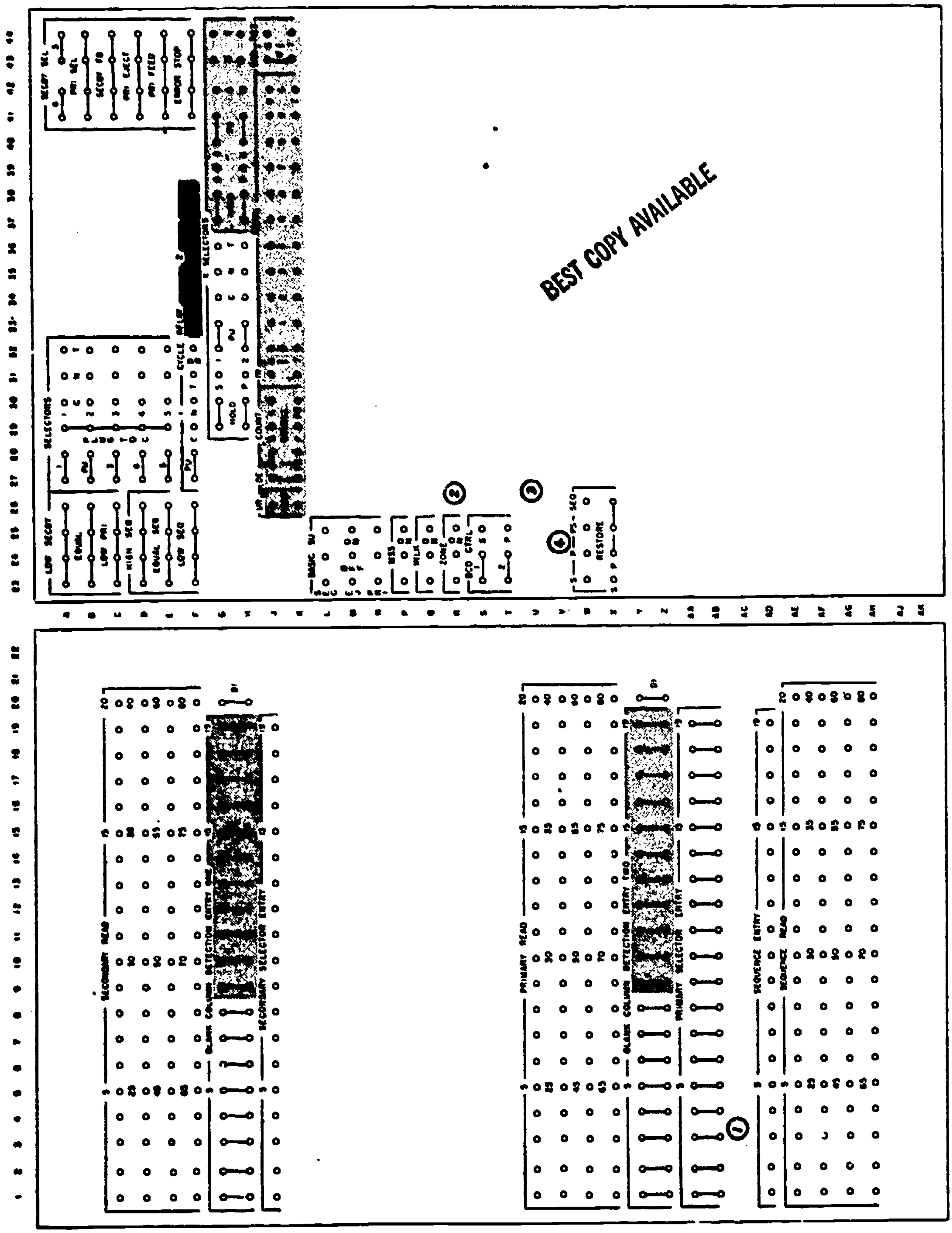

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Figure 8-22.—Type 87 Control Panel.

4. The PS hub is inactive. Primary selector magnets and primary sequence magnets are restored when the restore P hub is impulsed.

COLLATOR, TYPE 88

The IBM type 88 collator, pictured in figure 8-23, performs all operations previously described for the type 85. In addition, an editing feature allows for checking cards in both feeds for accuracy of numerical punching. Card feeding can be stopped whenever a double punch or blank column is detected in either feed. Each feed unit operates at 650 cards per minute. Up to 1300 cards per minute can be collated, depending upon the operation being performed.

OPERATING FEATURES

The switches and keys perform the same functions as described for the type 85 collator. The lights differ somewhat, as indicated in figure 8-24, and as explained below.

If a fuse burns out, card feeding will stop and the FUSE LIGHT will come on.

If a card jam has occurred in the rollers of the card transport area, the TRANSPORT LIGHT comes on. This light goes out after the card jam has been removed.

The DP&BC CHECK LIGHT goes on and card feeding stops if a double punch or blank column has been detected. An indicating lamp points out the position containing the double punch or blank column. If a blank column has been detected, the indicating lamp will glow continuously. A double punch causes only a flash on the lamp panel when the second punch in a column is detected. The reset key must be depressed to turn out the signal lights before card feeding can be resumed.

If a card fails to feed from either feed, a PRIMARY or SECONDARY CHECK LIGHT comes on. It also comes on, together with the DP&BC check light, when a double punch or blank column has been detected. Depressing the reset key turns out the check lights and permits card feeding to be restarted.

The PRIMARY and SECONDARY CONTROL STOP LIGHTS indicate that card feeding has stopped as a result of an error condition, recognized by control panel wiring, in the corresponding feed unit. Depressing the reset key turns out the stop lights and allows card feeding to be restarted.

Card Feed Units

The primary feed unit is located at the right end of the machine, and the secondary feed unit is at the left end. Since cards feed from opposite directions, primary cards must be placed face down with the 9-edge first, while secondary cards must be placed face down with the 12-edge first. It may be easier for you to remember that cards are placed face down in both hoppers with the 9-edge TO THE LEFT. The secondary feed hopper holds approximately 1200 cards, while the primary feed is equipped with a file feed which holds approximately 3600 cards.

Pockets

Five radial stackers, or pockets, are provided for receiving the cards. From right to left, they are numbered 1 through 5. Primary cards are ordinarily stacked in pocket 1 unless selected into pocket 2 or 3. Secondary cards stack in pocket 5 unless directed to pocket 4 or 3. Merged cards stack in pocket 3. Error cards are automatically stacked in pockets 1 and 5; thus selected cards should be directed to pocket 2 and 4 whenever possible. Each pocket holds approximately 1000 cards. The machine need not be stopped to remove cards from the pockets.

PRINCIPLES OF OPERATION

Most collating operations require that two numbers be compared. For example, in order to check the sequence of a file of cards, the number in one card must be compared with the number in the preceding card to ensure that the cards are in order. When merging, the number in a card from one feed must be compared with the number in a card from the other feed in order to determine which card is to be fed first. One of three conditions will exist when two numbers are compared, low, equal, or high.

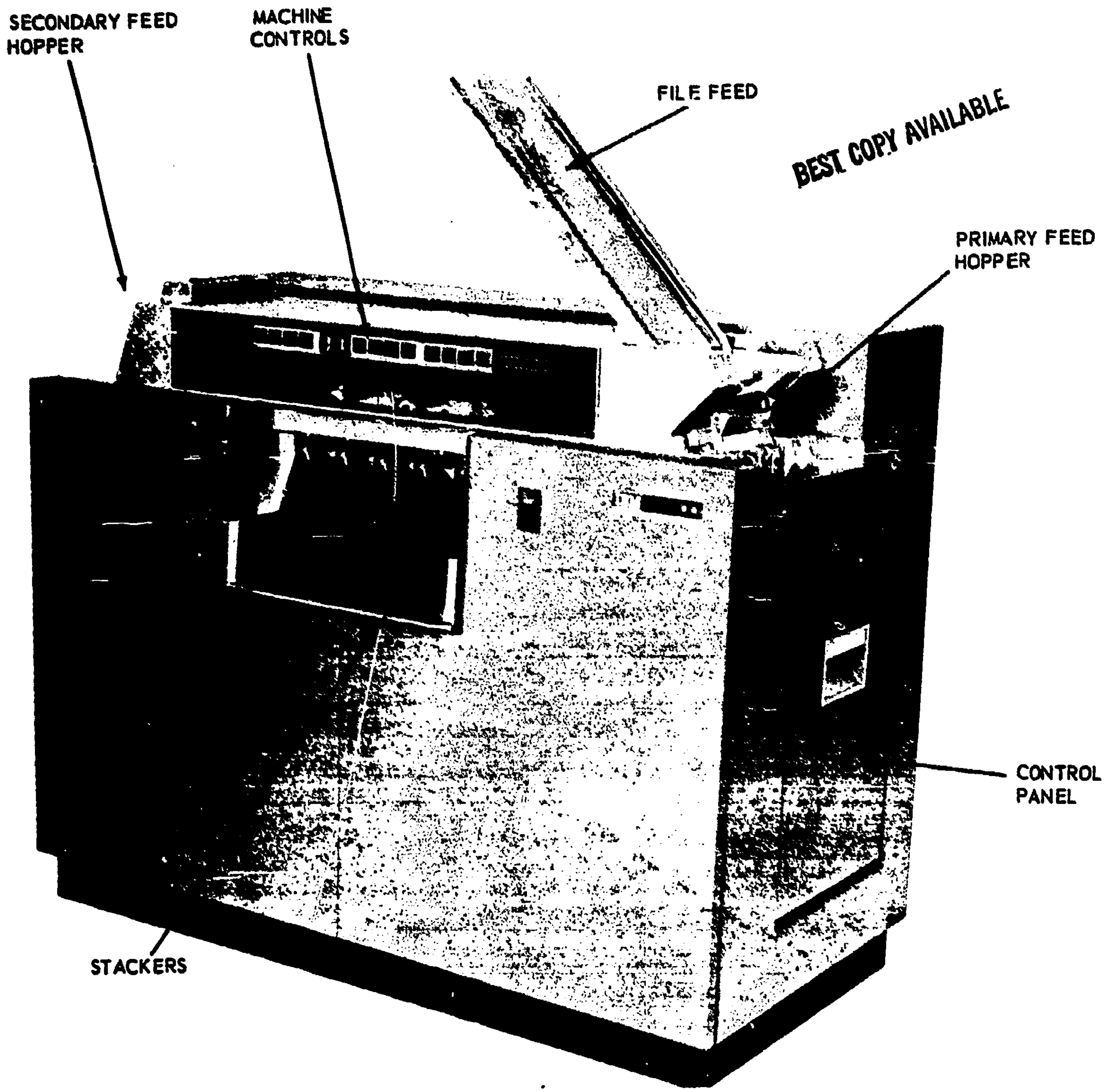

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Figure 8-23.—IBM Type 88 Collator.

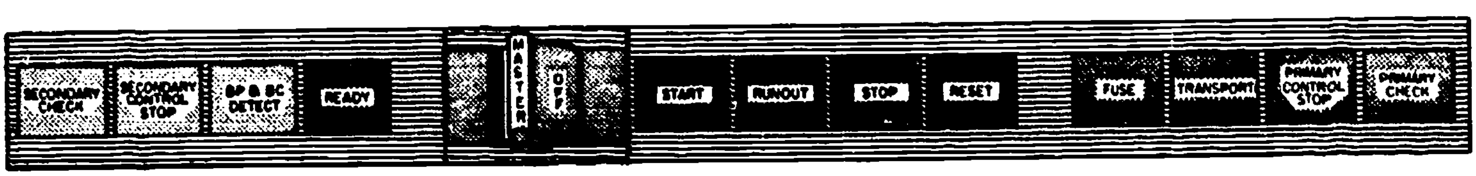

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Figure 8-24.—Machine Controls.

Schematic Diagram

The schematic diagram in figure 8-25 shows the paths of cards from the hoppers to the pockets. Separate sequence units provide for checking the sequence of both primary and secondary cards. The comparing unit provides for comparing the cards from one feed with cards from the other feed. Cards are directed to the various pockets by control panel wiring.

Control Panel

Figure 8-26 shows the entire control panel for a full capacity machine with the shaded areas representing optional features or devices. The control panel is divided into two main sections with the right side corresponding essentially to the primary feed, and the left side to the secondary feed.

Basic Machine Control

Regardless of the operation being performed, there are four groups of control panel hubs which are essentially involved. These hubs can be located by reference to figure 8-26. Other hubs will discussed when first used for a particular operation.

ALL CYCLES.–Each of these hubs (T, 17-28) emits an impulse for each machine cycle except when a check or control stop light is on. ALL CYCLES impulses are usually wired to primary or secondary feed if matching or merging is not being performed, or to selector pickup hubs. They should not be wired to a pocket entry.

SECONDARY/PRIMARY FEED.–Each feed unit has four common feed entry hubs. Secondary feeding occurs when the secondary feed hubs (T,13-16) receive an impulse, and primary feeding occurs when the primary feed hubs (T, 29-32) are impulsed. These hubs are not active during card feed run-in, nor when the merge or match switch is wired. They should be wired from ALL CYCLES only.

SEQUENCE ON, OFF.–The secondary sequence switch (L-N,21) and the primary sequence switch (L-N,43) must be wired for card feeding to occur from the respective feed unit. The center hub of either switch accepts an impulse from either the ON or OFF hub each machine cycle to permit card feeding. The OFF hub emits an impulse each machine cycle. The ON hub emits an impulse each machine cycle except when the corresponding sequence unit recognized a low sequence condition. If the center hub does not receive an impulse, card feeding stops and the corresponding control stop light goes on. The appropriate sequence switch must be wired ON for any operations involving

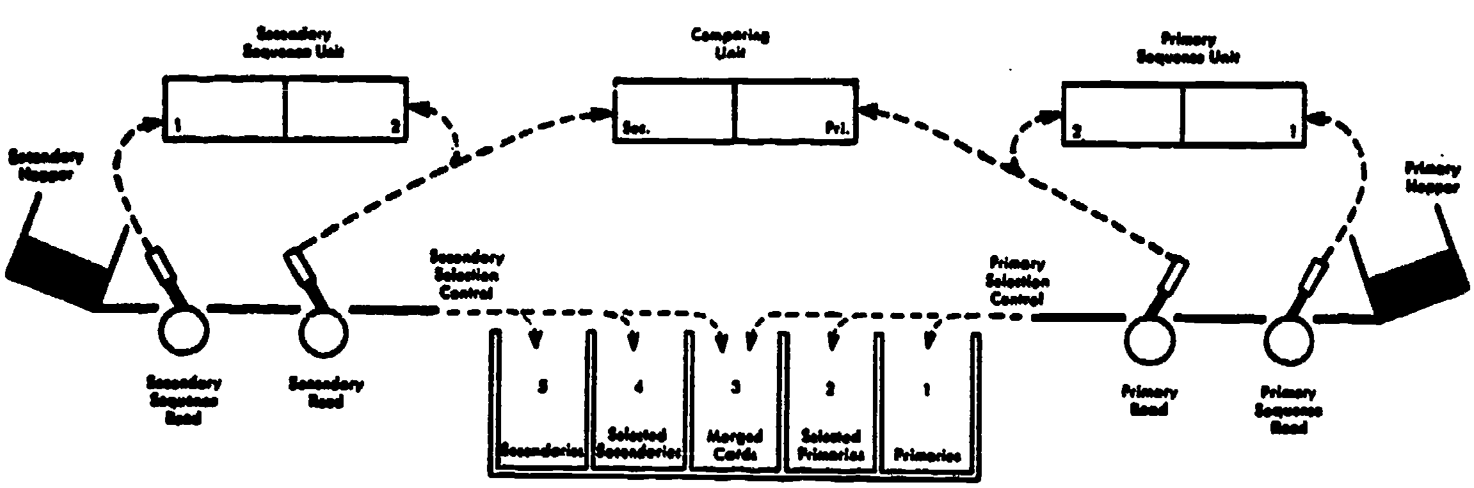

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Figure 8-25.–Card feed schematic diagram.

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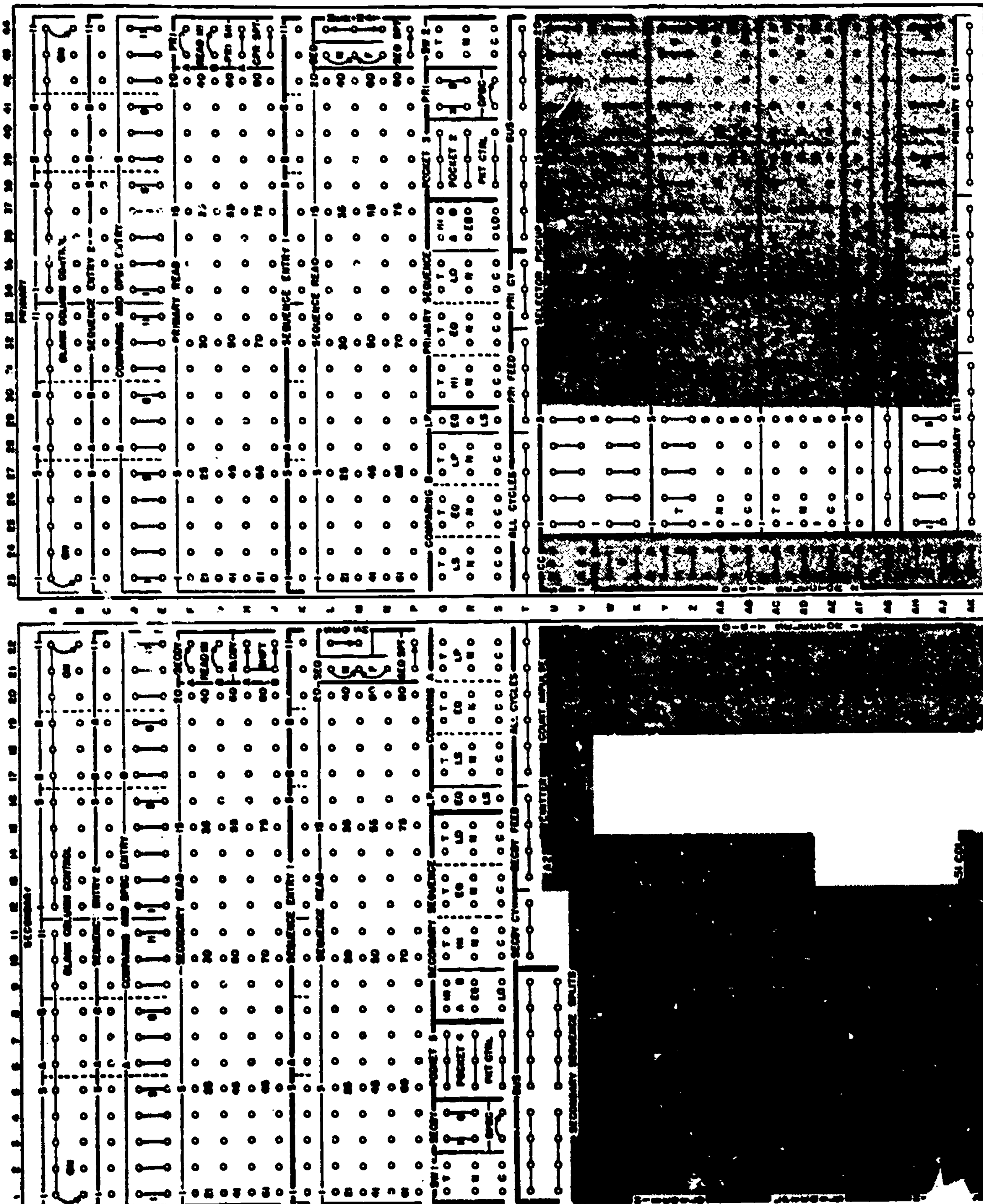

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Figure 8-26.—Type 88 Control Panel.

sequence checking, and wired OFF for all other operations. The sequence units operate when the sequence OFF hubs are wired, but the machine does not stop when a low sequence condition occurs.

POCKET CONTROL.--Primary cards automatically fall into pocket 1 and secondary cards into pocket 5 unless otherwise directed to one of the other pockets by control panel wiring.

The primary pocket control hubs (Q-S, 38-40) can be wired to direct primary cards to either pocket 2 or pocket 3. The three common pocket control exit hubs emit an impulse each machine cycle except when a check or control stop light is on. These exit hubs can be wired to pocket 2 or pocket 3, either directly or through selectors, to control the stacking of merged or selected primary cards. If both pocket 2 and pocket 3 receive an impulse at the same time, the card will be directed to pocket 3. If neither pocket entry receives an impulse, the card will fall into pocket 1. The pocket control exit hubs are inactive when the runout key is depressed if a check or control stop light is on.

The secondary pocket control hubs (Q-S, 5-7) can be wired to direct secondary cards to either pocket 4 or pocket 3. Either of the three common pocket control exit hubs can be wired to pocket 4 or pocket 3, either directly or through selectors, to control the stacking of merged or selected secondary cards. If both pockets 4 and 3 receive an impulse at the same time, the card will be directed to pocket 3. If neither pocket entry receives an impulse, the card will fall into pocket 5. The pocket control exit hubs emit an impulse each card cycle except when a check or control stop light is on.

PRINCIPLES OF CONTROL PANEL WIRING

Control panel wiring for typical operations which may be performed on the type 88 is discussed in the following paragraphs. Analysis charts will not be shown, since the sequence and comparing units compare the readings from cards in the same manner as the type 85.

Checking Sequence

Each sequence unit in a full capacity machine provides for checking the sequence of up to 22 columns of data. Each unit can be split into two groups of 11 positions each by wiring the sequence split switches (secondary, P, 21-22 and primary, P, 43-44). The secondary sequence unit can further be controlled to operate with the primary feed by wiring the sequence shift switch (L-M, 22). However, to aid you in understanding how the sequence units operate each unit will be treated as one group and will be used with the respective feed.

In figure 8-27 two separate cost analysis files are to be sequence checked on job order number.

1. The control field in each file of cards is wired from SEQUENCE READ to SEQUENCE ENTRY 1, and from PRIMARY and SECONDARY READ to the corresponding positions of SEQUENCE ENTRY 2. As can be seen by reference to figure 8-25, the readings from the primary and secondary read brushes are compared with readings from the sequence read brushes, resulting in a high, equal, or low sequence condition in the sequence units.
2. An all cycles impulse is wired to secondary feed and to primary feed to cause both feed units to operate each card cycle.
3. The secondary and primary sequence switches are wired ON to stop the machine when a low sequence condition is detected in either sequence unit.
4. Secondary cards are directed to pocket 4, and primary cards to pocket 2. Pockets 1 and 5 are reserved for error runout.

Merging

In order to merge two files of cards the comparing unit must be used to compare the control field in one file of cards with the control field in the other file. The comparing unit in the full capacity machine is capable of comparing a maximum of 22 columns of data.

In addition to the comparing unit both sequence units must be used for a merging operation. Card feeding is controlled by the MERGE SWITCH (L-M, 44). When this switch is ON, internal circuits are set up to control card feeding from either feed, thus avoiding considerable control panel wiring. With the sequence and comparing units properly wired, and the merge

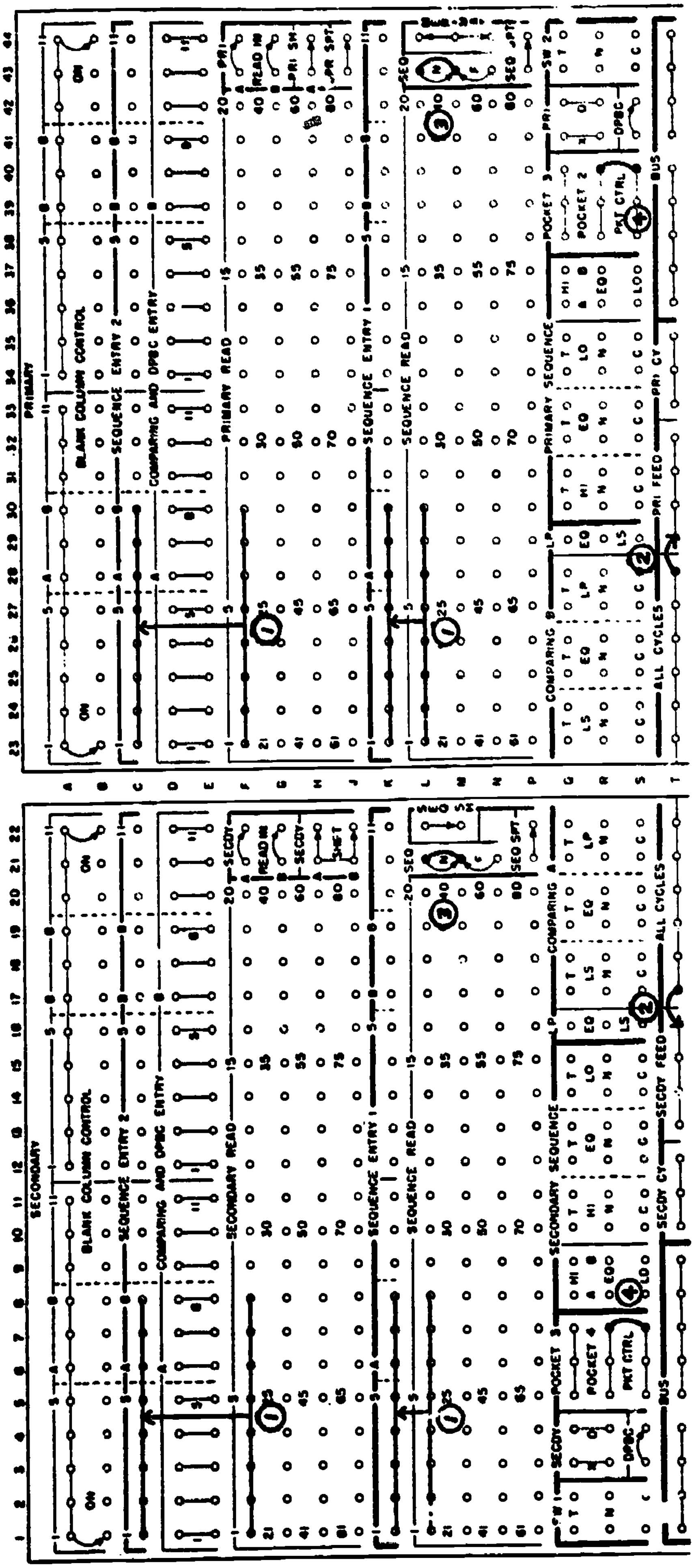

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Figure 8-27.—Checking sequence.

switch wired ON, card feeding is controlled under one of five conditions as follows:

1. Primary feed on a low primary.
2. Secondary feed on a low secondary.
3. Primary feed on an equal reading in the comparing unit together with an equal sequence reading in the primary sequence unit.
4. Primary and secondary feed on an equal reading in the comparing unit together with a high sequence reading in the primary sequence unit. The primary card will feed first.
5. Primary and secondary feed on an equal reading in the comparing unit, high sequence reading in the primary sequence unit, and an equal sequence reading in the secondary sequence unit. In this case, the equal secondary sequence condition interlocks the primary feed to prevent further feeding of primary cards until all equal secondaries have been fed.

Figure 8-28 illustrates the wiring necessary to merge two files of cards.

1. The primary and secondary control fields are wired to the comparing and sequence units.
2. The merge switch, when wired ON, automatically controls merging.
3. Primary and secondary sequence switches are wired ON, causing card feeding to stop when an error in sequence is detected in either sequence unit.
4. All cards are directed to pocket 3.

Merging With Selection

Cards from either feed that do not match a card in the other feed can be selected during a merging operation. Each condition that can exist in the comparing unit is represented by a selector (Q-S, 17-28). There are two sets of identical selectors for the comparing unit. One is labeled comparing A, and the other is comparing B. Either one of these may be used, whichever is the most convenient.

One of the comparing selectors (in A and B) transfers each machine cycle, depending upon the condition in the comparing unit. For example, if an equal reading is present in the comparing unit, the EQUAL selectors transfer, and any impulse entered into C (common) is available out of T (transferred). When a selector is not transferred, a connection exists between C and N (normal).

Wiring for merging with selection is illustrated in figure 8-29.

1. The control fields are wired the same as for straight merging.
2. Primary and secondary sequence switches are wired ON.
3. The merge switch is wired ON to control card feeding.
4. Pocket control is wired through the transferred side of the equal comparing selector to pocket 3. This causes equal cards from both feeds to merge into pocket 3.
5. Pocket control is wired straight to pockets 2 and 4 to select low primaries and low secondaries. Since an impulse wired to pocket 3 takes precedence over an impulse wired to pockets 2 and 4, the only time cards will be stacked in pockets 2 and 4 is when the reading in the comparing unit is other than equal.

Matching

The comparing unit and both sequence units must be used for a matching operation. When the MATCH SWITCH (M-N, 44) is wired ON, card feeding is automatically controlled under one of five conditions as follows:

1. Primary feed on a low primary.
2. Secondary feed on a low secondary.
3. Primary and secondary feed on an equal reading in the comparing unit, high primary sequence reading in the primary sequence unit, and a high secondary sequence reading in the secondary sequence unit.
4. Primary and secondary feed on an equal reading in the comparing unit, high primary sequence, and equal secondary sequence. The equal secondary sequence condition interlocks the primary feed to allow continuous feeding of multiple secondaries until a high secondary sequence reading is reached.
5. Primary feed on an equal reading in the comparing unit, equal primary sequence and high secondary sequence. The equal secondary card is held and fed with the last equal primary card.

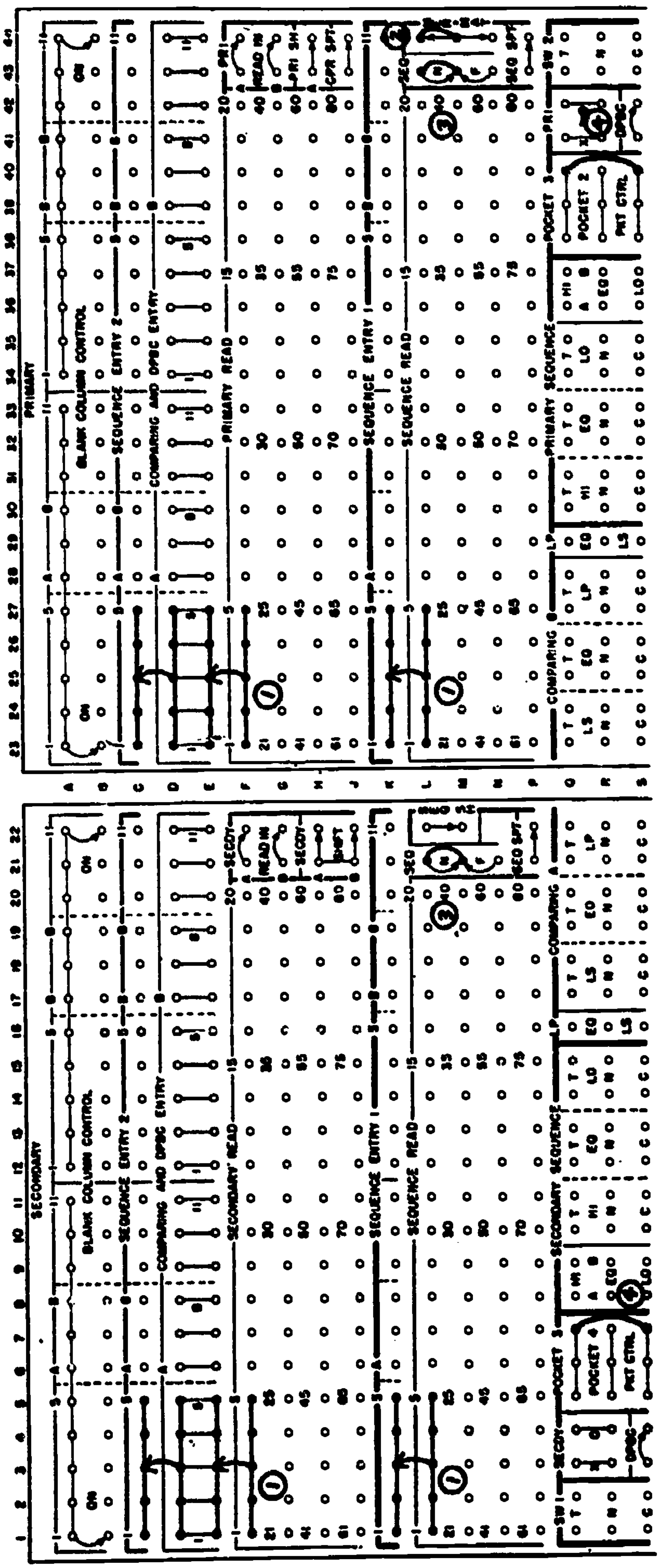

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Figure 8-28.—Merging.

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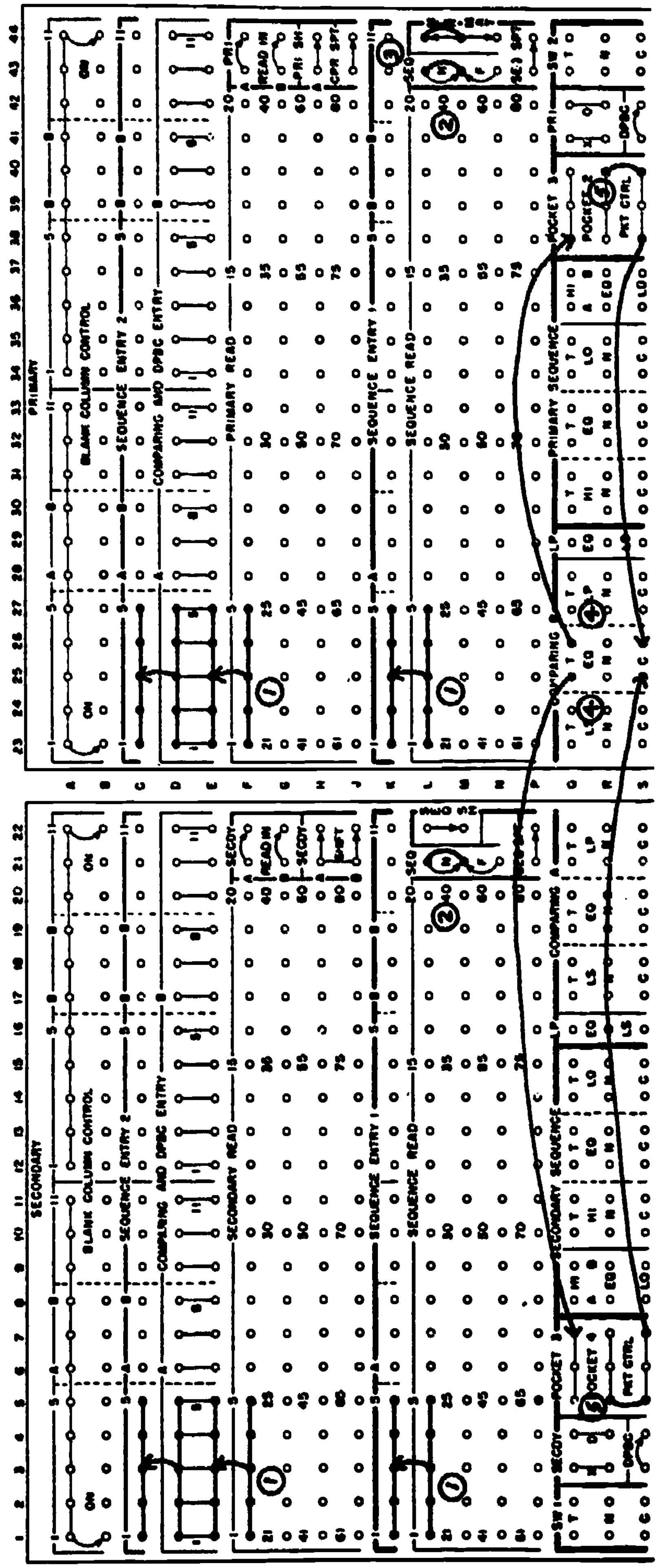

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Figure 8-29.—Merging with selection.

The wiring for matching is illustrated in figure 8-30.

1. The control fields are wired the same as for straight merging.
2. Primary and secondary sequence switches are wired ON.
3. The match switch is wired ON to control card feeding.
4. Matched primary cards are direct to pocket 2 and matched secondary cards to pocket 4 by wiring POCKET CONTROL through the transferred side of the equal comparing selector to pockets 2 and 4. Unmatched primaries and secondaries are automatically directed to pockets 1 and 5 respectively.

Card Selection

Certain cards may be selected from a file under many varying conditions through the use of selectors. Control panel hubs which are used to control selectors are illustrated in figure 8-31.

1. Each selector has two sets of pickup hubs which must be impulsed at the same time in order for the selector to transfer. A single impulse wired to one pickup can be jackplugged to the other, or each pickup can be impulsed from a different source. When both upper and lower pickups are impulsed at the same time, a selector transfers immediately. If neither pickup hub receives an impulse, or if only one is impulsed, the selector remains normal.
2. Each selector has two sets of common, normal and transferred hubs. An internal connection exists between common and normal when a selector is not transferred, and between common and transferred when the selector is transferred. These connections are made only between hubs in each particular set. For example, an impulse entered into common of the lower set cannot be obtained from the normal or transferred hubs of the upper set, and vice versa.
3. Each selector has a set of common selector assignment entry hubs which are used to assign a selector to operate with the primary or secondary feed, or for control use. These entry hubs must be wired from primary, secondary, or control exit only.
4. A secondary exit impulse, emitted each secondary card feed cycle, can be wired to a selector assignment entry to allow a selector, picked up from any source, to reamin transferred until the start of the next secondary card feed cycle.
5. A primary exit impulse, emitted each primary card feed cycle, can be wired to a selector assignment entry to allow a selector, picked up from any source, to remain transferred until the start of the next primary card feed cycle.
6. When a control exit impulse is wired to a selector assignment entry, the selector can be picked up on any machine cycle during control time (after card reading time) and will remain transferrred through the reading of the next card (except the last digit). These hubs emit an impulse each machine cycle.
7. When a primary or secondary exit is wired to a selector assignment entry, the selector can be held transferred by wiring SELECTOR HOLD. Once the selector transfers, it will remain transferred until the hold circuit is broken. This is done by wiring the hold exit through another selector to HOLD ENTRY.
8. The PRIMARY X AND O hubs emit an impulse corresponding to the X and O punching positions each primary card feed cycle. They are normally wired to one of the selector pickup hubs to condition the selector to transfer when an X or O is read from a primary card.
9. An impulse is emitted by the SECONDARY X AND O hubs each secondary card feed cycle. These impulses are normally used to condition a selector to transfer when an X or O is read from a secondary card.

It is possible to perform many selection operations if you have a thorough understanding of how selectors work. While it is impossible to list all the methods of selection in this manual, the wiring shown in figure 8-32 may help you to adapt selectors for other types of card selection. In this illustration, secondary cards punched with an X are selected, and the first card of each primary control group is selected during a merging operation.

1. Wiring for merging is performed in the usual manner, with the exception of pocket control.

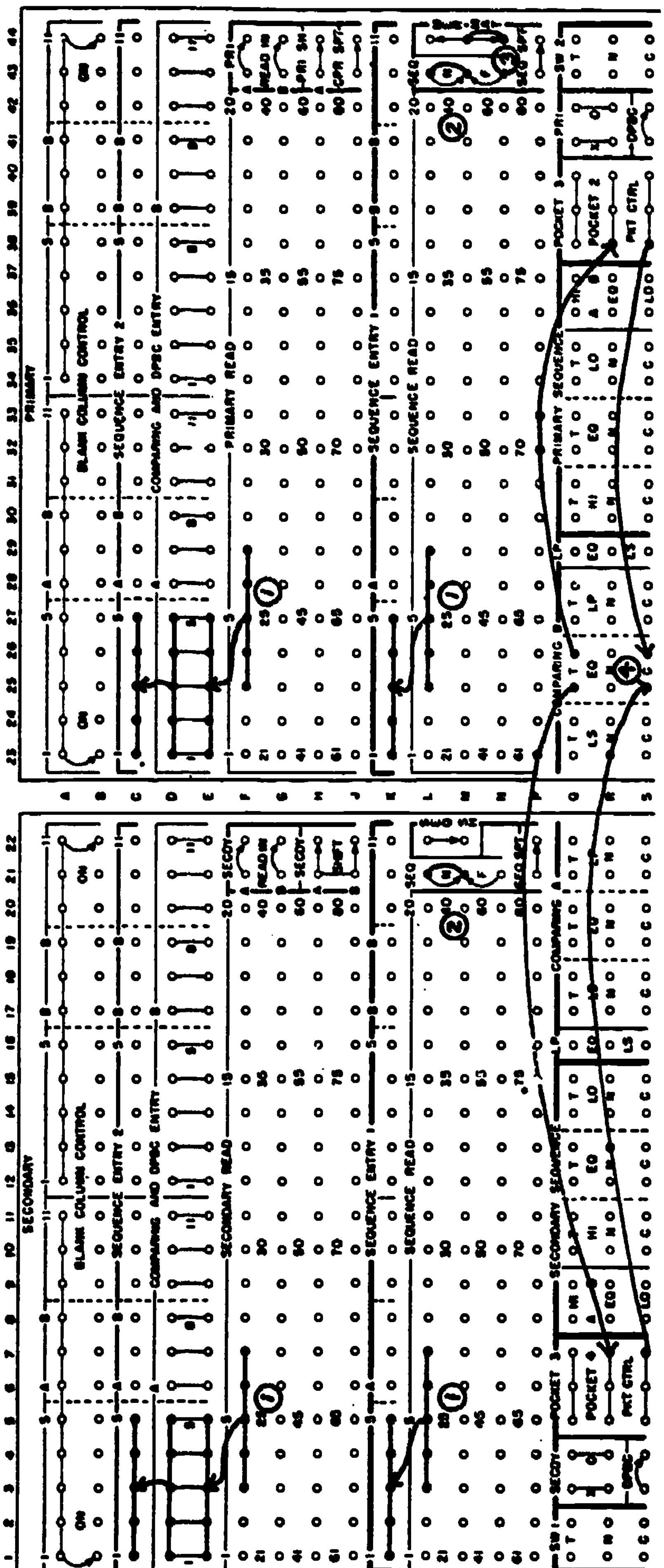

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Figure 8-30.—Matching.

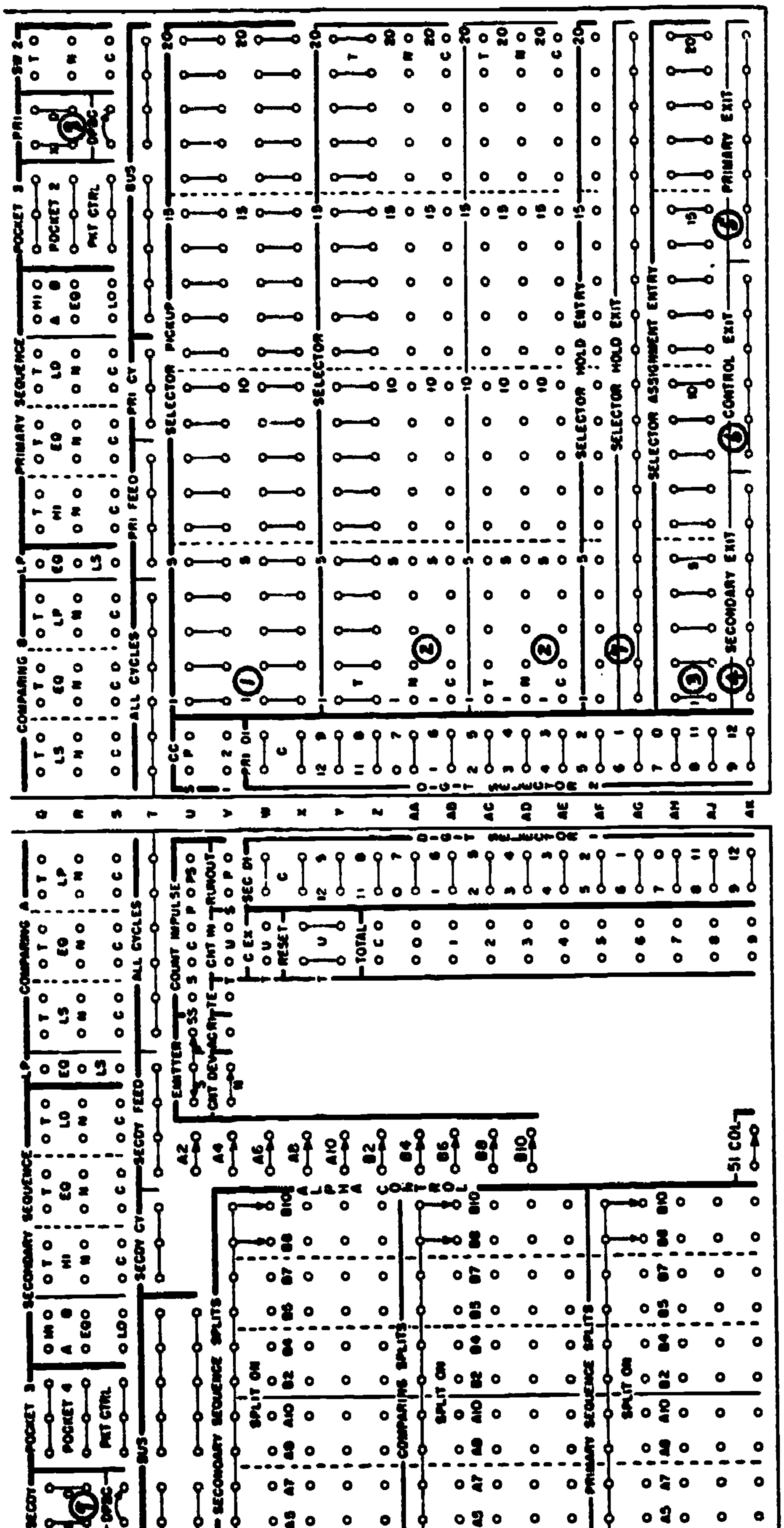

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Figure 8-31.—Hubs used for card selection.

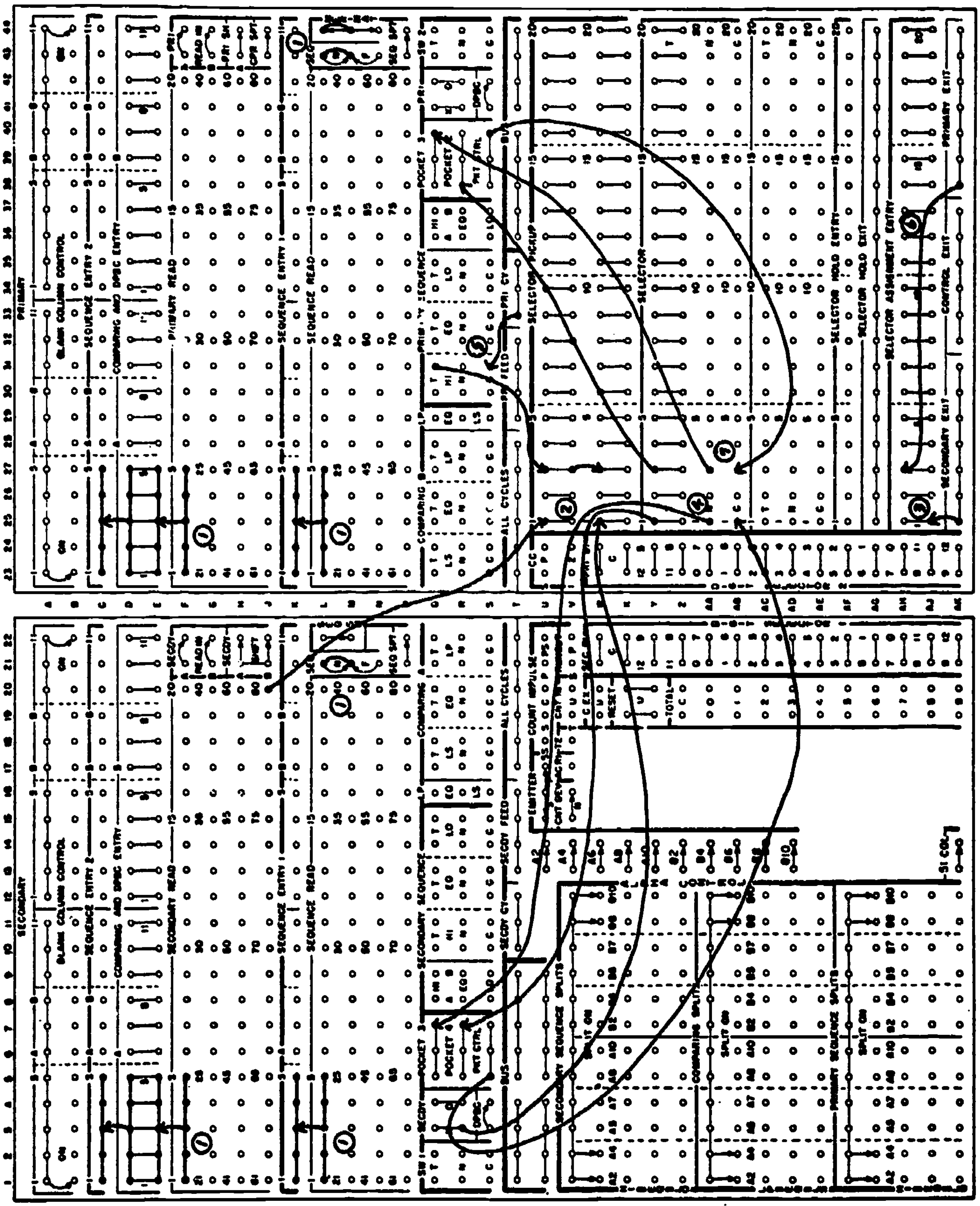

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Figure 8-32.—Card selection.

2. X-punched secondary cards are selected by wiring secondary read 80 to one pickup of selector 1, and a secondary X impulse to the other pickup. Selector 1 will be transferred when an X-80 secondary card is read.

3. Selector 1 is held for a secondary card feed cycle.

4. A pocket control impulse is wired through the transferred side of selector 1 to pocket 4, and through the normal side to pocket 3. This causes all X-80 secondary cards to stack into pocket 4 and all NX-80 secondary cards to merge into pocket 3.

5. The first card of a primary control group is recognized by a high primary sequence condition. Since this card is not in stacking position, as seen by reference to figure 8-25, selection must be delayed until the following primary card feed cycle. A PRIMARY CYCLES impulse, emitted each primary card feed cycle, is wired through the transferred side of the high primary sequence selector to both pickups of selector 3. Since the primary cycles impulse cannot reach selector 3 pickup until the primary card feed cycle following the cycle on which a high primary sequence condition was recognized, selector 3 will be transferred when the first card of a primary control group has reached the stacking position.

6. Selector 3 is held for a primary card feed cycle.

7. A pocket control impulse, wired through the transferred side of selector 3, directs the first card of primary control group to pocket 2. The same pocket control impulse, wired through the normal side of selector 3, causes all other primary cards to merge in pocket 3.

Editing

Cards in each feed should always be checked for double punches or blank columns to assure accuracy of any giv· collating operation. This check can be perfor. .d separately or in conjunction with other operations. For purposes of simplicity, wiring for double punch and blank column detection as a separate operation, using both feeds, is shown in figure 8-33.

1. Primary and secondary read are wired to COMPARING AND DPBC entry. These entry hubs provide entrance to the comparing unit for comparing and for double punch and blank column detection. A double punch is recognized as two or more digits 0 through 9 punched in a single column. Control X or 12 punches are not detected as part of a double punch.

2. The blank column control hubs must be jackplugged if blank columns in addition to double punches are to be detected.

3. The primary and secondary READ IN switches are wired. This wiring causes the readings in the selector unit to clear each card cycle in order to allow a new reading to enter. If the MERGE or MATCH switch is wired, the READ IN switches need not be wired since read-in is then internally controlled.

4. The sequence switches are wired OFF to permit card feeding.

5. Cards feed continuously from both feeds by wiring ALL CYCLES to primary and secondary feed. Since pocket control is not wired, primary cards are directed automatically to pocket 1, and secondary cards to pocket 5.

6. The DPBC switches are wired ON to cause the machine to stop and the signal lights to turn on when a double punch or blank column is detected.

COLLATOR, TYPE 188

The IBM type 188 collator shown in figure 8-34 performs all operations mentioned previously for the type 88, and can also process alphamerical data. The alphamerical collating sequence can be selected on the control panel for the desired application. The type 188 uses magnetic core storage for its comparing rather than electromagnets.

OPERATING FEATURES

The switches, keys, and lights on the operator's panel (fig. 8-35) allow operations control and indicate the condition of the machine while running or conditions that may have caused feed stoppage. The operating switches and keys are essentially the same as for the type 88 with the exception of the STORAGE SELECTOR SWITCH that works in conjunction with the POSITION ADVANCE KEY. These two will be explained under operating procedures.

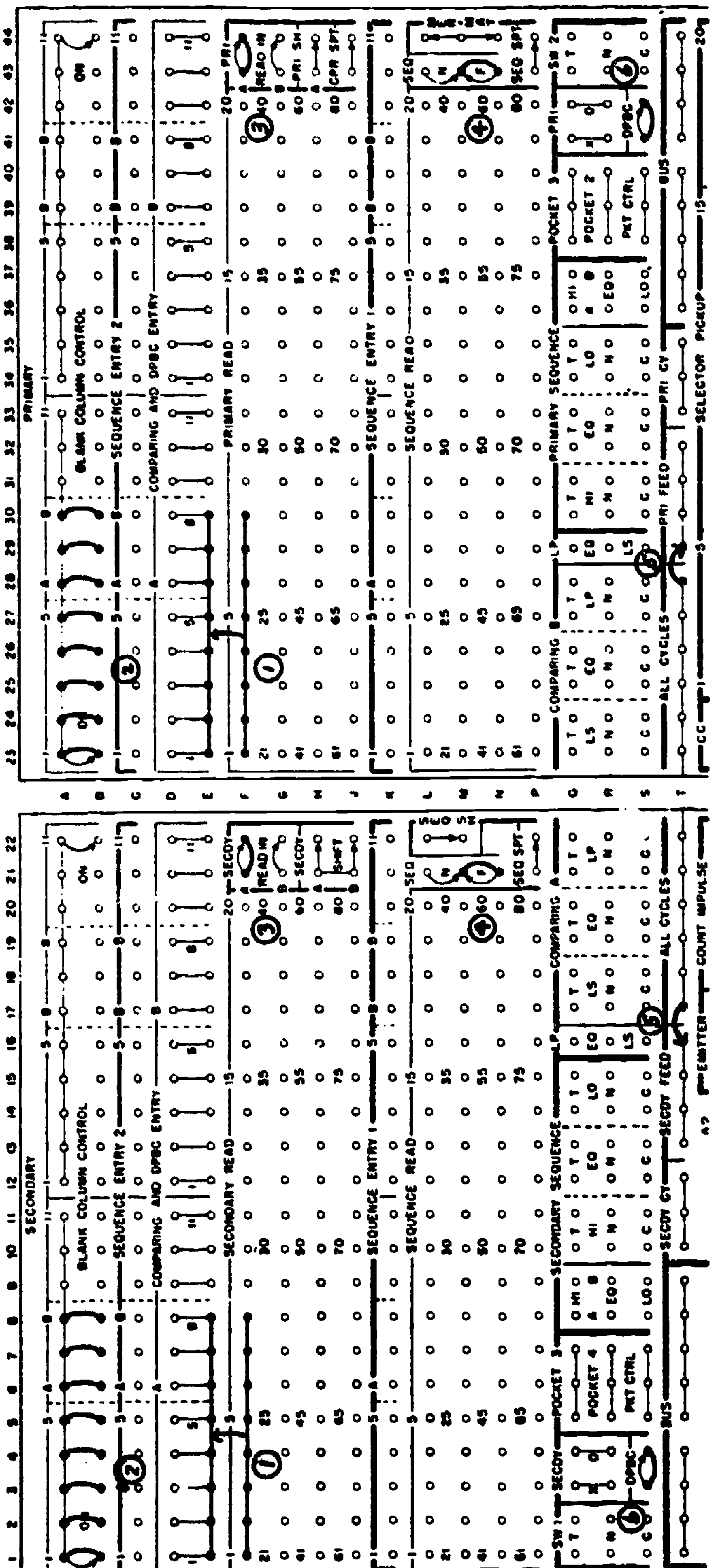

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Figure 8-33.—Editing.

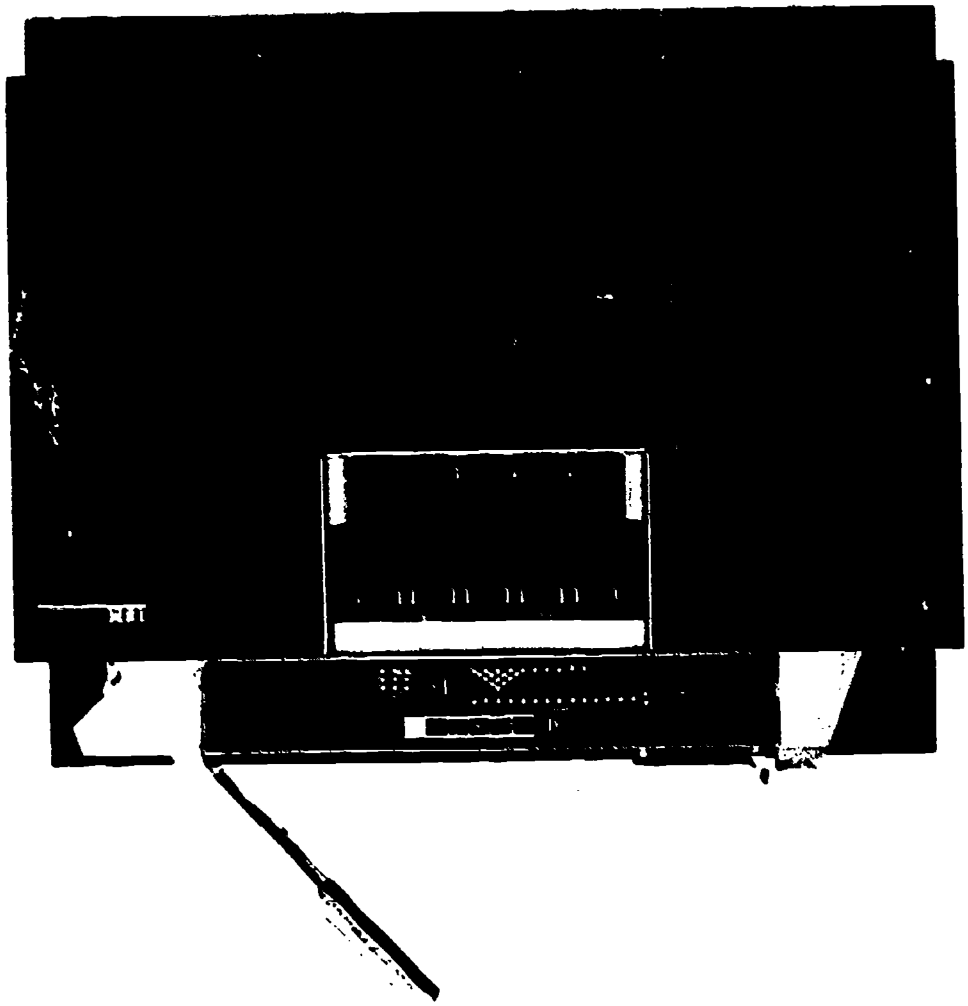

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Figure 8-34.—IBM Type 188 Collator.

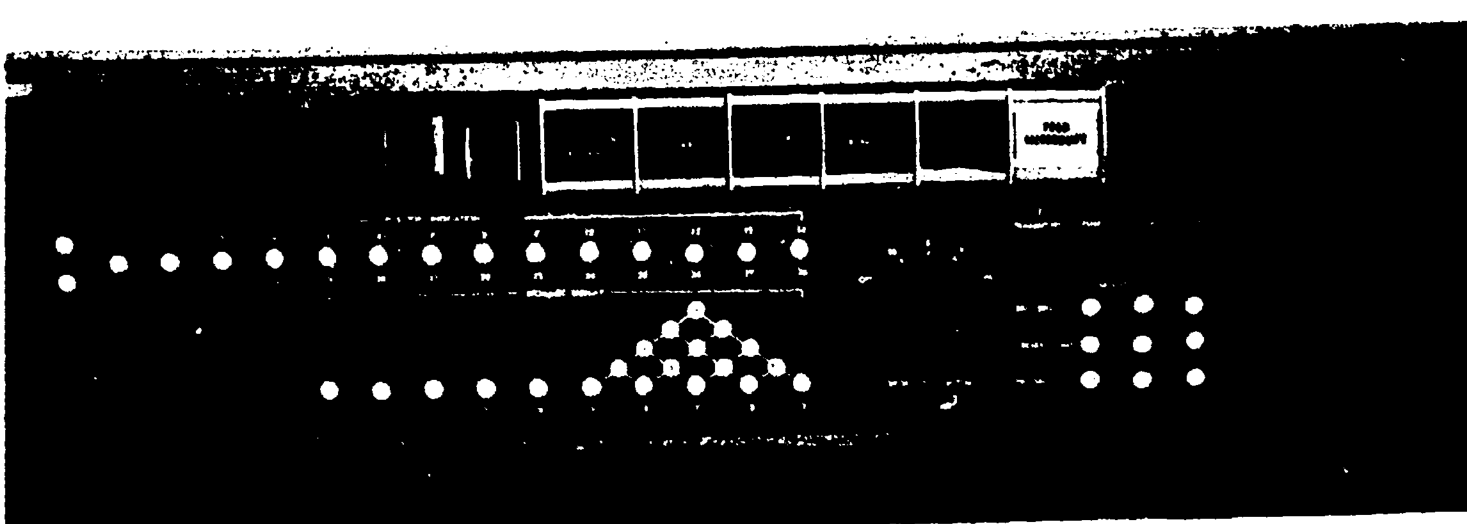

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Figure 8-35.—Type 188 Machine Controls.

Feed `top Lights

The PRIMARY and SECONDARY LIGHTS are used with the feed stop lights to indicate the feed that caused the stop.

The CONTROL PANEL LIGHT indicates that the machine stopped due to an error condition recognized by control panel wiring, such as the cards being out of sequence.

The FUSE LIGHT signals a blown fuse, while the TRANSPORT, CARD LEVER, and CARD-GAP LIGHTS all indicate a card jam or misfeeding.

A malfunction in the controls of the feed knives and feed rolls which control the movement of cards is indicated by the CLUTCH LIGHT.

The CODE CHECK LIGHT comes on when a double punch or blank column error is detected in storage.

Indicating Lights

The FEED INTERRUPT LIGHT signals that power is on but cards are not feeding. It goes off when cards are passing through the machine. The STORAGE DISPLAY LIGHTS and POSITION INDICATOR LIGHTS will be explained under operating procedures.

The ANSWER LIGHTS indicate the results of the comparison between the storage units.

PRINCIPLES OF OPERATION

You have learned that in any operation accomplished by collators, cards are read and their numbers compared. The results of the comparison are then used to control advancement of cards and pocket selection.

The schematic diagram in figure 8-36 shows the reading stations, secondary and primary storage areas, the comparing action and resultant answers, and the five pockets.

Read Stations

The primary and secondary feed units contain only one set each of 80 read brushes.

Storage Units

The storage units consist of 16, 22 or 28 positions of magnetic core storage, depending on the machine model. As only one read station is provided in each feed unit, control panel wiring requires only that the impulse be delivered to one storage SEQUENCE ENTRY. The data enters the sequence side of the SECONDARY or PRIMARY storage unit from the respective reading station.

After the initial read-in is completed from the brushes to the sequence-storage area, a second storage area is needed for comparing two cards in one feed. This is provided by another group of magnetic cores in each unit. The primary sequence data is transferred to the PRIMARY area, and the secondary sequence data is transferred to the SECONDARY area. The read-in to primary or secondary storage is an internal transfer of data from sequence storage. This transfer of data takes place at the beginning of a card-feed cycle before new data is read into primary sequence storage.

At the end of each read-in cycle, a comparing operation is executed by the machine circuitry for detection of a sequence error in either feed. This compares each position of storage serially from high to low-order. The high-, low- or equal-condition sensed by this comparison is set in the machine circuitry for feed control and pocket selection on the control panel, if any selection is wired.

When both feeds are being operated, a comparison also takes place between the secondary and primary core locations. This is called a CROSS COMPARE, and one of three answers is available for control panel wiring.

Pockets

After cards are read, they pass into one of five pockets or stackers. The operator can lift out the cards in proper sequence without stopping the machine. Each pocket, holding approximately 1000 cards, is equipped with a pocket-stop lever to stop card feeding when the pocket is full.

The five pockets are numbered 1 of 5 from right to left, and are designated according to the cards stacked in them:

Pocket 1–Primaries
Pocket 2–Selected Primaries
Pocket 3–Merged Cards

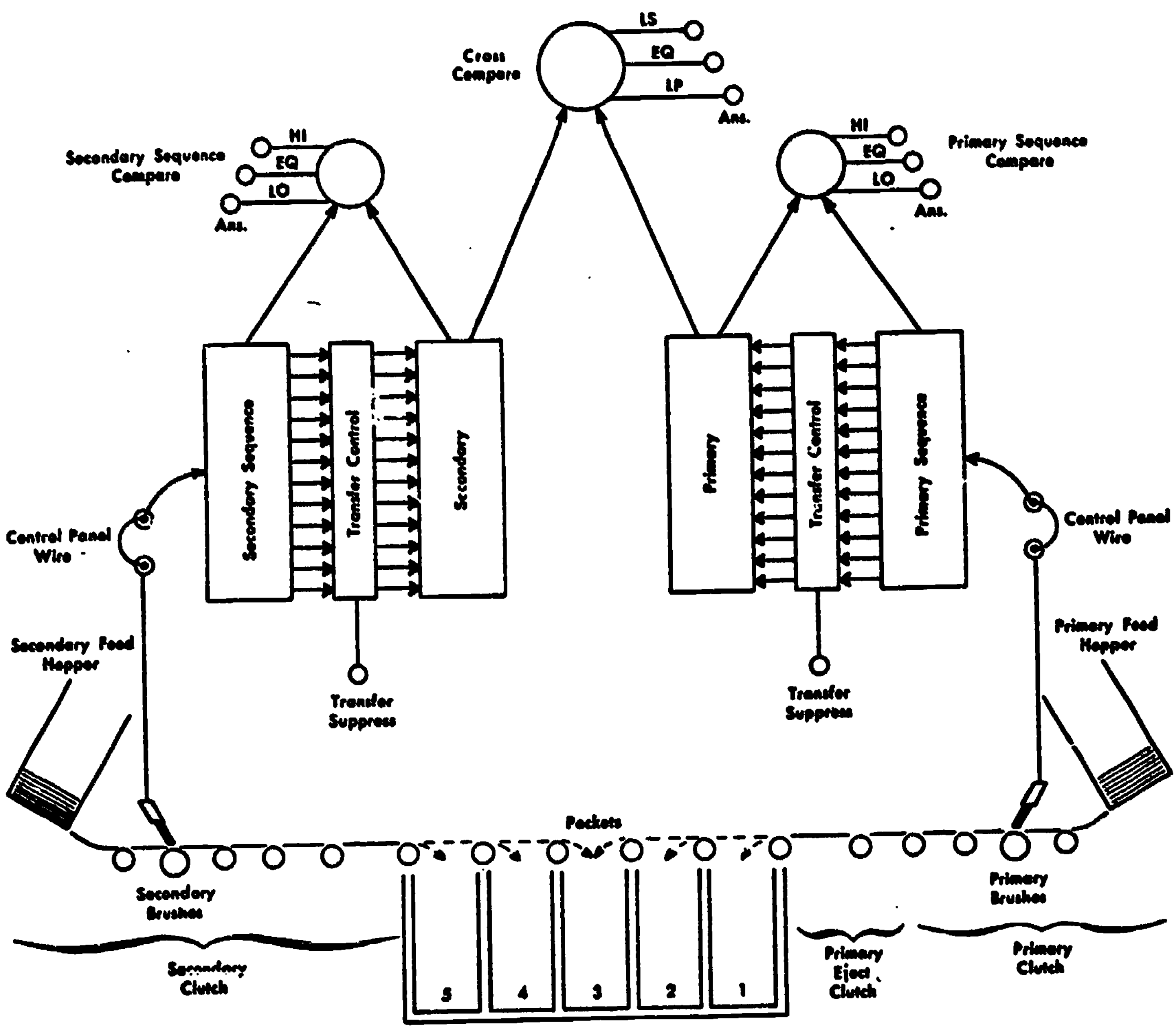

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Figure 8-36.–Schematic diagram.

Pocket 4–Selected Secondaries
Pocket 5–Secondaries

Primary cards normally go into pocket 1, unless directed by control-panel wiring to pockets 2 or 3. Secondary cards normally go into pocket 5, unless directed by control-panel wiring to pockets 3 or 4. Pocket 3 is common to both feeds and serves as the merging pocket. Error cards automatically run out to pockets 1 and 5. Therefore, when possible, pockets 2 and 4 should be used for selected cards, reserving pockets 1 and 5 for error cards.

The cards enter the pocket so that they stack on the 80-column end. As the cards fill the stacker, they are pushed to the front of the pocket to keep the back area clear for the cards entering. The pocket is equipped with a card pusher that forces the cards to the front until the capacity of the pocket (approximately 1000 cards) is reached. At this point the pocket-stop switch is activated and the machine is stopped.

Control Panel

The control panel for a full capacity machine is shown in figure 8-37 with the shaded areas representing optional features. The upper right portion of the two-section panel corresponds essentially to the primary feed and the upper left side to the secondary feed. The lower part of each section is used for control.

The basic setup and basic machine control hubs can be located by referring to figure 8-37 as they are described below. Supplemental hubs will be discussed when used.

MERGE/MATCH (C,D,E,44).—These switches are used to establish a basic setup. By wiring the switch for the appropriate application, internal wiring automatically controls card feeding and error checking.

ALL CYCLES (J,K,L,14,31).—Each of these six exit hubs emits an impulse on each machine cycle. All cycles impulses are normally wired to feed entries or pocket select entries.

PRIMARY FEED (J,K,L,33).—An impulse to any one of these hubs picks the primary and primary eject clutch, causing a primary feed.

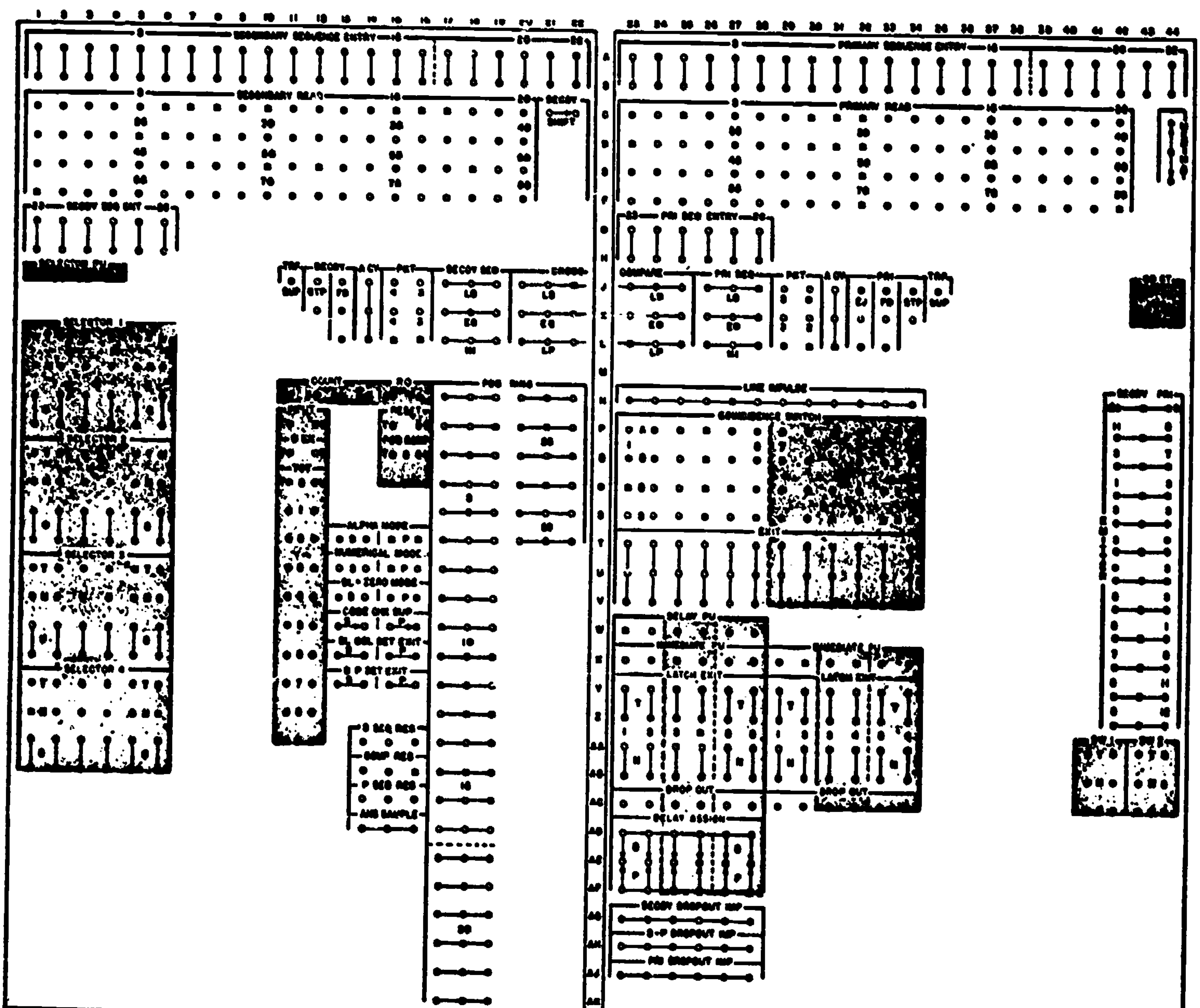

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Figure 8-37.—Type 188 Control Panel.

PRIMARY EJECT (J,K,L,32).–An impulse to one of these hubs operates the primary eject clutch to cause a card to be moved from the eject position to the stacker.

SECONDARY FEED (J,K,L,13).–Picks the secondary clutch when impulsed, causing a secondary feed.

POCKETS 2,3, AND POCKETS 3,4,(J,K,L,15,16,29,30).–These are entry hubs used to control the stacking of cards into various pockets. They are nromally wired from ALL CYCLES, selected impulses, or from impulses generated from compared data in the storage positions.

POSITION RING (N-T, 17-22; U-AK, 17-19).–The number of these positions is the same as the storage capacity. They emit impulses in time with the corresponding position that is being read out of storage internally and are normally wired to the mode control hubs.

Modes

The storage units containing the data for comparison can be compared in three modes, controllable on a columnar basis. The mode of comparison can be selected on the control panel for the specific application, concurrent with other applications. The three modes of comparison are:

ALPHAMERICAL (T, 13-16).–This mode provides a comparison with a low-to-high order of Blank, 11 special characters, A-Z, 0-9. In this mode double-punch detection is automatic. Therefore, special characters that have two digits in their coding are detected. When this condition exists, the code-check suppress switch must be wired ON for the columns containing these characters.

The alphamerical collating sequence (low-to-high) recognized by the IBM 188 Collator is:

1. Blank column
2. 11-special characters

12-3-8	(.)
12-4-8	(¤)
12	(&)
11-3-8	($)
11-4-8	(*)
11	(-)
0-1	(/)
0-3-8	(,)
0-4-8	(%)
3-8	(#)
4-8	(@)

3. Letters A through Z
4. Digits 0 through 9.

NUMERICAL BLANK DETECTED (U, 13-16).–This mode provides comparison with a low-to-high sequence of 0-9. A blank or multiple punch (0-9) is detected as an error. Card columns can be overpunched with an 11 or 12-punch or both.

When wired for numerical mode, the first column NOT to be collated or sequence checked must be wired from position ring exit corresponding to that position to either of the other two modes.

NUMERICAL–BLANK EQUAL ZERO (V, 13-16).–This mode provides comparison with a low-to-high sequence of Blank or Zero, 1-9. Blanks are treated as zeros and do not cause a validity-check error. Double punching (0-9) is considered an error. Columns can be overpunched with an 11- or 12-punch or both.

PRINCIPLES OF CONTROL PANEL WIRING

There are many operations that can be performed on the 188 collator and several different ways to wire the control panel to obtain the desired results. The following paragraphs illustrated with wiring diagrams describe some of the typical applications.

Checking Sequence

Figure 8-38 illustrates the control panel wiring for sequence checking cards in the primary feed using the three modes of control. Three fields are to be sequence checked. Columns 1-5 are alphamerical field, columns 6-12 are numerical, and columns 13-15 are numerical-blank equal zero.

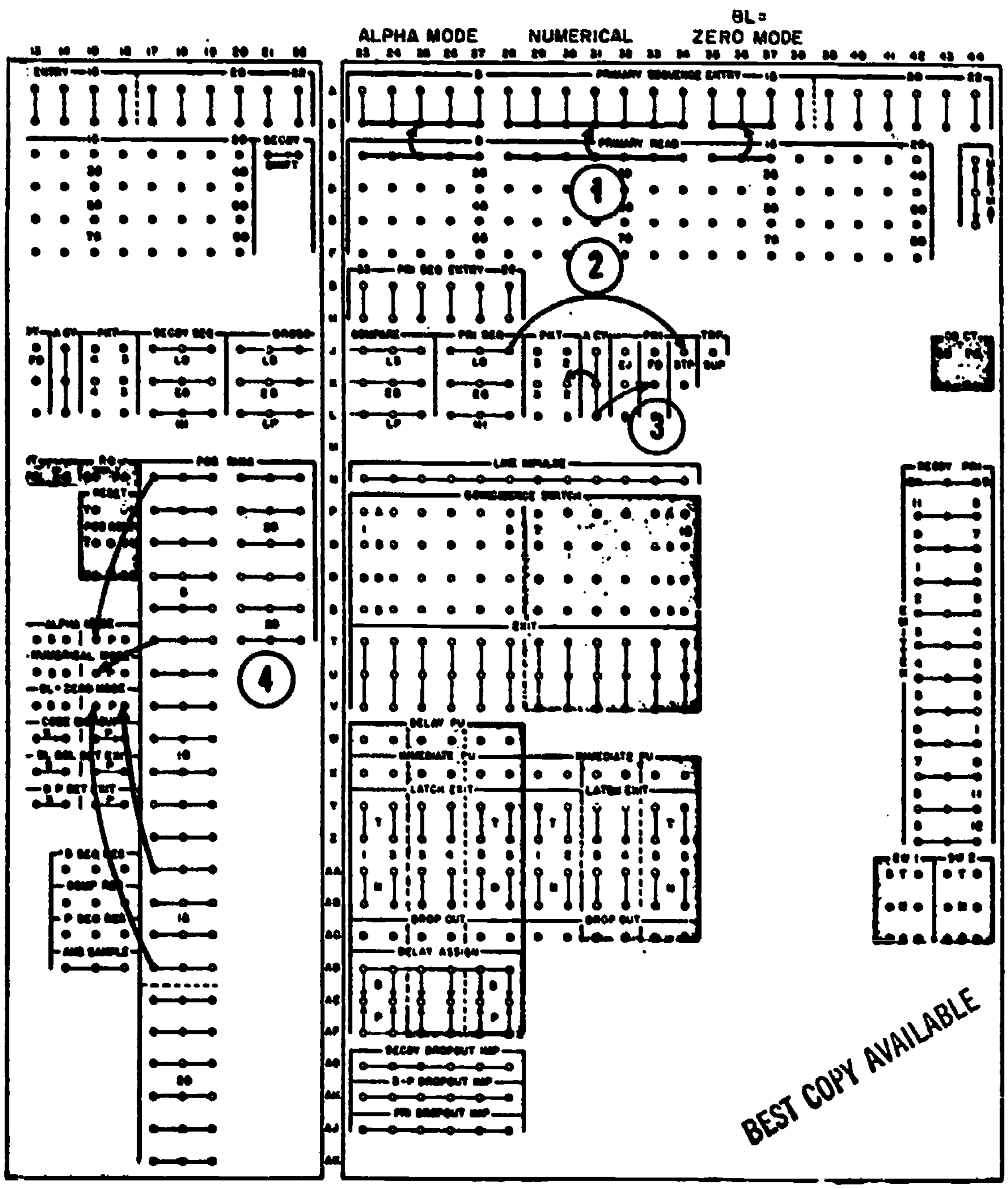

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Figure 8-38.—Checking Sequence.

1. The control fields are wired from PRIMARY READ to PRIMARY SEQUENCE ENTRY. This wiring causes data to be read into the storage units.

2. The high, low, or equal comparison in the storage units is available at the answer hubs, so the wiring to sequence check the ascending order of the cards is LOW PRIMARY SEQUENCE to PRIMARY STOP.

3. Wire ALL CYCLES to PRIMARY FEED to feed cards every machine cycle, and to POCKET 2 to stack all cards in pocket 2.

4. POSITION RING 1 is wired to ALPHA MODE PRIMARY to set the circuitry for the first field (1-5).

POSITION RING 6 is wired to NUMERICAL MODE PRIMARY for the second field (6-12).

POSITION RING 13 is wired to BLANK EQUAL ZERO MODE PRIMARY for the 13-15 field.

POSITION RING 16 is wired to BLANK EQUAL ZERO MODE PRIMARY so that the unused positions of storage are treated as zero.

This conditions storage so that blank column detection will not affect the remaining positions.

Checking sequence in the secondary feed could be done by duplicating the wiring utilizing the secondary hubs, and stacking secondary cards into pockets 3 or 4.

Merging

The MERGE SWITCH controls card feeding from either feed in a merging operation. The machine automatically stops on a low sequence condition.

Wiring for a numerical merging operation is illustrated in figure 8-39.

1. The primary and secondary control fields are wired to the primary and secondary sequence entries.
2. Merge switch is wired to control card feeding.
3. All cycles wired to pocket control 3 in both feeds direct the cards to the merge pocket.
4. Position ring 1 is wired to numerical mode hubs of both feeds to set the circuitry. Position ring 6 is the first column not to be collated or

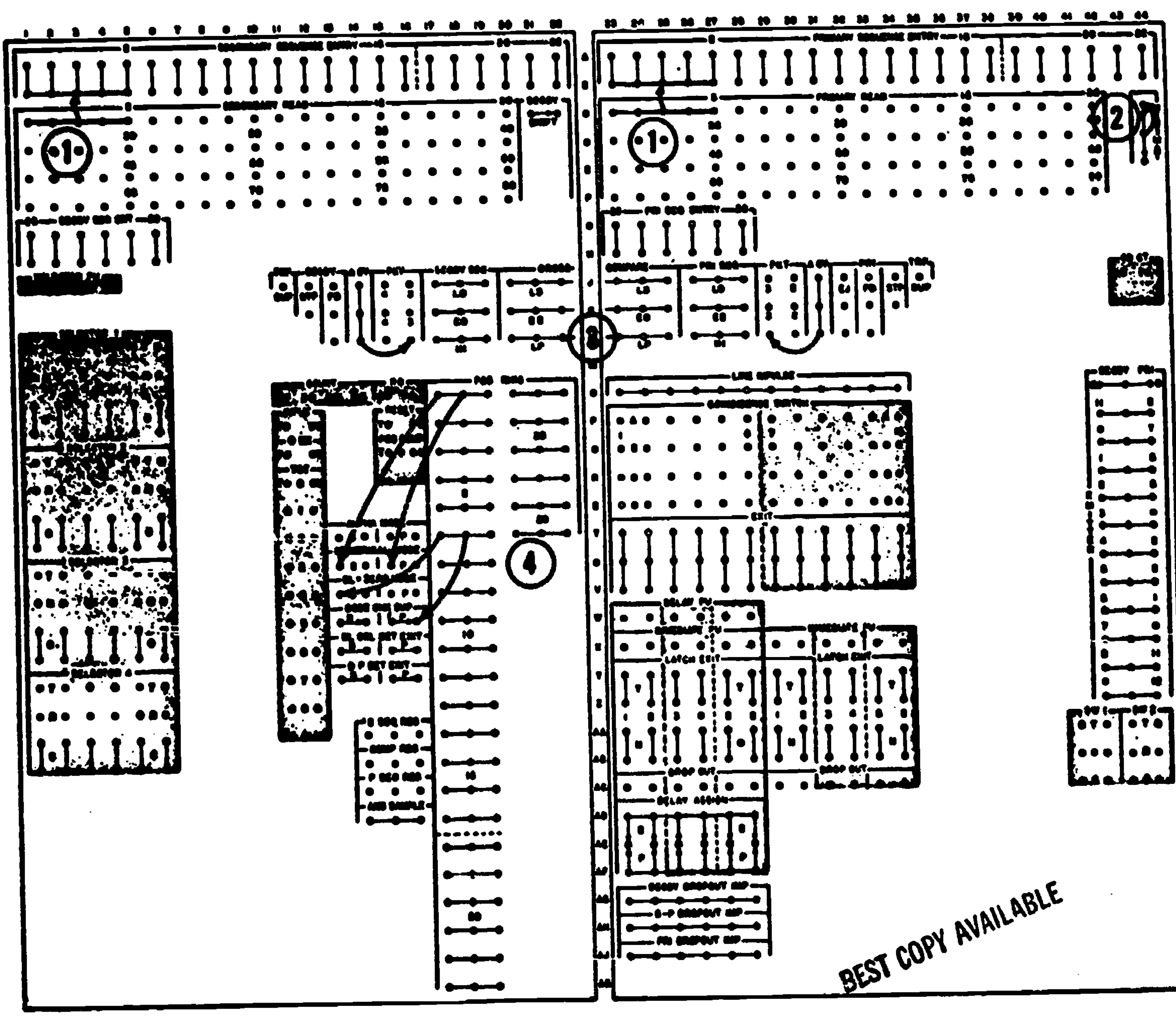

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Figure 8-39.—Merging.

sequence checked and must be wired to the blank equal zero mode or alpha mode.

Merging With Selection

The cross compare hubs are associated with their respective storage areas. They are used for controlling the machine operation according to the results of the comparisons made between the data in primary and secondary storage.

Wiring for merging with selection is illustrated in figure 8-40.

1. The control fields are wired the same as for straight merging.
2. Wire merge switch to control card feeding automatically.
3. Wire equal cross compare answer hubs to select pocket 3 for both primary and secondary cards.

All cycles wired to pocket 2 selects low primary cards into pocket 2. All cycles wired to pocket 4 select low secondary cards into pocket

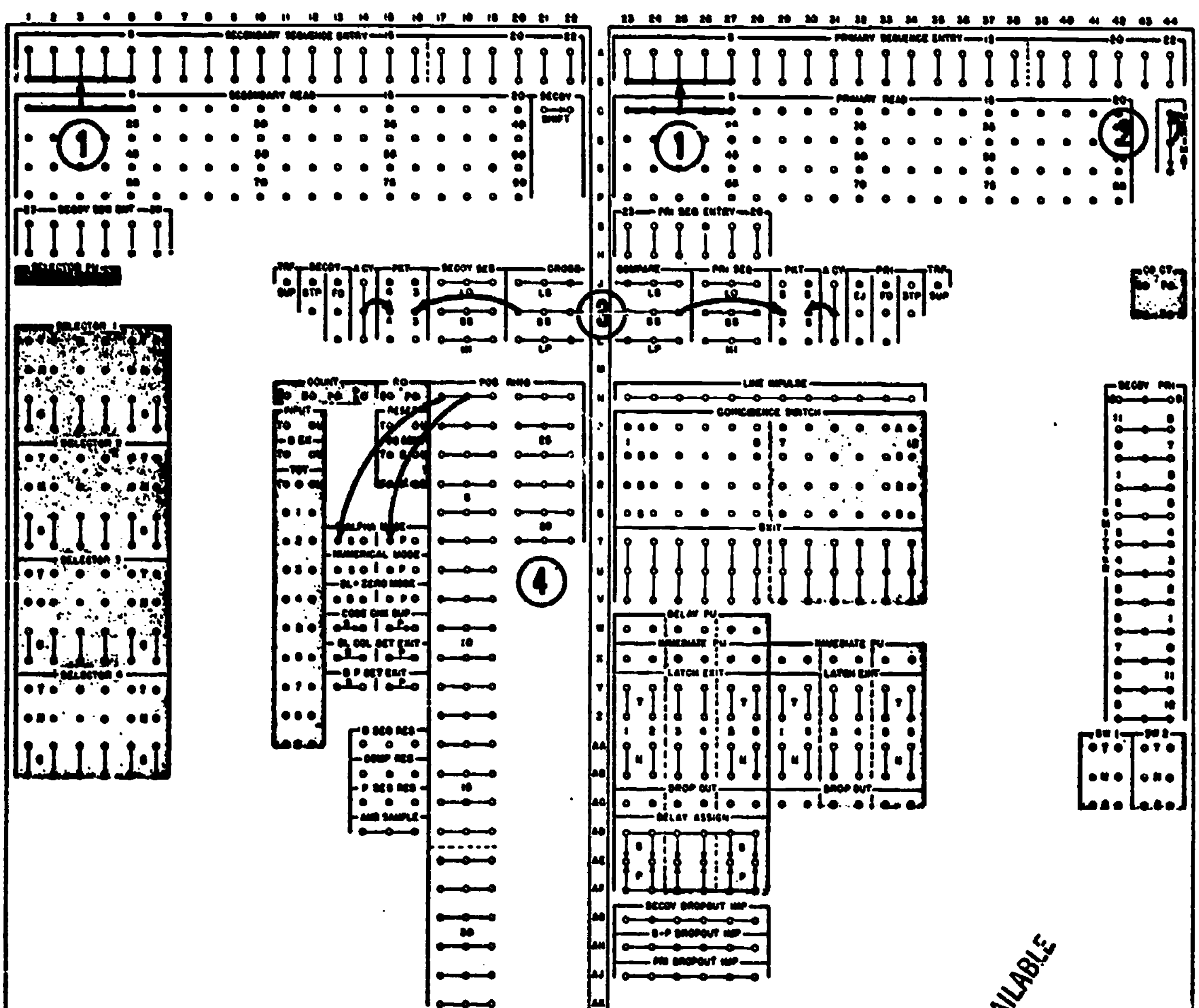

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Figure 8-40.—Merging with selection.

4. When equals feed, the impulse to pocket 3 takes precedence.

4. Wire position ring 1 to alpha mode.

Matching

The match switch controls card feeding on a matching operation by internal circuitry. The machine stops automatically on a low sequence condition and operates in the same pattern as the merging operation, with the exception that the primary and secondary feed simultaneously when the comparing areas are equal.

The wiring for matching is illustrated in figure 8-41.

1. The control fields are wired the same as for straight merging.
2. Wire match switch to control card feeding.
3. Equal cross compare answer hubs are wired to pockets 2 and 4. This causes the matched cards in the primary and secondary to stack in pockets 2 and 4 respectively. The

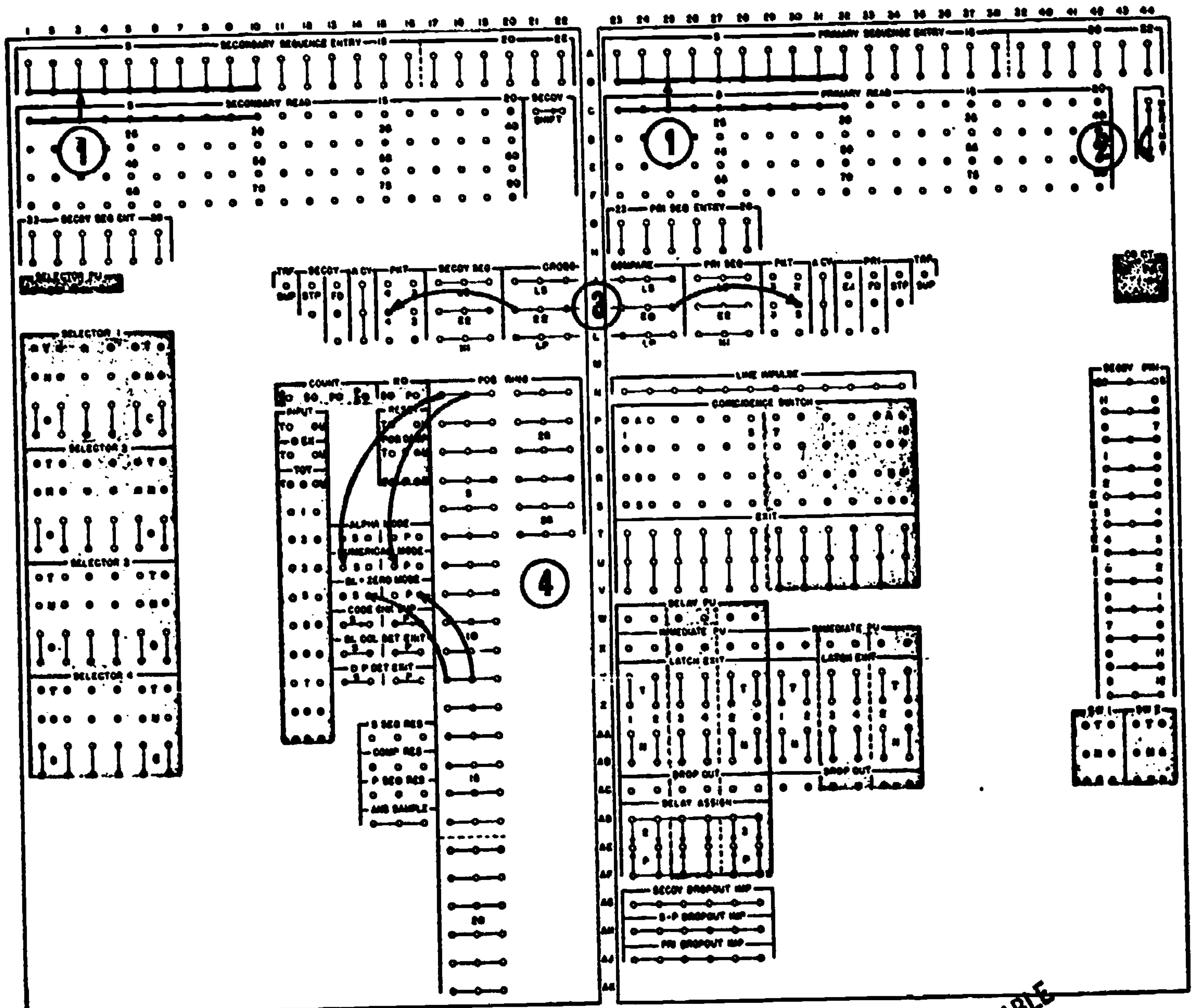

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Figure 8-41.—Matching.

unmatched primaries and secondaries stack into pockets 1 and 5 respectively.

4. Position ring 1 is wired to numeric mode, and the first column to be ignored is wired to blank equal zero.

OPERATING PROCEDURES

This section contains the explanation of keys, lights and switches involved in the operator's procedures for hanfling error conditions.

Magnetic Core Storage

The data is represented in storage in a special coding structure. For each character position of storage there are 10 bits. The bits are labeled from left to right: G1, G2, 12, 11, O, A, B, C, D and E, as shown in figure 8-42. The character code chart shows the bit combinations that appear for each acceptable character in storage.

Storage may be interrogated to determine what characters are present in the storage areas by the STORAGE SELECTOR SWITCH, POSITION ADVANCE KEY, POSITION INDICATOR LIGHTS and the STORAGE DISPLAY LIGHTS. The storage interrogation is not possible without the code check light being on, which, in turn, activates the POSITION ADVANCE KEY.

Storage-Selector Switch

The storage-selector switch is a rotary switch with five settings: OFF, SS, S, P, and PS (off, secondary sequence storage, secondary storage, primary storage, and primary sequence storage). The switch can be manually rotated to select the particular storage unit to be interrogated by the position-advance key. Or, it can be set to the OFF position to turn OFF all the lights except the feed-stop lights. Until an error condition is detected, this switch is normally set to OFF.

Postion-Advance Key

The position advance key is used to advance the position ring one step at a time to interrogate the four storage units position by position. It works in conjuction with the storage-selector switch and is activated by a feed stop caused by a code-check condition.

Storage-Display Lights

The storage-display lights are used to display the information in each position of storage one position at a time. The character code chart should be consulted for the displayed code. For example, if a position in storage contained the letter A, it would be represented on the display lights by the 12, A, and B lights. The display lights are changed as the position advance key is operated when the code check light is ON.

Position-Indicator Lights

The position-indicator lights show the position of storage being interrogated.

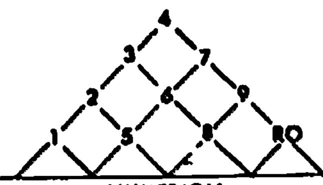
Runout Key

When the last card is fed from either hopper, card feeding stops with three cards still in the feed. If these cards are to be run out, the runout key must be pressed until the feed with the empty hopper takes one cycle. Normal comparing and functional operations occur. The machine then continues operating until the opposite feed hopper is empty. The runout key must be pressed again and held until all the remaining cards have run out.

The runout key is also used whenever card feeding stops resulting in a feed-stop light coming on. Cards must be removed from the corresponding hopper before that feed can be run out.

Reset key

The reset key is used to reset any error condition that is indicated by a feed-stop light except FUSE and TRANSPORT. Pressing this key also resets the indicator light and permits a continuation of the operation. If a visual check is to be made of an error condition in storage when the code-check light is on, RESET must not to be pressed until after the check is completed.



	GENERATED		ZONE			NUMERICAL						
Bit	10	9	8	7	6	5	4	3	2	1		
Code	G1	G2	12	11	0	A	B	C	D	E		
Blank	x	x										
. (12-3-8)		x	x			x		x	x			
□ (12-4-8)		x	x					x	x	x		
& (12)		x	x									
$ (11-3-8)		x		x		x		x	x			
* (11-4-8)		x		x				x	x	x		
— (11)		x		x								
/ (0-1)		x			x	x	x					
, (0-3-8)		x			x	x		x	x			
% (0-4-8)		x			x			x	x	x		
# (3-8)		x				x		x	x			
@ (4-8)		x						x	x	x		
A (12-1)			x			x	x					
B (12-2)			x			x		x				
C (12-3)			x			x			x			
D (12-4)			x			x				x		
E (12-5)			x				x	x				
F (12-6)			x				x		x			
G (12-7)			x				x			x		
H (12-8)			x					x	x			
I (12-9)			x					x		x		
J (11-1)				x		x	x					
K (11-2)				x		x		x				
L (11-3)				x		x			x			
M (11-4)				x		x				x		
N (11-5)				x			x	x				
O (11-6)				x			x		x			
P (11-7)				x			x			x		
Q (11-8)				x				x	x			
R (11-9)				x				x		x		
S (0-2)					x	x		x				
T (0-3)					x	x			x			
U (0-4)					x	x				x		
V (0-5)					x		x	x				
W (0-6)					x		x		x			
X (0-7)					x		x			x		
Y (0-8)					x			x	x			
Z (0-9)					x			x		x		
0					x							
1						x	x					
2						x		x				
3						x			x			
4						x				x		
5							x	x				
6							x		x			
7							x			x		
8								x	x			
9								x		x		
Run out									x	x		

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Figure 8-42.—Character code chart.

Code Check Light Procedures

A machine stop with the code-check light ON indicates that a double punch or a blank column has been detected. The primary or secondary light turns ON in conjunction with a feed-stop light to indicate the feed in which the condition occurred.

When the code-check light is ON, the operator can check storage to see what data is in each position being used. The procedure for checking storage is:

1. Do not reset the code-check light.
2. Observe the position-indicator light. This shows the first position of storage having a double punch or blank column.
3. Rotate the storage-selector switch to primary or secondary-sequence storage as indicated by the primary or secondary light.
4. Additional positions of storage should be checked for double punching or blank columns by pressing the position-advance key. This key causes the position ring to step, one position at a time, through all the positions of storage. It then loops back from the highest position to position one to repeat the operation. It is necessary only to operate the position-advance key to the end of the field being compared.
5. Check the storage display lights for each position to determine the bit configuration representing the character in storage. Check the character-code chart (figure 8-24) for the bit coding for alphabetic and numerical characters.
6. To check the card in question, run out cards with the runout key without resetting the code-check light.
7. Three cards are fed into pocket 1 on runout. The second card in the pocket is the card in error.
8. Beginning at a convenient control break, place the cards in the hopper and press the reset key.
9. Press START to continue operation.

Other Error Procedures

When a misfeed or card jam occurs, the machine stops and a card gap, card lever or transport light turns on. For these indicators you should have your supervisor or an experienced operator show you the correct procedures.

Do not attempt to correct these conditions without proper supervision (until you have gained sufficient supervised experience). Damage to the machine and/or harm to yourself may result.

CHAPTER 9

ACCOUNTING MACHINES

INTRODUCTION

The punched card accounting principle is composed of three basic steps. First, source data must be converted to punched cards. Second, these cards must be sorted to the sequence in which they are to be used. Third, the finished product, usually in the form of a printed report, must be prepared. This chapter discusses the machines used to accomplish the third step.

Accounting machines are designed to print and accumulate data contained in punched cards at speeds to 150 cards per minute. The speed of operation depends upon the type of machine used and the particular job being performed. Operations to be discussed in this chapter are for the 407 type (figure 9-1) accounting machines. These operations can be grouped in four general categories as follows:

1. DETAIL PRINTING. Detail printing is the printing, or listing, of data from each card that passes through the machine. All or any part of the card can be printed in any sequence desired through proper control panel wiring.
2. GROUP PRINTING. Group printing differs from detail printing in that only the identifying data for a particular group of cards is printed. This information usually is taken from the first card of a control group, and all other cards in that group are tabulated without any data being printed from them. This type of printing is used primarily to identify totals that are being accumulated.
3. ACCUMULATING. Totals punched in cards, or a count for each card, can be accumulated and stored in counters until such time as it is desired to have these totals printed. The machine can be directed through proper control panel wiring to add or subtract certain cards and disregard others.
4. PROGRAMMING. This is the process by which the machine can tell the difference between cards in one control group and those in another. This is done by comparing a card at one reading station with a card at the following reading station, much the same as comparing is performed in a collator. Impulses resulting from an unequal reading normally are used to start an automatic program cycle so that accumulated totals can be printed.

There are several types of accounting machines which may be used to perform the operations listed above. However, only the IBM type 407 is discussed in this chapter, since it is the accounting machine you will most likely be required to operate. You will notice that certain operations discussed will be familiar to you already because of a similar operation discussed in one of the preceding chapters. For example, you know that a machine differentiates between a control field in one card and a control field in another by comparing the two cards in a comparing unit. You know also how an impulse is allowed to travel through the normal and transferred sides of a selector, depending upon whether the selector is normal or transferred.

This chapter presents the basic principles involved in wiring a control panel for performing some of the common accounting machine applications.

If you have a thorough understanding of these principles, you can develop a skill for wiring control panels to perform more complicated jobs, limited only by the capacity of the machine and your own ingenuity. Additional information concerning accounting machines can be obtained from the appropriate machine reference manual printed by the manufacturer. Consult your supervisor for assistance in obtaining such manuals.

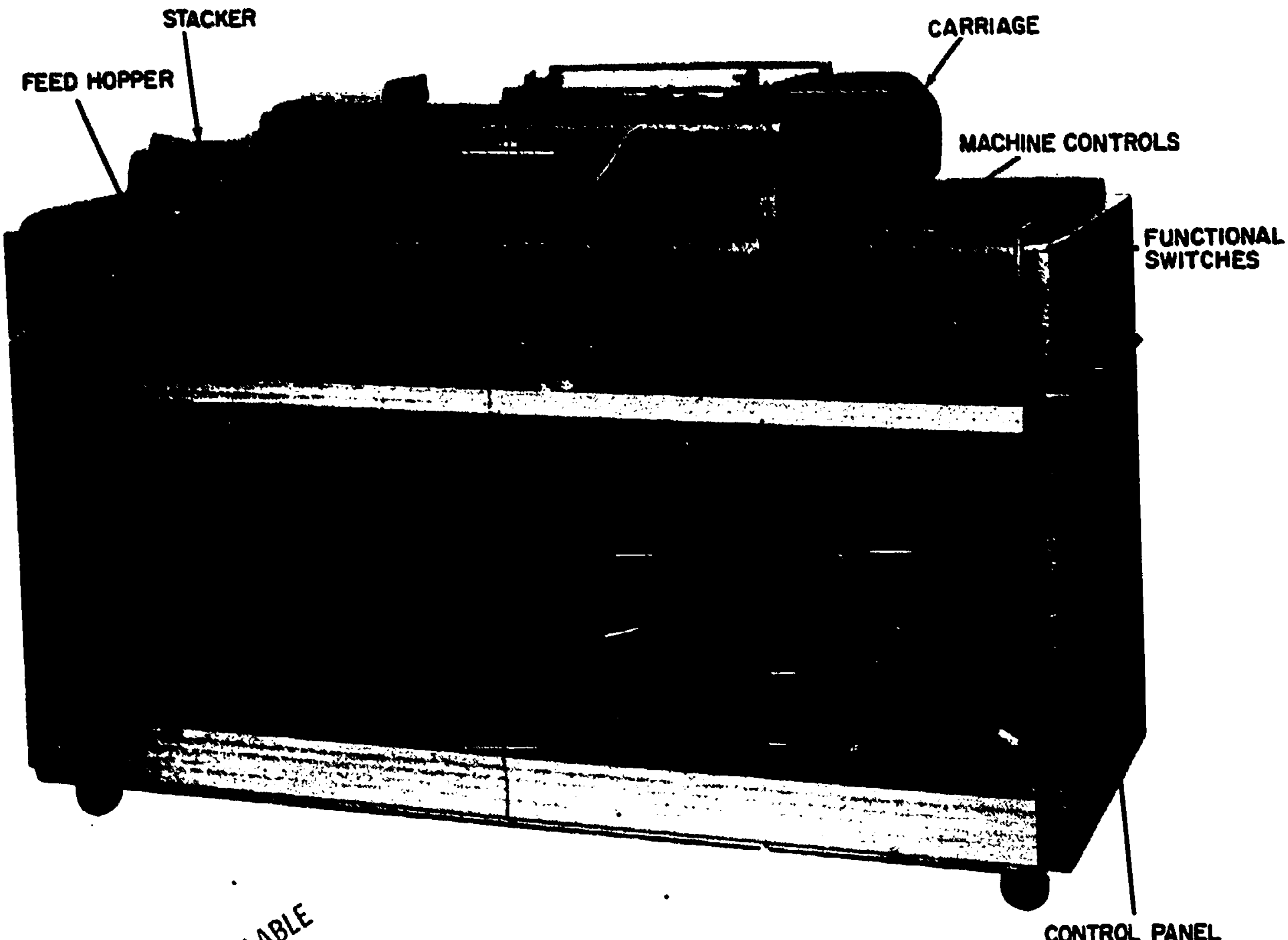

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Figure 9-1.—IBM Type 407 Accounting machine.

MACHINE CONTROLS

The keys for controlling machine operations and lights for indicating certain conditions are illustrated in figure 9-2.

MAIN LINE SWITCH (not shown)—located on the upper left end of the machine, must be ON for all machine operations.

START—The start key must be depressed to start cards feeding through the machine.

STOP—When the stop key is depressed, card feeding stops before the next card is fed.

FINAL TOTAL—The final total key provides for a manual control of total printing. Final totals can be printed when this key is depressed, provided the following conditions have been met:

1. The final total toggle switch in ON.
2. The last card has been run out of the machine.
3. The machine is idling.

AUTO STOP—When the automatic stop hub on the control panel is impulsed, this light goes on and card feeding stops. The light goes off and card feeding resumes when the start key is depressed.

RESET CHECK—The type 407 has a reset check circuit installed which is designed to determine whether counters in the machine are

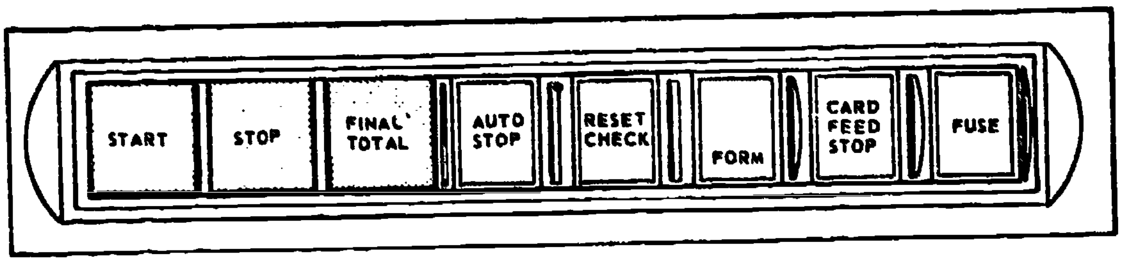

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Figure 9-2.—Machine controls.

reset correctly. This circuit is controlled by a reset check toggle switch located on the right end of the machine. The reset check circuit is made inactive when this switch is OFF and the reset check light flashes during machine operation to call this to your attention. If the reset check switch if ON and a counter fails to reset correctly, card feeding stops and the reset check light comes on. On later model machines the counter which fails to reset correctly is identified by a light under the cover near the feed hopper. You will find that a reset error usually is caused by improper counter wiring or broken wire on the control panel.

FORM–An unlabeled light, which is the upper half of the form light, goes on when the main line switch is on and the machine is idling. The form light (lower half) goes on and the machine stops when the last form has passed the form stops, provided the form stop toggle switch is ON. This light can be turned off by inserting new forms and depressing the start key.

CARD FEED STOP–This light comes on if a card fails to feed from the hopper or if a card jam occurs. Once the cause is corrected the stop key extinguishes the light.

FUSE–If a fuse burns out, the fuse light goes on. This light goes out when the bad fuse has been replaced.

Functional Switches

The functional control switches are located on the right end of the machine. These toggle switches can be seen in figure 9-3.

ALTERATION 1, 2, 3, 4–When any of the four alteration switches are turned on, a corresponding alteration switch selector in the machine transfers. These selectors can be wired on the control panel so that one panel may be used for more than one operation without changing the wiring. The switches function in both positions, transferred (T) or normal (N).

INVERTED–The inverted form switch is turned on only when inverted forms are used. Inverted forms are those in which detail cards are printed before the heading cards. It is set to CONVENTIONAL for normal operations.

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Figure 9-3.—Functional switches.

FINAL TOTAL This switch works in conjunction with the final total key, provided the control panel has been wired for final totals. With this switch off the final total remains in the machine indefinitely and may cause subsequent erroneous totals if the counter is not reset.

FORM STOP–When a form is inserted in the carriage, it passes under a set of form stop levers. These levers drop into slots in the carriage when the bottom edge of the last form passes by them and cause card feeding to stop, provided the form stop switch is turn on. They will not stop card feeding if the form stop switch is turned off.

RESET CHECK–The function of this switch is described under RESET CHECK LIGHT.

OPERATING FEATURES

The IBM type 407 accounting machine can perform all operations previously listed at the beginning of this chapter. Detail printing (listing) or group printing (tabulating) can be performed at the rate of 150 cards per minute.

FEED UNIT

Cards are placed in the feed hopper face down, with the 9-edge toward the throat. The capacity of the hopper is approximately 1,000 cards. Card feeding normally stops when the last card feeds from the hopper, and the start key must be depressed to run the cards remaining in the machine into the stacker.

The stacker is located above and behind the hopper (figure 9-1). A stacker stop switch (not shown) causes card feeding to stop when the stacker becomes full. Cards can be added to the hopper or taken from the stacker without stopping the machine.

Card Reading

As cards feed through the accounting machine, they pass two reading stations. The first and second reading stations are illustrated in figure 9-4. Each card stops momentarily at each reading station so that it may be ready by 960 brushes corresponding to the 960 possible punching positions in a card. Any hole punched in the card allows a corresponding brush to make contact with a metal segment and causes an electrical impulse to be emitted. This impulse is transmitted from the commutator, which rotates clockwise to the brushes in that position, causing an impulse to become available from the corresponding reading hub on the control panel. There are 80 commutators at each reading station, one for each column of the card.

Impulses from the first reading station usually are wired to selector pickups or other machine control hubs to control machine operation on the following cycle. Impulses from the second reading station normally are wired to print or to counter entries either directly or through selectors which are controlled from the first reading station.

PRINT UNIT

The function of the print unit is to record information on a report form or document. This information can be printed one line for each card (detail printing) or one line for a group of cards (group printing).

The print unit consists of 120 printwheels arranged in a solid bank that prints within a width of 12 inches, 10 characters to the inch. Each printwheel contains the 26 alphabetic characters, digits 0 through 9, and 11 special characters.

The row of printwheels is located in front of the platen (roller). At printing time they are moved against the platen. (See figure 9-5.)

A ribbon, similar to that used on typewriters, moves behind the printwheels from a spool on the right, through the ribbon guides, to a spool on the left. When the right spool is completely unwound, the action is automatically reversed.

CARRIAGE FEATURES

Several of the carriage operating features can be seen by reference to figure 9-5.

When the PLATEN CLUTCH KNOB is pointed upward, the platen is engaged so that automatic line spacing and skipping can be accomplished. When the platen is engaged, it can be rotated manually only by turning the VERNIER KNOB. The primary purpose of the vernier knob is to provide a means of obtaining the correct printing position between lines when

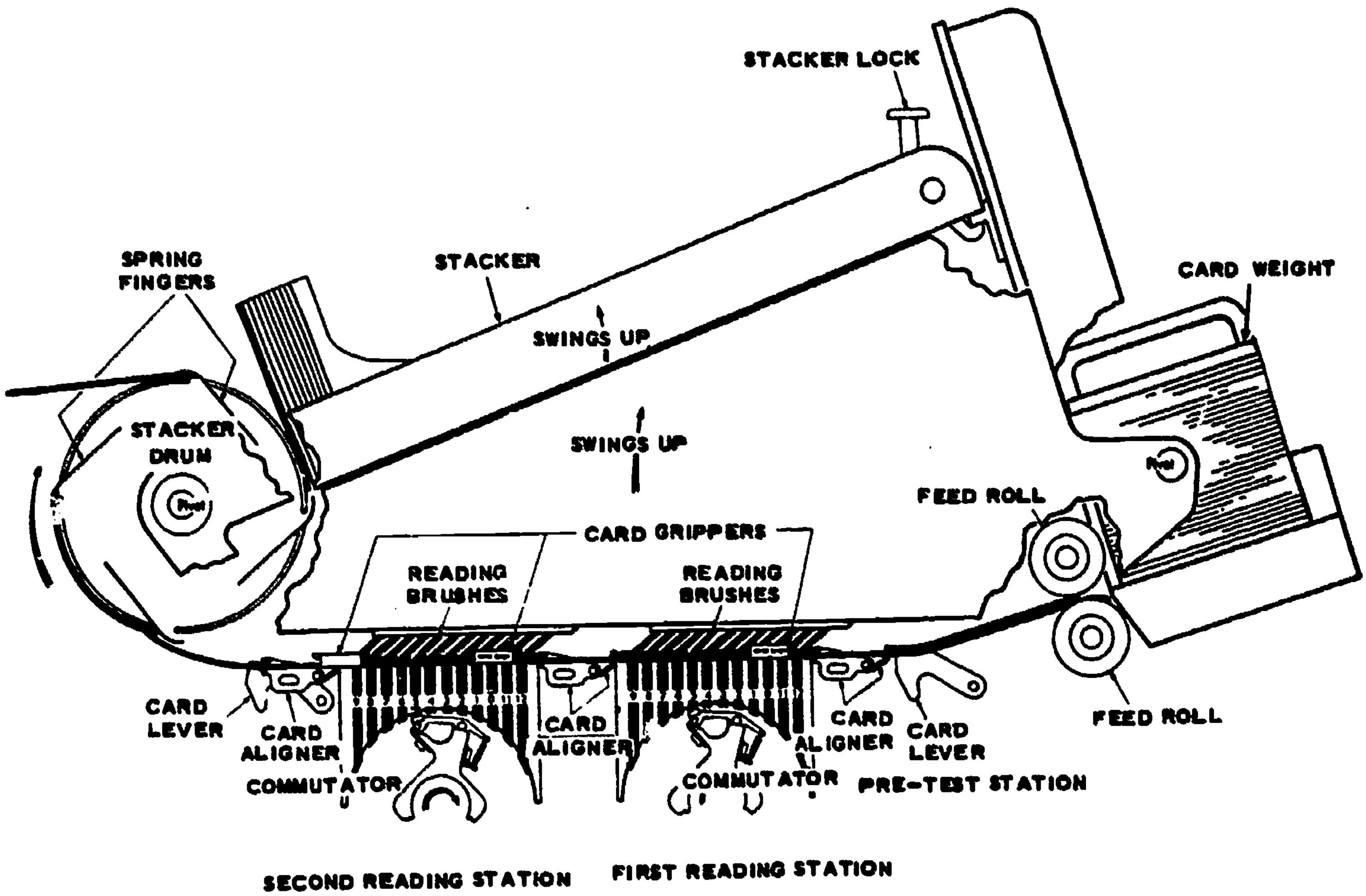

Figure 9-4.—Card feed schematic.

ruled forms are being used. The platen can be disengaged by turning the platen clutch knob to the right. The platen can then be turned manually by rotating the PLATEN KNOB in order to position the form at the desired printing line.

The RESTORE KEY must be depressed before an operation is started in order to set the carriage tape for the first printing line (home position) on the form. The platen should be disengaged when the restore key is depressed if skipping from one form to another is not desired.

When the STOP KEY is depressed, carriage operation stops immediately and card feeding stops at the end of the cycle. It should be used only to stop undesired carriage skipping or for setting up for an operation and should not be used to stop card feeding.

The SPACE KEY can be depressed when the accounting machine is stopped and the platen clutch is engaged, to advance a form one line for each key depression.

The following features can be located in figure 9-6.

Outfold Guide Bar

The outfold guide bar fits across the front of the forms tractor. It is spring loaded for easy removal prior to inserting forms. When the forms are properly positioned the bar must be replaced to insure smooth form feeding.

Form Thickness Adjustment

The distance between the printwheels and the platen can be increased or decreased, depending

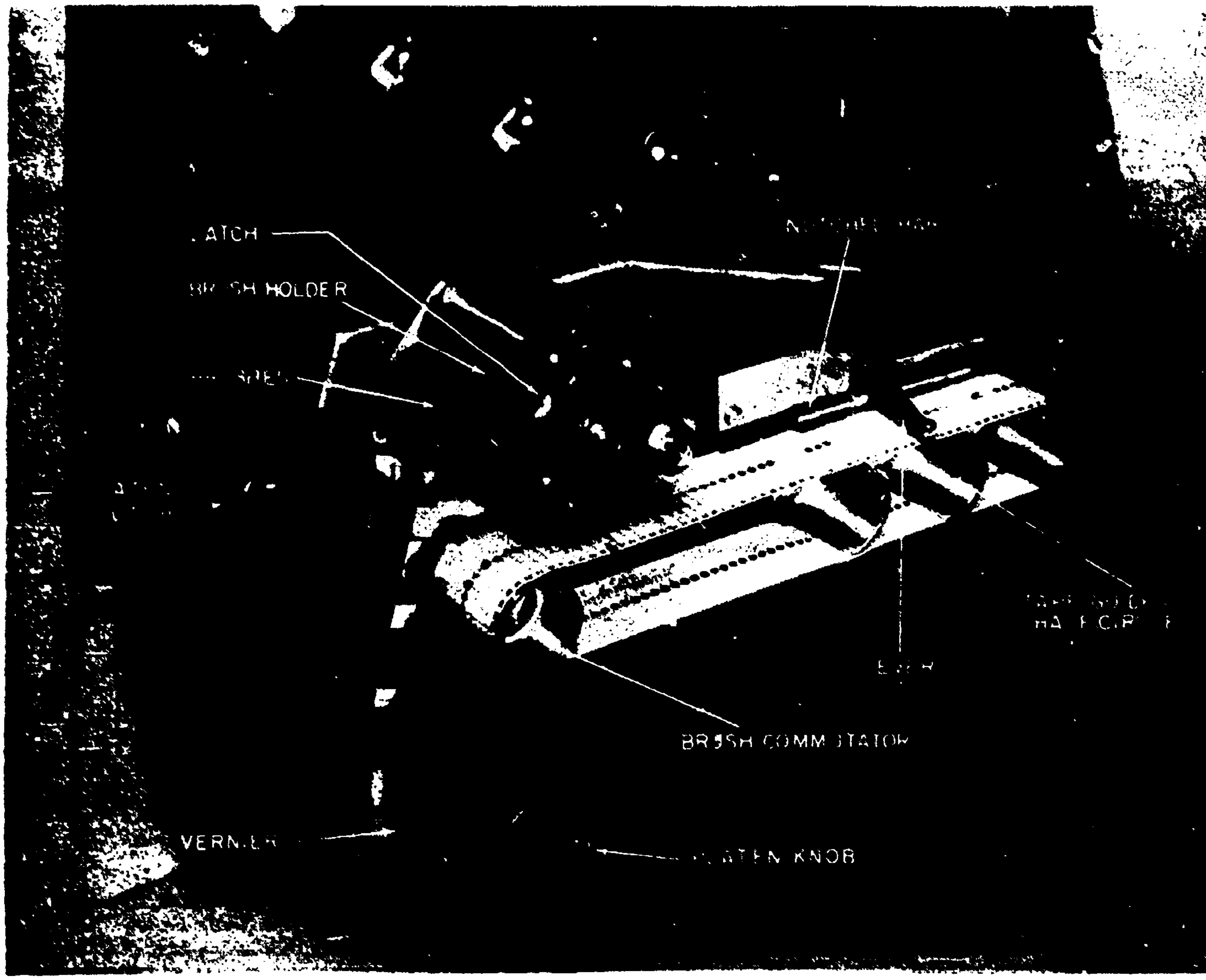

Figure 9-5.—Carriage tape controls. R49.117X

upon the number of copies in the report being prepared. The form thickness adjustment dial, located at the left end of the carriage, contains seven positions numbered 0 through 6. It should be set at the position where best printing results are obtained.

Pressure Release Lever

The pressure release lever is set in the forward position when a form feeding device is not used, so that pressure is applied to the paper by the form feed wheels to cause proper form feeding. When a form feeding device is used, this lever must be pushed back so that the feed rolls are released and the paper can be moved freely around the platen.

End-of-Form Stop

When a form is inserted in the carriage, it passes under a set of end-of-form stop levers. These levers drop into slots in the carriage when the bottom edge of the last form passes by them and cause card feeding to stop, provided the form-stop toggle switch is turned on. They will not stop card feeding if the form-stop toggle switch is turned off.

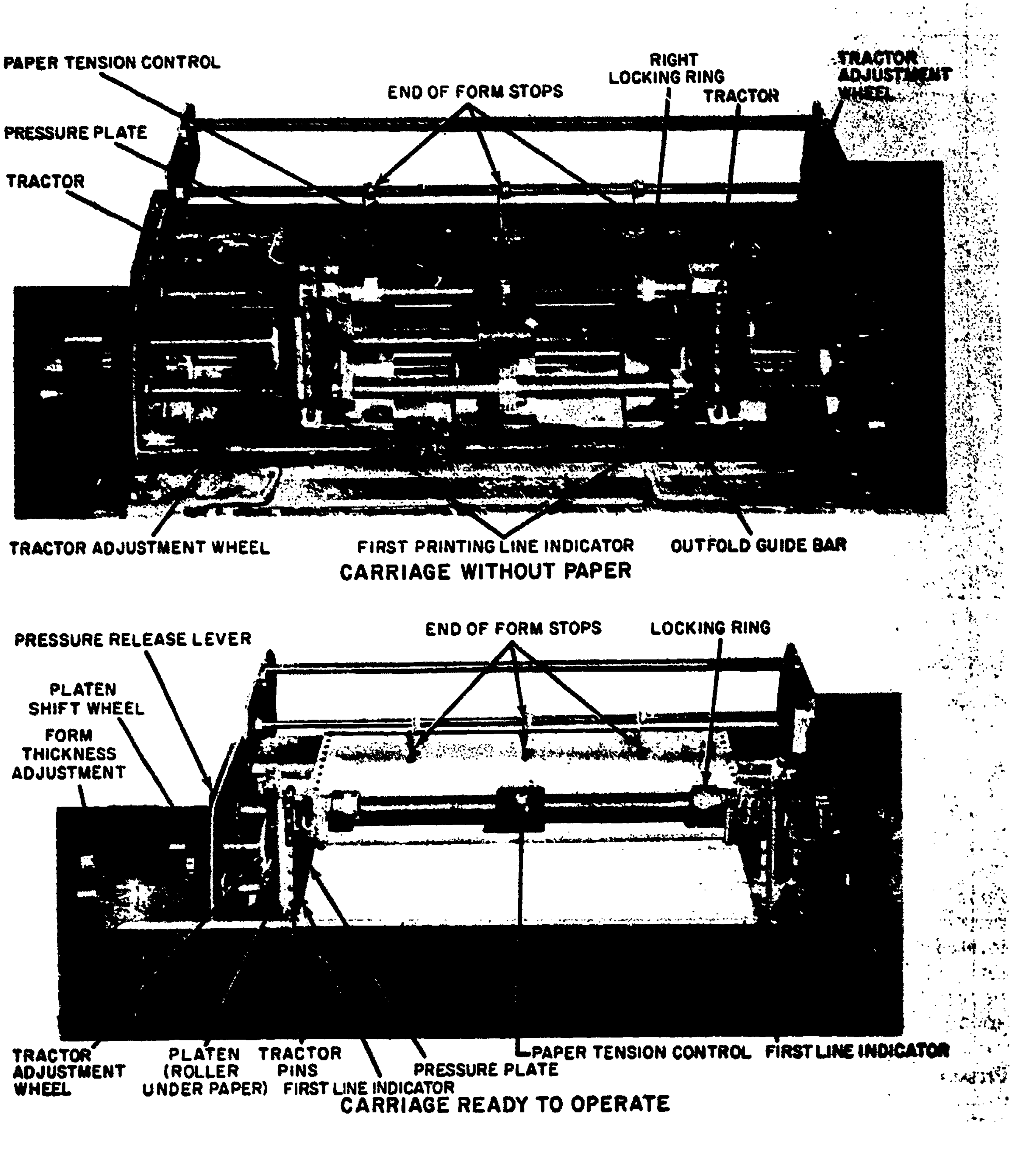

Figure 9-6.—Carriage paper controls.

BEST COPY AVAILABLE

Platen Shift Wheel

The platen shift wheel can be rotated to shift the platen, either right or left, a total of four inches. It is used primarily to align a form so that printing will occur in the desired space across the form. This wheel can be turned while the machine is in operation.

TAPE CONTROLLED CARRIAGE

Automatic feeding and spacing of continuous forms used for preparing reports on the accounting machine are made possible by the tape controlled carriage mounted atop the machine. A forms tractor is used for feeding marginally punched continuous forms. It has two adjustable tractor-type pin feed units, one for each side of the form. The standard forms tractor provides spacing of either six or eight lines to the inch.

This carriage is controlled by punches in a narrow paper tape which is inserted in the carriage. The tape corresponds to the exact length of one or more forms, and is punched with holes which are generally used to stop the form after it has skipped to a predetermined line on the form and to skip from one form to another.

CARRIAGE TAPE

The installed carriage control tape is shown in figure 9-5. Figure 9-7 is a closeup showing the tape characteristics.

The round holes in the center of the tape are prepunched for the pin feed drive that advances the tape as the printed form moves through the carriage. The numbered horizontal lines correspond to the printing lines on a form when six lines to the inch are printed. There are 12 punching positions, represented by numbered vertical lines, to control the skipping and overflow of forms. These punching positions are called channels.

The punches by themselves do not control the carriage but must be present to allow proper control panel wiring.

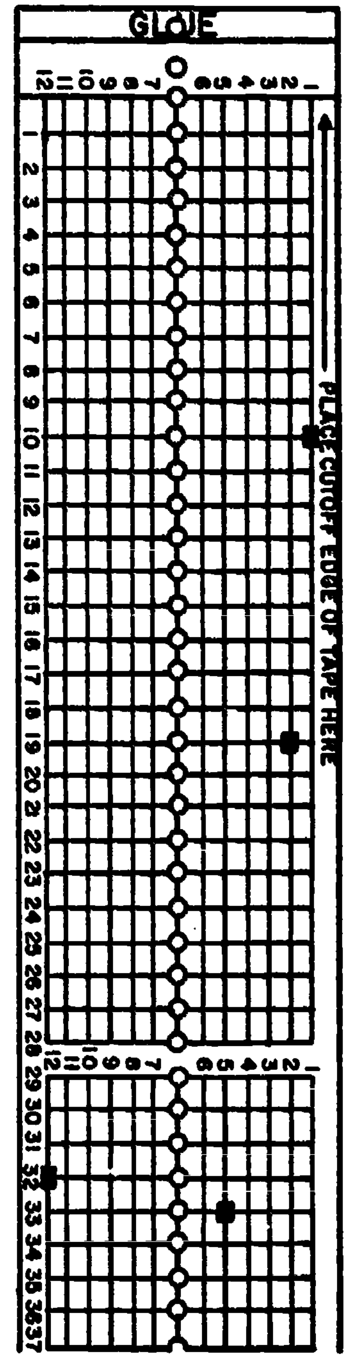

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Figure 9-7.—Control tape.

Tape Channels

The channel punch uses are explained as follows:

CHANNEL 1—A punch is placed in channel 1 to indicate the starting position for the first printing line of each page. When overflow

(channel 12) is detected through control panel wiring, the carriage tape will advance the paper until channel 1 is detected.

For report setup the restore key is depressed to ensure the carriage tape is initially positioned at channel 1.

CHANNELS 2-10–These positions are used to indicate stopping positions for printing positions other than the first line. They may be used to identify the first body line when two-part (heading and body) forms are used. Any class of total can be printed on a predetermined line by starting a skip when program start is initiated and stopping the skip by a punch in one of these channels. Single sheet forms can be processed through the carriage and ejected automatically when printing is completed. These channels can be used for many other functions in which skipping between the first and last printing lines is desired.

CHANNEL 11–Channel 11 is normally used for selective spacing operations.

CHANNEL 12–Skipping can be controlled so that when one form is completely filled, the next form advances to the first printing or body line. This overflow skipping is started by a punch in channel 12. Unlike punching in other channels, which are used to stop skipping, the punch in channel 12 is used to start a skip. When the punch in channel 12 is sensed by a tape reading brush during normal spacing, card feeding stops and skipping starts, if the control panel is properly wired.

PRINCIPLES OF CONTROL PANEL WIRING

Automatic operation of the accounting machine is made possible by the control panel illustrated by the diagram in figure 9-8. A universal control panel is used with the 407, 408 and 409 machines. The hubs with the heaviest outlines are used for the 408 and 409 only; the hubs outlined with cross-hatching are used for the 409 only. Shaded areas represent special devices or optional features. Operations described herein are limited to those features standard for the type 407.

There are many operations that can be performed on the type 407 accounting machine and several different ways to wire the control panel to obtain the desired results. The following paragraphs describe some typical applications with descriptive control panel wiring.

DETAIL PRINTING

Detail printing is the operation of LISTING each and every card that is read. The groups of hubs to be used for this operation are explained as follows:

SECOND READING–These hubs represent the 80 brushes that read the card at the second station. They appear at two locations on the control panel for convenience in wiring. The upper set of hubs is normally wired to COMPARING ENTRY. The lower set of hubs is normally wired to COUNTER ENTRY, and NORMAL or TRANSFER PRINT ENTRY.

NORMAL PRINT ENTRY–The 120 NORMAL PRINT ENTRY hubs are one of three sets of entries to the print wheels. Normally they are wired from SECOND READING to print either numerical or alphabetic information.

O-FLOW–Detail to Detail Normal. These hubs emit an impulse as the last body line of a form is printed. The last body line of a form is determined by a punch in channel 12 of the tape. If heading cards are used, these hubs normally are wired to the first body line carriage skip hubs. Without heading cards, these hubs are wired to skip to the first line of the next form.

CARRIAGE SKIPS, X, D, and IMMEDIATE–These hubs correspond to channels 1 to 10 on the tape. They receive impulses to initiate skips that are to be stopped by holes in the corresponding channels of the tape. The X hubs accept 11, 12, or skip control impulses and the D hubs accept any impulse to cause skipping on the following cycle. The I hubs accept CYCLE or skip control (SKIP CTRL) impulses to cause skipping on the same cycle.

When the X or D hubs are impulsed and a total intervenes, skipping takes place after the total prints. When the I hubs are impulsed and a total intervenes, skipping takes place before the total prints. When the X or D hubs are impulsed during program cycles, the skip will not become effective until after all program cycles are completed.

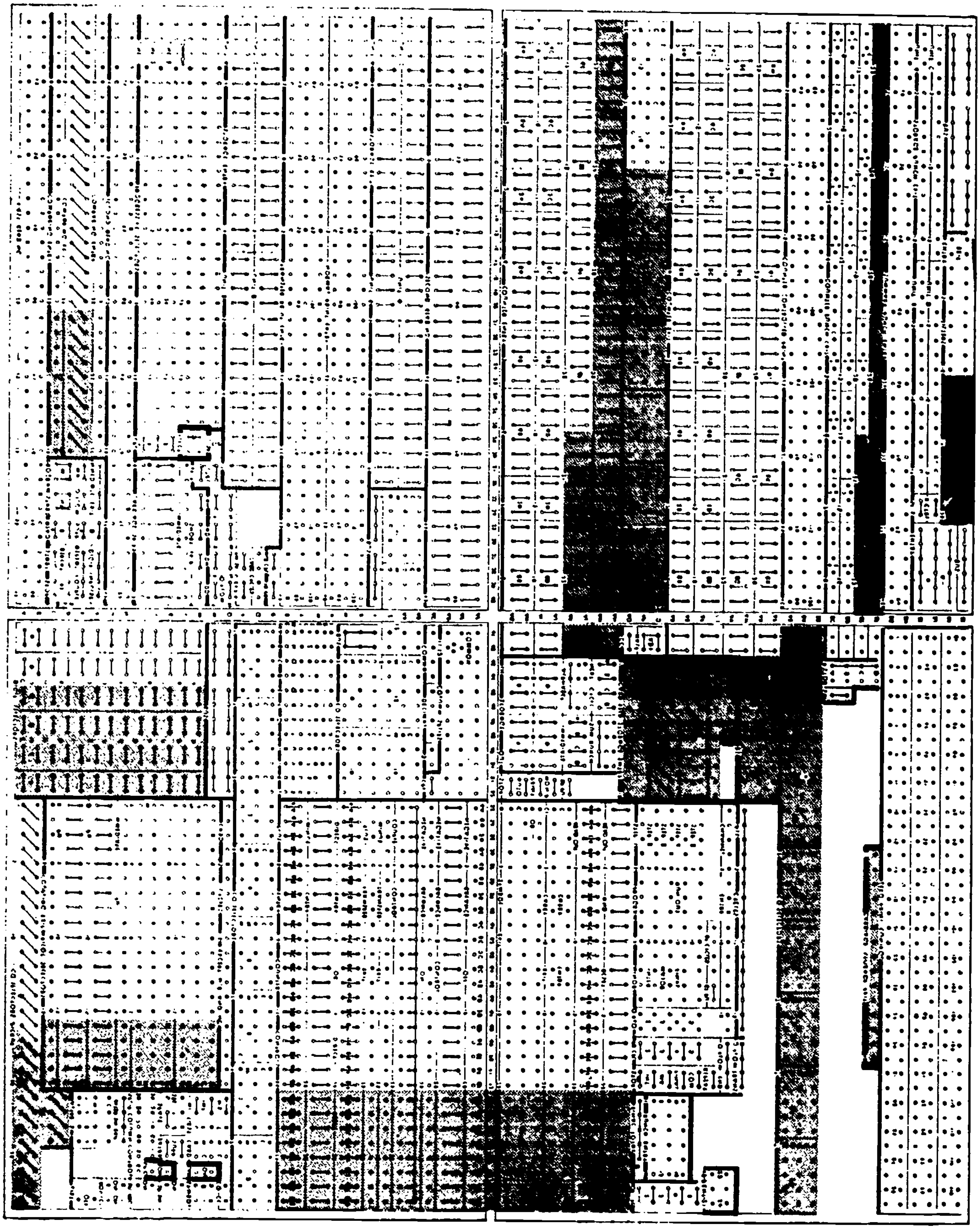

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Figure 9-8.—Type 407 control panel.

Channel 1 must be used to identify the first printing line, and channel 12, the overflow line.

SPACE 1-2–SPACE 1 hubs are connected for single spacing, and SPACE 2 hubs, for double spacing. These hubs stop rather than cause spacing, for an automatic space is initiated before each line prints. These hubs may be selected so that single or double spacing may be placed under the control of a specific punch in the card.

LIST–When the switch is off, the machine group prints. When the switch is not wired, the machine detail prints. The lower hub may be impulsed by a cycle impulse wired through selectors to control detail and group printing.

RO (Run Out)–When the run out switch is on, the last card in the machine runs out automatically into the stacker. When the switch is not wired, the last card must be run out into the stacker by pressing the start key.

ZERO PRINT CONTROL–Each printwheel has a pair of ZERO PRINT CONTROL hubs. They are jackplugged to print zeros to the right of significant digits. The high-order position of a field is always left unplugged. To print zeros, zero impulses must be received by the printwheel either from a card, from counter or from an emitter. A maximum of eight zeros may be controlled to print to the left or right (or four on each side) of a significant digit, or for zero balances. The ZERO PRINT CONTROL hubs also control the printing of commas, decimals, and dollar signs as they do zeros, when these symbols are wired to PRINT ENTRY from the COMMA, DECIMAL, and DOLLAR hubs located immediately above the column splits.

The wiring diagram for detail printing (figure 9-9) is for listing one alphabetic field (cc 1-10) and two numeric fields.

1. Space 1 is wired to provide a single spaced listing.
2. O FLOW is wired to detect a channel 12 punch in the carriage tape. The impulse is delivered to the carriage skip control hub D1, which will stop skipping when channel 1 is detected.
3. The numeric field of columns 15 through 21 is wired to normal print. The field is controlled to print all zeros appearing after the first significant digit.
4. The numeric field of columns 27 through 34 is wired to normal print. This field is zero print controlled to force zero printing to the left of a significant digit.
5. The runout feature is wired ON to provide automatic last card runout. This should not be wired if any arithmetic or program control operations are to be performed. As the machine could be left unattended, a runout before the file is finished could result in the whole job being rerun.
6. The list switch is left unwired to allow printing for each card.

SELECTIVE PRINTING

Selective printing is the detail printing of two or more different card formats in one file. This involves "X" punched cards for control of print entries and/or selectors. Review of pilot selectors and digit selectors in chapter 5 is recommended.

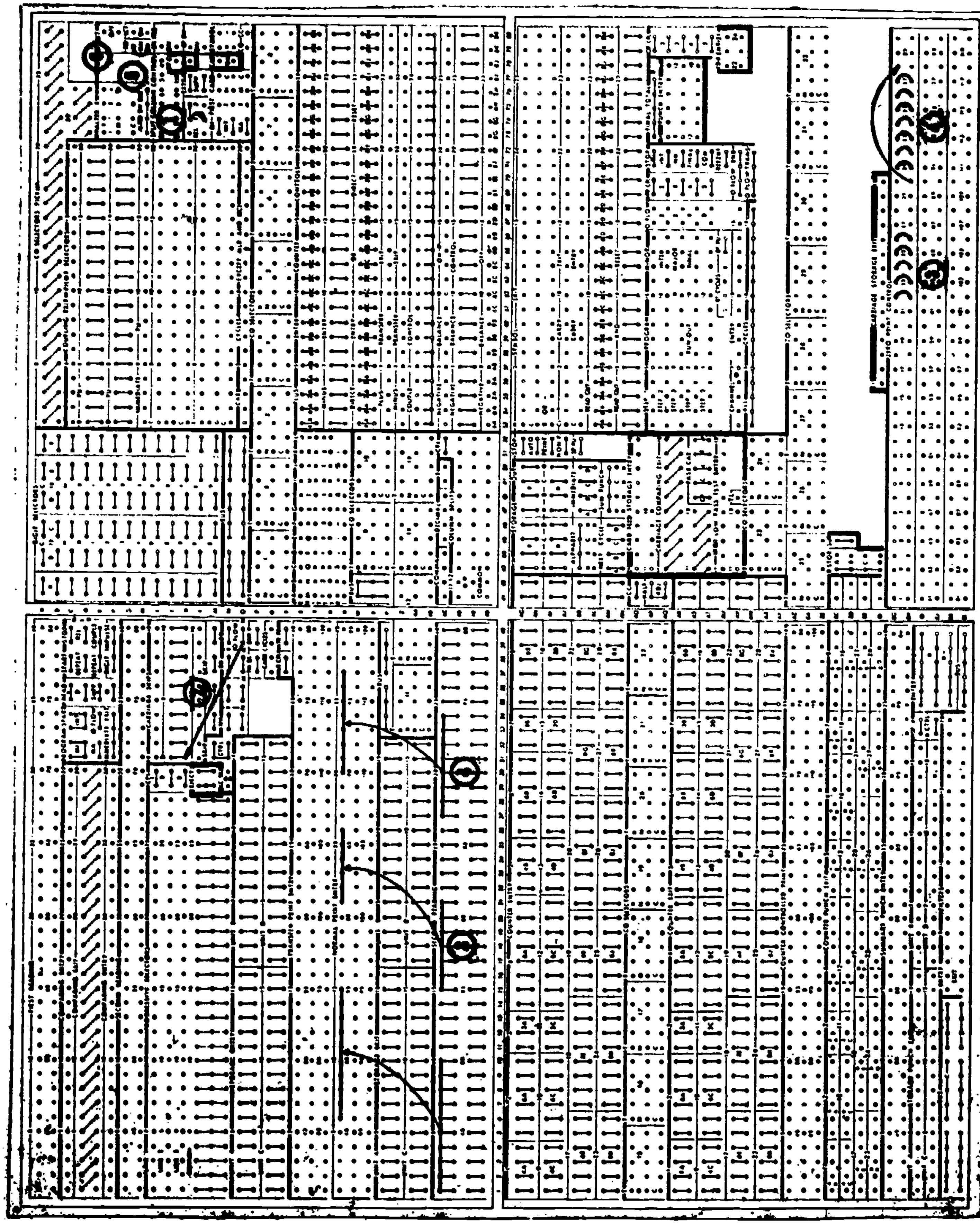
The hubs to be used in addition to those of the preceding operation are explained as follows:

FIRST READING–These hubs represent the 80 brushes that read the card at the first station. They are wired principally to COMPARING ENTRY, digit selectors, pilot and co-selector pickup and X or D carriage skips.

DIGIT SELECTORS–Two DIGIT SELECTORS, A and B, are standard. These selectors are used to select specific digits from a card column or to emit digits on every machine cycle. The C hub is impulsed from a reading station if a specific digit is to be selected or from DIGIT IMPULSE if the selector is to be used as an emitter.

PILOT SELECTORS–Fifteen pilot selectors are standard. Each selector has two positions arranged vertically and an X, D and IMMEDIATE pickup. When the X or D hubs are impulsed, the selector transfers on the following card or program cycle.

When X or D hubs are impulsed during a program cycle, the selector transfers on the following cycle and remains transferred for all remaining program cycles through the first card of the following group.



49.426

Figure 9-9.—Detail printing.

When the I hubs are impulsed, the selector transfers immediately. When I is impulsed during a program cycle, the selector transfers immediately and remains transferred for all program cycles and through the first card of the following group: When the I hub is impulsed on a card cycle it transfers immediately for the duration of that card cycle only.

Each selector also has a COUPLING EXIT which emits an impulse when the selector transfers and continues to emit as long as the selector remains transferred. It is normally wired to a CO-SELECTOR PICKUP.

CO-SELECTOR PICKUP–These are the pickup hubs for the co-selectors. When impulsed, they cause the co-selector to transfer immediately. They are normally wired from PILOT SELECTOR COUPLING EXIT or from program steps.

CARD CYCLES–These 20 hubs emit a cycle control impulse on card feed cycles for controlling entry into and printing from counters. This impulse starts before the 9 position in the card is read, and it continues until all adding into counters has been completed. These hubs are not active for program cycles.

There are four more hubs located at Q37-40 and two CO-CC (079-80) which are short impulses used to pickup co-selectors.

CHARACTER EMITTER–All letters, digits and special characters are emitted from the character EMITTER on each machine cycle. Usually they are wired through selectors to NORMAL or TRANSFER PRINT ENTRY or to COUNTER ENTRY (numbers only).

TRANSFER PRINT ENTRY–The 120 TRANSFER PRINT ENTRY hubs are one of three sets of entries to the printwheels. Like the transferred hubs of a selector, these hubs accept impulses only when they are made active by a cycle control impulse reaching TR PR.

TR PR (Transfer Print)–These common hubs represent the pickup for the 120-position TRANSFER PRINT ENTRY unit. These hubs are normally wired from cycles impulses. The transfer print unit remains transferred only for the duration of the impulse wired to TR PR.

The wiring diagram for selective printing (figure 9-10) is for selecting one of three card formats for detail printing. The card types are X/80, X/75 and NX. The X/75 cards differ from the NX cards only in the location of the first field. This job also depicts emitting of a date (20 NOV 1972) by combining two different methods of emitting.

1. The X/80 card format is wired to transfer print.
2. The X/80 cards are detected from first reading, and the impulse is delivered to the X pickup of a pilot selector.
3. One card cycle after being impulsed, the pilot selector will transfer and allow a card cycle impulse to activate the transfer print. This provides the transfer print as the active print entry when the X/80 card is at second reading.
4. The one field that differs between the X/75 and NX cards is field selected through co-selector 15 and 16. The other fields are straight wired to normal print which is active when transfer print is not.
5. Co-selectors 15 and 16 are controlled by detection of an X or NX in column 75 from first reading. When the pilot selector transfers, the coupling exit causes transfer of the co-selectors.
6. This wiring would allow the same control as the coupling exit.
7. The emitter hubs are utilized to cause printing of part of the date (20 NOV).
8. A digit impulse is wired into the common hub of digit selector A, allowing it to be used as an emitter for the last part of the date (1972). (All of the emitting could have been accomplished by either method 7 or 8.)

PROGRAM CONTROL

Before we go any farther, let's see what is meant by programming on accounting machines. Programming in a machine is a sequence of activities, or, to use machine terms, operations. The operations to be performed, and their sequence, are determined by control-panel wiring. Actually, a series of machine cycles is set aside for this purpose. These machine cycles are generally called PROGRAM CYCLES, PROGRAM STEPS, or TOTAL CYCLES.

Program control is the process by which the 407 distinguishes cards of one classification from those of another. The cards in a single classification are considered a program group.

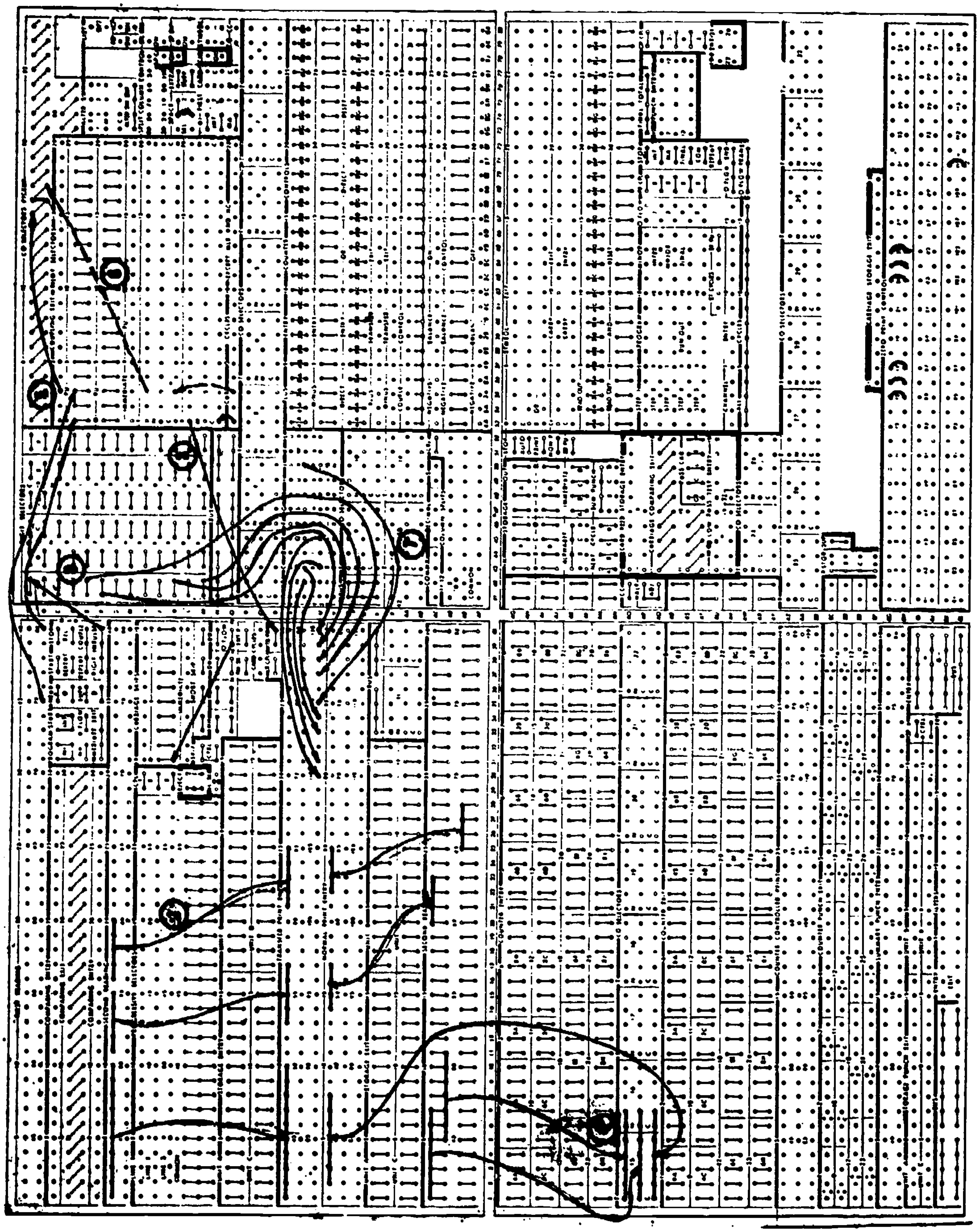


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Figure 9-10.—X and NX detail printing.

The machine can compare, by means of the first and second reading stations, the holes punched in two successive cards. Therefore, each card is compared twice as it passes through the machine, once with the card ahead of it and once with the card following it. When the punching in one card does not compare with the punching in the card ahead of it, the machine automatically starts a program cycle if the control panel is wired properly.

Three types of automatic totals can be obtained on the 407 and are classified as follows:

1. Minor–Program level 1
2. Intermediate–Program level 2
3. Major–Program level 3

A minor program is used for the classification of the smallest group, intermediate program for the next group and major program for the largest group.

Comparison is accomplished by wiring the control field from first reading to one set of comparing entry hubs and from second reading to the corresponding positions in the other set. The hubs used for wiring comparing can be located by reference to figure 9-11A. An impulse is emitted from the comparing exit hub of each comparing position that recognizes a difference in card comparing.

When a control field consisting of more than one column is wired for comparing, the comparing exit hubs of all comparing positions are jackplugged so that an unequal condition recognized in any column can travel through the jackplugs and be available from one source.

A comparing magnet can be impulsed once while the 9-1 punching positons are being read and again for the 11-12 zone positions, making it possible to compare alphabetic as well as numerical data. Zero punches are treated as blank since comparing is not effective for zeros.

Comparing exits are usually wired to one of the program start hubs to cause a program cycle to be started in order to print automatic totals for that particular program. Comparing exits can be used also for other functions such as skipping to a new page when a change in control group is recognized.

A program cycle for each type of total is started by wiring a comparing exit from a control field wired for comparing to the appropriate PROGRAM START hub (fig. 9-11B).

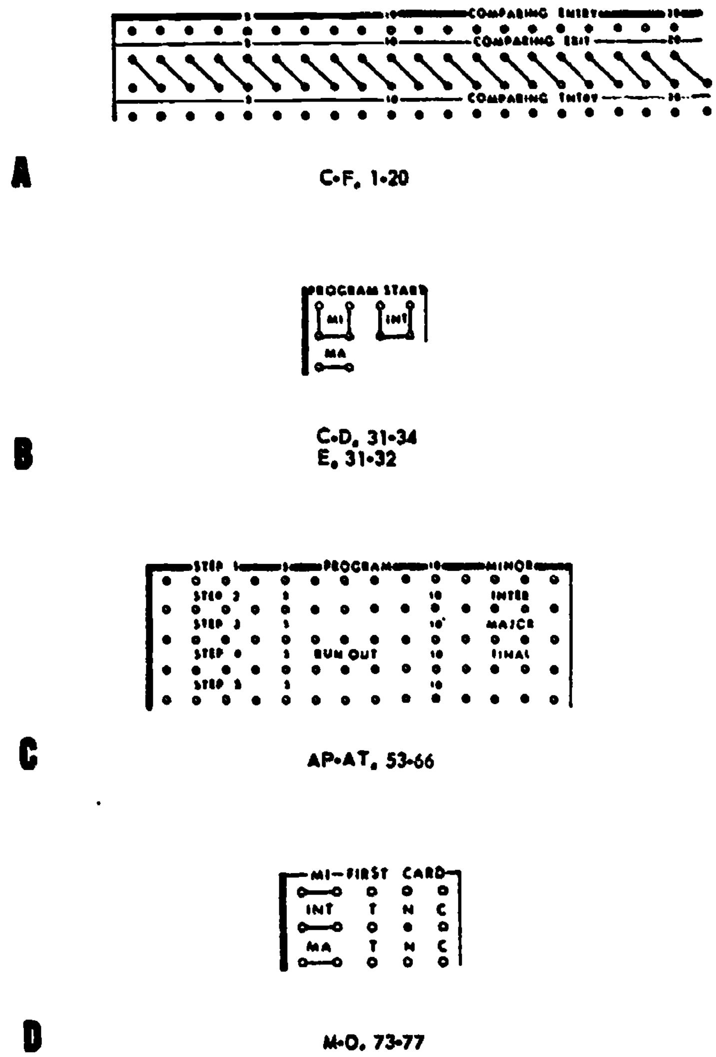

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Figure 9-11.–Program control hubs.

Each program step has 14 PROGRAM EXIT hubs shown in figure 9-11C that emit an all cycles impulse whenever the corresponding PROGRAM START is impulsed. Counters normally read out and reset under the control of the PROGRAM EXITS.

If program start major is impulsed but minor and intermediate are not, minor and intermediate program cycles are forced before the major. If program start intermediate is impulsed but minor is not, a minor program is forced before the intermediate.

Card feeding stops when a program start is initiated and resumes automatically upon completion of the required number of total cycles.

By reference to figure 9-11D you will notice a group of FIRST CARD hubs. The common hubs on the left, labeled MINOR, INTERMEDIATE, and MAJOR, emit an impulse for the first print cycle of the first card of their respective group, regardless of whether that card is a heading or detail card. FIRST CARD hubs are normally wired to cause a counter to add or subtract the first card of a group, to control transfer print entry or to control a co-selector.

Each first card hub has a first card selector which transfers automatically when the corresponding first card hub is active and remains normal at all other times. These selectors can be used to select card cycle impulses, cycle count impulses or single card columns to be group indicated.

Figure 9-12 is diagrammed for printing master and detail cards that have no distinguishing control punch. Department code number is punched in columns 1-5 of the cards with column 5 having a different code for each division within a department.

10000	Department Code
10001	Division code
10002	Division code–change
10002	
10010	Department code–change

1. Columns 1-4 are wired for comparing of department code from first and second reading.
2. Column 5 is wired for comparing the division code from first and second reading.
3. If a comparing difference is detected in department code, program cycles of minor and intermediate will be started (card feeding and reading do not occur during program cycles).
4. If a comparing difference in division code is detected, a minor program cycle will be started.
5. After the two program cycles have occurred, the card causing the comparing difference moves from first to second reading. At this time the selector for INT FIRST CARD is transferred and allows the card cycles impulse to reach the transfer print pickup hub.
6. The columns desired to print for a department (master card) are wired to transfer print which is active for the first card of an intermediate group.
7. The MI FIRST CARD is wired to coselector pickup 15. Columns 1-5 are wired directly to transfer print to print the department code for each master card. Columns 1-5 are also to print for the detail cards BUT ONLY the first one for each division group.

The MI FIRST CARD impulse provides transfer of the selector and normal printing for only the first card of each minor change. When repetitive data is printed only once for a group of cards, it is called GROUP INDICATION.

NOTE: First card minor indication occurs following a minor, intermediate and major change. Intermediate first card is active following an intermediate or major change. They all occur at once, however, and not in series (as do program cycles); therefore, even though columns 1-5 are allowed to reach normal print, normal print is not active because transfer print is impulsed from INT FIRST CARD and is the active print entry.

8. Normal print is wired for the detail card fields to be printed from second reading.

9. The INT FIRST CARD impulse is wired to the I pickup of a pilot selector. This causes space control to allow double spacing after the printing of a master card and single spacing for details. This wiring allows the master card printing to be spaced apart from the preceding and forthcoming detail printing.

NOTE: Automatic single spacing is provided for each program cycle taken. Therefore, the last minor card will be printed, then two spaces taken (MI and INT) before printing a master card.

Figure 9-13 is an example of the listing that the preceding wiring would provide.

ARITHMETIC OPERATIONS

The 407 is capable of performing two arithmetic functions, addition and subtraction. The units provided to accomplish these functions are called COUNTERS. There may be from 20 to 28

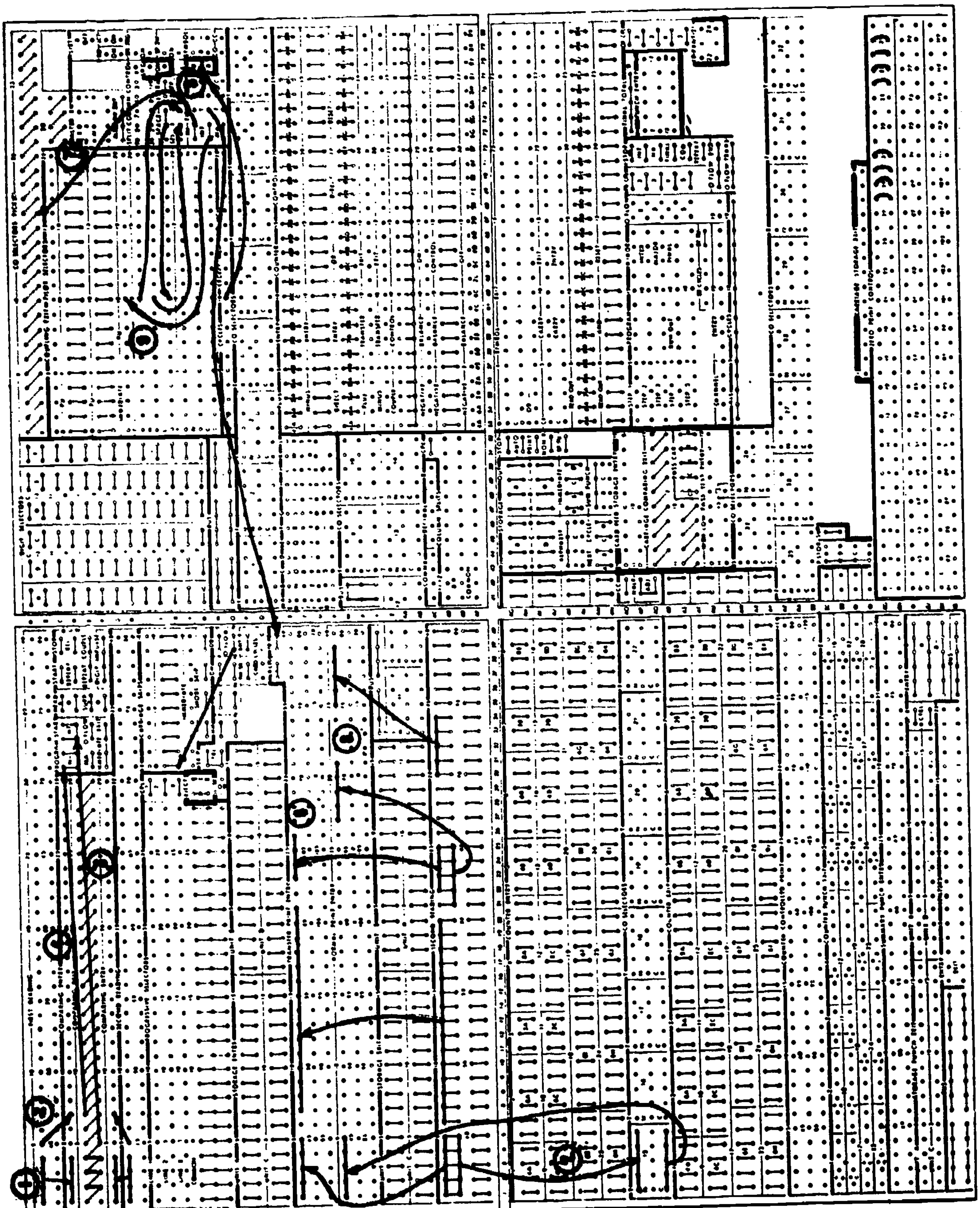

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Figure 9-12.—Program control printing.

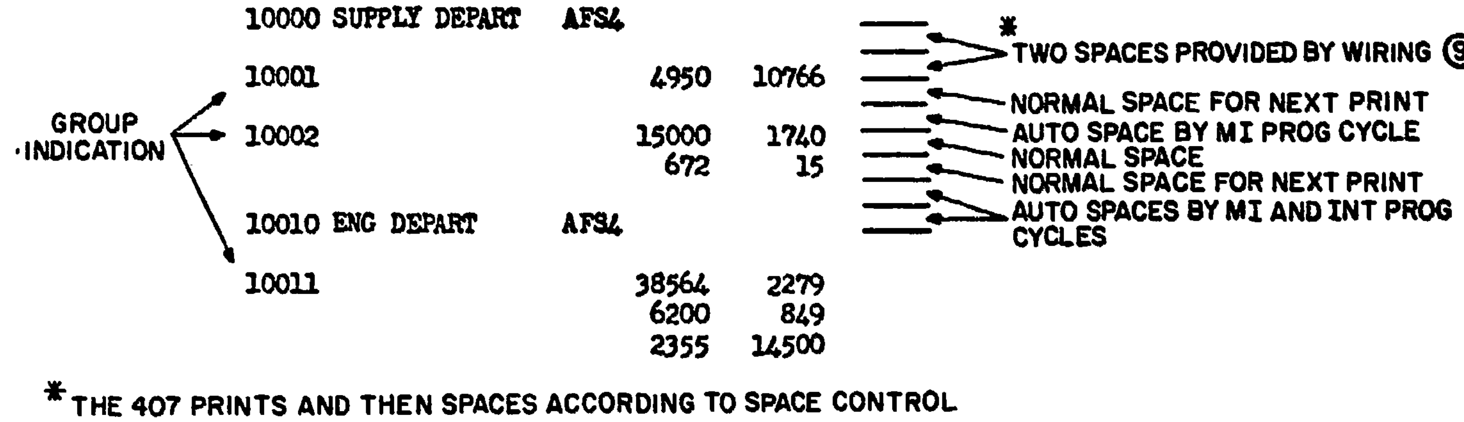

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Figure 9-13.—Program control listing.

various capacity counter units, depending on the machine model and/or options. The counter units vary in position size. There are 3, 4, 6 and 8 position counters provided. Each of these positions has a separate entry within each counter unit. Each position of a counter also has an exit. Each counter has one set of controls to direct the function of addition or subtraction and control the mechanics of operation.

The hubs used in connection with entry, exit and control of counters are explained as follows:

COUNTER ENTRY—These counter positions are arranged in convenient groups of 4, 6, 3 and 8 positions. COUNTER ENTRIES are normally wired from SECOND READING for the purpose of adding, subtracting or group-indicating information read from the card. The entry of every counter group is internally connected to the corresponding COUNTER EXIT positions unless DIRECT ENTRY for that counter group is wired. These hubs are receptive on the first half of the cycle only.

COUNTER EXITS—Counter exits emit impulses for information that is detail or total-printed from the counter. To detail-print the counter must be impulsed to add or subtract, at which time COUNTER ENTRIES are internally connected to COUNTER EXITS. To total-print the counter must be read out and reset, and the exits must be wired to COUNTER-CONTROLLED PRINT. COUNTER EXITS do not emit impulses when the counter is impulsed to DIRECT ENTRY at which time they are internally disconnected from COUNTER ENTRY. Also, COUNTER EXITS do not emit impulses when DIRECT RESET is wired.

COUNTER-CONTROLLED PRINT—These hubs are one of three sets of entries to the printwheels, the other two being NORMAL and TRANSFER PRINT ENTRY. Normally they are wired from COUNTER EXITS, receiving the information from the counter during the first half of the cycle and returning it to the counter during the second half of the cycle. The printwheels are set up for printing during the first half of the cycle. If the counter is wired to reset, the returned information during the second half of the cycle either adds or subtracts in the counter to reach a zero balance, thus affording a check between the amounts printed on a report and the amount accumulated in the counter.

These hubs provide the only means by which a counter may be reset as the total is printed because counter clearing is done in the second half of the cycle. Counter exit positions containing significant digits must be wired to COUNTER-CONTROLLED PRINT in order to reset.

Alphabetic or special character information cannot be wired to COUNTER-CONTROLLED

PRINT because these hubs do not accept zone impulses.

COUNTER CONTROL PLUS–A CARD CYCLE, ALL CYCLE, PROGRAM or FIRST CARD impulse introduced into these hubs will cause the corresponding counter to add. TRANSFER EXIT PLUS is also wired to COUNTER CONTROL PLUS when positive information is being trnasferred from another counter.

COUNTER CONTROL MINUS–A CARD CYCLE, ALL CYCLES, PROGRAM or FIRST CARD impulse introduced into these hubs will cause the corresponding counter to subtract. TRANSFER EXIT MINUS is also wired to COUNTER CONTROL MINUS when minus information is being transferred from another counter. When the minus hubs are impulsed, both the C and R or –hubs for the corresponding counter are active.

DIRECT ENTRY OR DIRECT RESET–These are DIRECT ENTRY hubs when the same impulse is wired to them that is also wired to the corresponding PLUS or MINUS hubs. An impulse to DIRECT ENTRY separates the COUNTER ENTRY from the COUNTER EXIT. The information wired to the COUNTER ENTRY hubs will enter the counter directly from the card rather than from the COUNTER-CONTROLLED PRINT hubs. When DIRECT ENTRY is wired, no printing occurs. It is normally used during group printing operations to prevent overprinting and when transferring from another counter information that is not to be printed.

These are DIRECT RESET hubs when the same impulse is wired to them that is also wired to the corresponding READ-OUT and RESET hubs. An impulse to DIRECT RESET causes the total to clear out of the counter without reading out of the COUNTER EXIT hubs. A counter is normally wired for DIRECT RESET whenever the counter is to be cleared without printing the total. Totals cannot be transferred from one counter to another when DIRECT RESET is wired.

TRANSFER PLUS-MINUS EXIT–The TRANSFER PLUS EXIT hubs emit an impulse when the corresponding counter READ-OUT and RESET hubs are impulsed and the counter is plus. They are wired to the PLUS ENTRY of another (receiving) counter.

The TRANSFER MINUS EXIT hubs emit an impulse when the corresponding counter READ-OUT and RESET hubs are impulsed and the counter is minus or zero. They are wired to the MINUS ENTRY of another (receiving) counter.

COUPLE CONTROL–Whenever counters are coupled, the COUPLE CONTROL hubs of all but the high-order counter must be connected. This wiring ensures that a zero test will be made in every coupled counter when NEGATIVE BALANCE is wired off and prevents the punching of credit X's from any but the high-order counter during summary-punch operations.

NEGATIVE BALANCE ON–These hubs emit an impulse at the end of the cycle during which the corresponding counter turns negative and for every cycle thereafter as long as the counter remains negative. Normally they are wired to NEGATIVE BALANCE CONTROL to convert complement figures or to the pickup of a selector to control other functions of the machine.

NEGATIVE BALANCE CONTROL–These are entry hubs wired either from NEGATIVE BALANCE ON to convert complementary results or from NEGATIVE BALANCE OFF to convert zero balance 9's to zeros.

NEGATIVE BALANCE OFF–These hubs emit an impulse at the end of the cycle during which the corresponding counter zero balances. They are wired to NEGATIVE BALANCE CONTROL to convert zero balance 9's to zeros or to selector pickup hubs to control other functions of the machine.

SYMBOL EXIT–These hubs emit the equivalent of an 8-4-11 impulse whenever the corresponding counter is impulsed to READ OUT or READ OUT and RESET. They are wired to NORMAL or TRANSFER PRINT ENTRY for the printing of asterisk symbols for totals. They cannot be wired to COUNTER-CONTROLLED PRINT because these hubs do not accept zone impulses.

C SYMBOL EXIT–These hubs emit a C (12-3) impulse whenever the corresponding counter is impulsed to subtract. They also emit a C impulse whenever the corresponding counter is negative and is impulsed to READ OUT or

READ OUT and RESET. They are wired to NORMAL or TRANSFER PRINT ENTRY in conjunction with the R hub to identify a credit item or a credit total. They cannot be wired to COUNTER-CONTROLLED PRINT.

R or - SYMBOL EXIT–If the R or - switch is wired for R, these hubs emit an R (11-9) impulse whenever the corresponding counter is impulsed to subtract or whenever that counter is impulsed to READ OUT or READ OUT and RESET a converted negative total. If the R switch is not wired or is wired for minus, these hubs emit a minus (11) impulse under the same condition as the R hubs. The R or - hubs are wired to NORMAL or TRANSFER PRINT ENTRY to identify credit items or credit totals. They cannot be wired to COUNTER-CONTROLLED PRINT.

CARRY EXIT-CARRY ENTRY–The CI and C hubs must always be connected whenever a counter is in use. This is necessary because all counters reset to 9's. When counters are coupled, the CI of the high-order counter is wired to the C of the low order counter and the remaining CI and C hubs of the group are connected from right to left.

READ OUT–These hubs accept cycle impulses to cause a counter to read out without resetting. They are normally used for progressive totalling.

READ OUT AND RESET–These hubs accept cycle impulses to cause a counter to read out and reset.

ALL CYCLES–These common hubs emit all cycles impulses on every machine cycle except summary-punch cycles or long carriage skips. They are normally used as a substitute for other cycle impulses when properly controlled.

CC (CYCLE COUNT)–The CC hub emits a 1 impulse during the first and second half of every machine cycle. Normally it is wired to COUNTER ENTRY to count cards or groups or cards or to PROGRAM START to cause one or more programs to be initiated for every card.

Figure 9-14 depicts a wiring diagram to accomplish accumulation of three totals. The first total is arrived at by the addition of the data in card columns 3-5. The second total results from adding or subtracting the data from card columns 10-14. The third total is a card count.

1. Counter 4A is impulsed to add for every card cycle. Only addition is to be accomplished; therefore, NEGATIVE BALANCE OFF is wired to NEGATIVE BALANCE CONTROL. As the counters originally are set at all 9's instead of zero, the CI hub must always be wired to the C hub. If CI is not wired to C, the total will be one less than the true total.

2. Counter 6C is controlled to add or subtract by selecting the card cycles impulse by an X or NX/80 indication. As there is a chance that the counter will hold a negative amount, the NEGATIVE BALANCE ON is wired to NEGATIVE BALANCE CONTROL to ensure that the printout is a true figure. (Counters work with what is referred to as 9's complement. It is not necessary that you understand this process to accomplish proper board wiring.) The CI is wired to C for the same reason as counter 4A.

3. Counter 4D is controlled to add for every card cycle. The machine emitted 1 impulse (CC) is wired to the counter entry of 4D.

4. The DIRECT ENTRY HUB of counter 4D is also impulsed by every card cycle. This wiring suppresses the print of the 1 for each line of print. An internal connection normally exists between counter entries and exits which allows the read impulses to travel to COUNTER CONTROL PRINT. The impulsing of a direct entry hub eliminates the connection and thus disallows the normal printing for data wired to that counter. The data will still be added.

5. STEP 4 of the program cycle hubs (FINAL) is wired to cause the counter to READ OUT (print the accumulated total) and RESET (cleared of the total and set to 9's).

6. The impulse from the FINAL cycle hub will be generated only if the LCT (Last Card Total) switch is wired, the FINAL TOTAL toggle switch (figure 9-3) is ON and the operator does the following:

When the last card has been read, the machine will stop. The operator then depresses the START key to run the cards out of the machine. Once the machine is clear of cards the wiring will force a final total.

If the RO switch had been wired no operator action would be required.

NOTE: All exit hubs of used counters MUST be wired for all arithmetic functions.

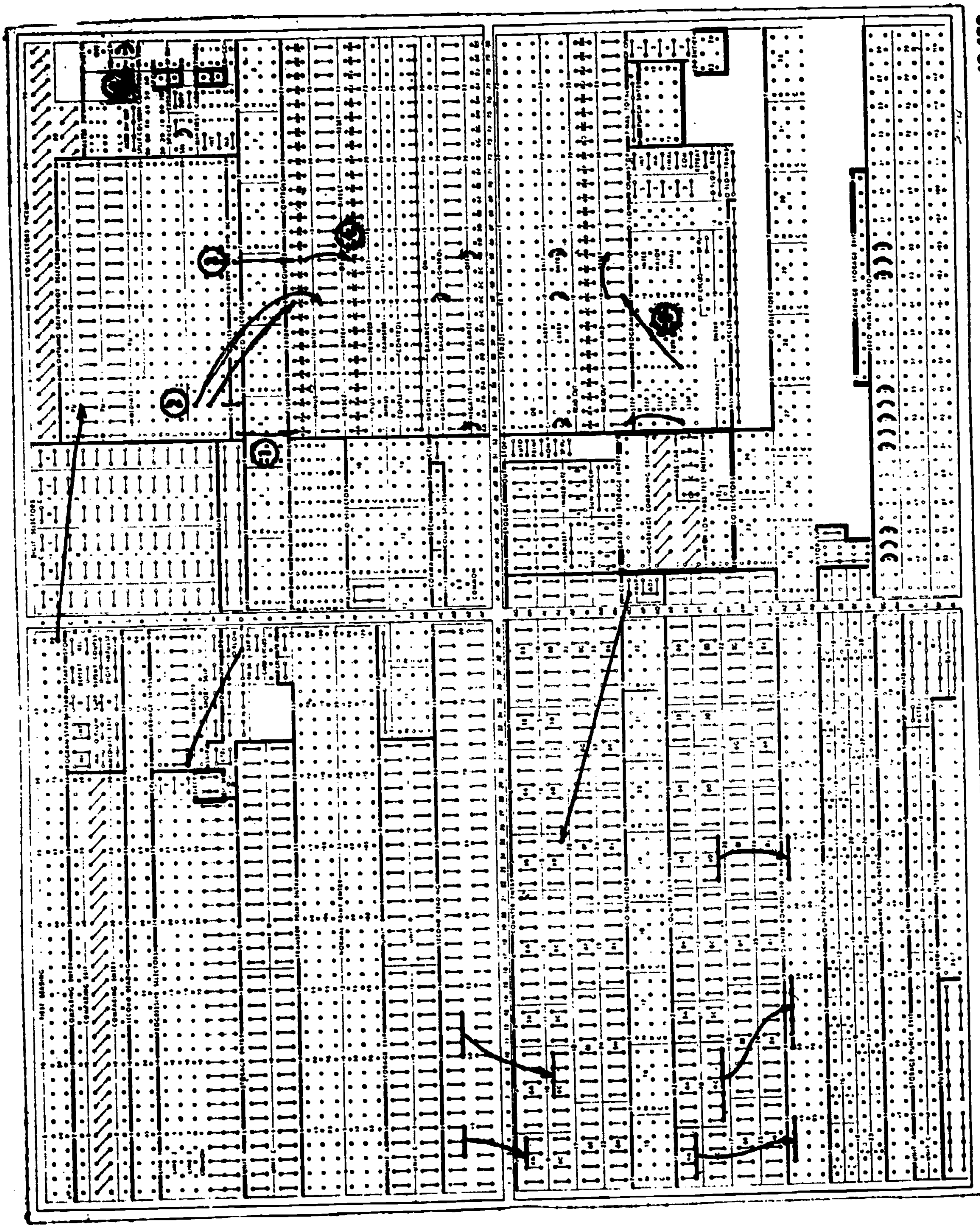

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Figure 9-14.—Single counter control.

Counter Coupling

There may be times when a job will require more than an eight position counter for accumulation. In a case such as this two or more counters may be coupled together to function as one unit.

Figure 9-15 is an example of counter coupling.

1. The counters to be used as one unit are impulsed to add at the same time.

2. The units position counter has the COUPLE CONTROL hubs wired. If more than two counters are coupled, all counters except the high order counter must have couple control wired.

3. The two counters are to perform addition only; therefore, the NEGATIVE BALANCE OFF is wired to NEGATIVE BALANCE CONTROL. The units position counter must be the one that is wired. This wiring works in conjunction with the COUPLE CONTROL to ensure that all coupled counters are checked for zero balance (all 9's). The remaining coupled counters have only the negative balance control hubs connected.

4. The CI hub of the units counter is wired to the C hub of the high order counter. This wiring allows for carry action from the high order position of the units counter to the low order position of the next higher order counter.

The CI hub of the high order counter is wired to the C hub of the units counter. This wiring ensures a true figure is provided when the first amount is added to the initial setting of all 9's.

5. The coupled counters are wired to readout and reset simultaneously.

6. The coupled counters are impulsed to add or subtract together.

7. The units position counter is wired for couple control.

8. Determining that a counter contains a negative amount is accomplished by testing the high order position. When counters are coupled, the high order counter contains the high order position. It is, therefore, required that the high order counter be wired from NEGATIVE BALANCE ON to NEGATIVE BALANCE CONTROL. The remaining lower order counters are connected by the negative balance control hubs only.

9. The C and R SYMBOL EXITS are wired to normal print. This wiring will allow a CR to print each time the counter is instructed to subtract and when a negative total is present when readout is impulsed.

9A. The SYMBOL R hubs are connected to provide the printing of an R rather than a minus sign (–).

10. The CI and C hubs are connected for proper carry control.

11. The coupled counters are controlled to readout and reset at the same time.

NOTE: The high order COUNTER ENTRY hub of a counter or coupled counters must never be wired.

GROUP PRINTING

Group printing is an operation that produces only one line of printing for each program group. Figure 9-16A is a listing provided by previously described wiring principles. Figure 9-16B would be the result of the same wiring as required for printout 9-16A with only two control differences. The LIST OFF hub would be wired and the counters utilized would have to be wired for direct entry.

OPERATING SUGGESTIONS

When a report leaves the accounting machine, it has passed the final phase of machine processing required for its preparation. The following operating suggestions are listed to help you, the operator, make sure that the report has been prepared in accordance with instructions given you and that the format and contents are correct to the best of your knowledge.

CARRIAGE TAPE PUNCHING

To prepare a tape for the routine operation of page overflow follow this procedure:

1. Place a blank tape on top of a sheet of the continuous form paper you are going to use so that the dark horizontal line, just under the GLUE portion of the tape, is even with the top

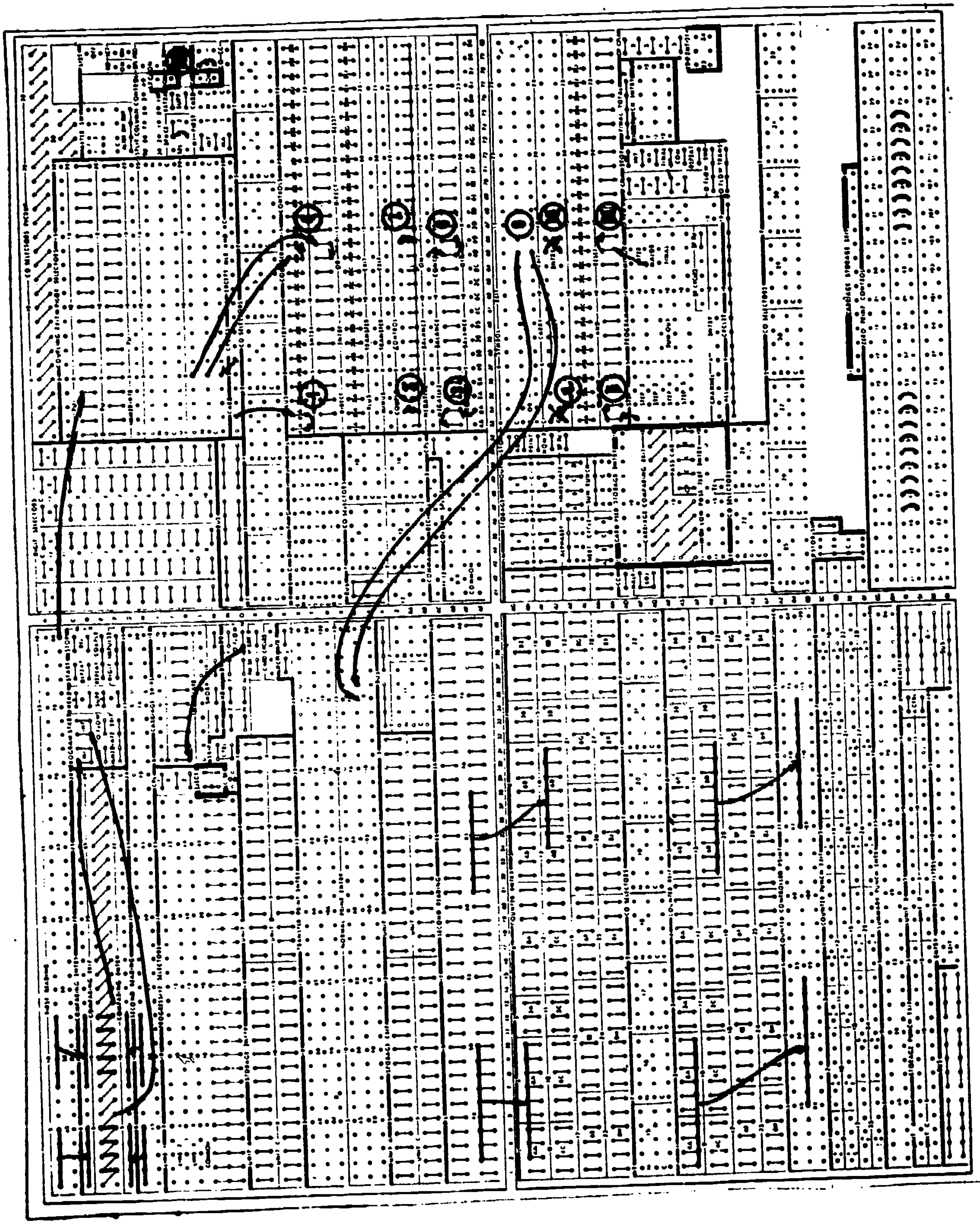

Figure 9-15.—Coupled counter control.

EXPENSE DISTRIBUTION
BY DEPARTMENT OR BRANCH

Dept. or Branch	Account No. Gen. Ledg.	Account No. Sub. Ledg.	Our Invoice Number	Date Mo.	Date Day	Amount	Amount by Account	Amount by Dept. or Branch
82	431	112	12066	12	10	300.00		
82	431	112	12153	12	28	300.00		
						600.00*		
82	431	113	12066	12	10	150.00		
82	431	113	12066	12	10	150.00		
82	431	113	12066	12	10	125.00		
82	431	113	12153	12	28	150.00		
82	431	113	12153	12	28	150.00		
82	431	113	12153	12	28	125.00		
						850.00*		
82	431	114	12066	12	10	50.00		
82	431	114	12066	12	10	75.00		
82	431	114	12066	12	10	50.00		
82	431	114	12153	12	28	50.00		
82	431	114	12153	12	28	50.00		
82	431	114	12153	12	28	75.00		
						350.00*		
82	431	520	12149	12	28	360.43		
						360.43*		
82	431	700	12082	12	14	2.25		
						2.25*		
82	431	750	12003	12	01	100.00		
						100.00*		
82	431	810	12112	12	18	70.20		
						70.20*		
82	431	850	12043	12	07	24.75		
						24.75*		
							2357.63	
82	432	841	12151	12	28	1792.86		
						1792.86*		
							1792.86	
								4150.49

A. DETAIL PRINTED REPORT

EXPENSE DISTRIBUTION
BY DEPARTMENT OR BRANCH

Dept. or Branch	Account No. Gen. Ledg.	Account No. Sub. Ledg.	Our Invoice Number	Date Mo.	Date Day	Amount	Amount by Account	Amount by Dept. or Branch
82	431	112				600.00		
82	431	113				850.00		
82	431	114				350.00		
82	431	520				360.43		
82	431	700				2.25		
82	431	750				100.00		
82	431	810				70.20		
82	431	850				24.75		
							2357.63	
82	432	841				1792.86		
							1792.86	
								4150.49

B. GROUP PRINTED REPORT

49.432

Figure 9-16.—407 printouts.

edge of the form. Now place a mark in channel 1 on the line corresponding to the first line on the form where you wish printing to start, which is usually one inch from the top of the form. Next, place a mark in channel 12 corresponding to the last line on the form to be printed, which is usually one inch from the bottom edge of the form. Finally, place a mark on the line corresponding to the bottom edge of the form. This is your end-of-tape mark.

2. The tape markings for one form should be repeated as many times as the usable length of the tape allows. In this way the tape can be used to control several forms in one revolution through the sensing mechanism, thus increasing the life of the tape.

3. After the tape has been marked with channel punching positions and the end-of-tape mark, insert the tape in a tape punch similar to the one shown in figure 9-17 and punch the channels that you have marked. If your installation has an accounting machine with a tape controlled carriage, you will be furnished with a tape punch and plenty of blank tapes.

4. After all channel markings have been punched, cut the tape along the line corresponding to your end-of-tape mark. Roughen the GLUE end of the tape to remove the glaze.

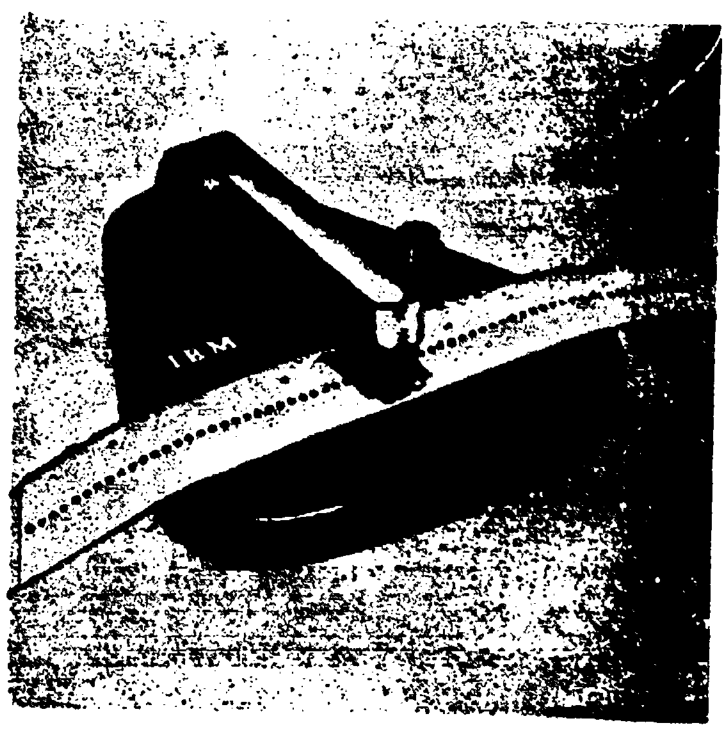

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Figure 9-17.—Tape punch.

Now loop the tape into a belt, and glue the ends so that the bottom end-of-tape line is lined up exactly with the dark line just under the GLUE portion. The center feed holes must be aligned to present the appearance of a continuous tape. The tape is now ready to be inserted in the carriage.

OPERATING THE CARRIAGE

You can save yourself considerable time and effort at the beginning of an operation on the accounting machine by first making sure that the carriage is properly set for operation. The following paragraphs should assist you in seeing that this is done.

Inserting the Tape

Before attempting to insert the tape, first make sure the platen clutch is disengaged and the brush holder is raised. The brush holder, which contains the brushes that read the punches in the tape channels, can be raised by pushing the latch to the left. The numbered edge of the tape must be placed in the outward position, toward you. The center feed holes are placed over the pinfeed drive wheel and the tape is then placed around the tape guides. Either guide may be used, depending upon the length of the tape. The lever just above the tape guides can be raised so that the guides can be moved to the desired position. Always leave a little slack in the tape after it has been inserted to prevent the tape from tearing under undue strain. Lower the brush holder and push it down until it latches. Depress the carriage restore key in order to place channel 1 at the home position. The platen clutch must be engaged before printing is started.

Inserting the Forms

The form thickness adjustment should be set at the position where the best printing for the particular forms used is obtained. If a form feeding device is used, make sure the pressure release lever is pushed back so that the forms will feed properly. Be sure the forms are fed under the form stops and not over them. Position the paper so that the first printing line is in position to be printed, and align the paper so that printing will occur in the desired locations across the form.

Operating the Carriage Controls

Do not use the carriage stop key to stop card feeding in the accounting machine. Although this key will stop card feeding when depressed, it is not intended to be used in place of the regular stop key on the accounting machine. Use it only to stop a carriage operation. Make sure the carriage has been restored and the platen clutch is engaged before beginning an operation. Failure to restore the carriage causes improper spacing of forms, and failure to engage the platen causes overprinting.

OPERATING THE MACHINE

Preparation of an accurate report hinges primarily upon a correctly wired control panel and a properly functioning accounting machine. Therefore, each operation should be tested for proper control panel wiring and machine operation prior to starting the actual job. Some reports which take hours to prepare are later found to be worthless because the operator failed to test the operation before he began turning out the report.

In addition to testing the operation, the following points should be kept in mind when operating an accounting machine.

Starting the Operation

Always depress the final total key before starting any operation, and before placing cards in the feed hopper, in order to clear any counters which may have totals in them from a preceding operation.

Joggle cards into perfect alignment before placing them in the feed hopper in order to ensure proper feeding.

During the Operation

Check the report from time to time as it is being prepared to make sure it is being prepared correctly. If totals are supposed to balance to

predetermined totals, be sure to check these off as they print.

In the event that card feeding stops and the reset check light comes on, raise the cover around the feed hopper and check the indicator lights. Figure 9-18 shows the location of the RESET CHECK INDICATOR. Each light is numbered so that the counter in question may be located on the control panel.

Once the counter in question is located, check for the following common causes:

1. Coupled counters are wired to add only, and CI is not wired to C.

This is because the normal path for the test impulse is through the CI to C wiring. If the proper connections are not made, the test impulse is not allowed to pass from the high-order counter to the low-order counter.

2. COUNTER EXIT positions are erroneously wired to NORMAL or TRANSFER PRINT ENTRY instead of to COUNTER-CONTROLLED PRINT.

When COUNTER EXITS are wired to NORMAL or TRANSFER PRINT ENTRY, the only way that the counter can clear is by direct reset.

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Figure 9-18.—Stacker raised.

3. Emitted impulses such as dollar, decimal, comma, and special characters overlap positions wired from COUNTER EXIT to COUNTER-CONTROLLED PRINT.

For example, a decimal is wired to NORMAL or TRANSFER PRINT ENTRY 60, and a COUNTER EXIT POSITION is wired to counter-controlled print 60. In such cases the symbol impulse back-circuits to the counter exit position in the second half of the reset cycle and prevents the counter from resetting to 9's.

4. The total in a counter exceeds the number of positions wired from COUNTER EXIT to COUNTER-CONTROLLED PRINT.

This condition can be described as total overflow and is more apt to occur during the preparation of a report than during the initial testing of the control panel.

If all counter wiring is correct and the reset check light turns ON, the machine is malfunctioning.

In case of a card feed failure remove all cards from the hopper, correct the card that failed to feed and replace cards in the hopper. Depress the stop key to turn out the card feed stop light; then depress the start key. Card feeding will be resumed without having disturbed normal controls or spacing operations.

Unless it is absolutely necessary for you to be somewhere else, stay with the machine while it is in operation so that you can make sure cards and paper are feeding properly, and that the printed forms are stacked correctly.

Stopping the Operation

Always use the stop key to stop card feeding. Never turn off the main line switch when the machine is in operation.

Depress the start key at the end of an operation in order to run the cards remaining in the machine into the stacker.

In case of a card jam stop the machine immediately and call your supervisor if you do not know what to do. He will demonstrate the correct procedure for removing a card jam.

CHAPTER 10

ELECTRONIC DATA PROCESSING

INTRODUCTION

Before you proceed in this chapter, it may be beneficial for you to review that portion of chapter 2 dealing with electronic data processing.

Up until now we have been discussing data processing as it is done with electric accounting machines. With EAM the cards have to be physically moved from one machine to another to accomplish a specific function. If the cards were to be put in sequence, they would have to be run through the sorter. The next step might be to gangpunch information which would require the cards to be transported to the reproducer, etc. Each step of the job to be run usually calls for a different machine, which requires human intervention (physically handling the cards).

Electronic data processing has practically eliminated human intervention from beginning to end of a job process. Once the data is initially provided to the computer, it can sort, calculate, re-sort, calculate some more and repeat any of these or more without the operator having to physically move files.

In order to understand how a computer can do all these things it is first necessary that you understand the relationship of the components or units that comprise a system. The best illustration is a functional diagram (figure 10-1). The definition of a functional diagram is: a diagram that represents the functional relationships among the parts of a system. The functions depicted in a functional diagram illustrate the communications of a system for input, control, storage (retrieval and sending) and output.

To help you in completely understanding the functional diagram a review and refinement of the three basic elements of data processing follows:

INPUT.—Pertaining to a device, process, or channel involved in the insertion of data. The term input may, therefore, be used when referring to data or a device. The device may be a card reader, tape drive, paper tape reader, disk or any other piece of hardware capable of inputting data.

PROCESSING.—This term is really misused by Data Processing Technicians. By itself it is not meaningful, but has picked up its own general definition in the computer world. It is used as a general term for whatever type of PROCESS to which we refer (i.e., data processing, batch processing, information processing, etc.). Where it appears in this manual, processing refers to data processing. Data processing is the execution of a systematic sequence of operations performed upon data.

Data processing is performed by the central processing unit (CPU), which includes at least the three sections shown. The functional diagram (figure 10-1) shows the relationship of the CPU and the system's hardware.

Notice that the heart of the system is the CENTRAL PROCESSING UNIT (CPU). The processing unit receives data and instructions from input devices, stores them, and refers to them as they are needed during the processing routine. The central processing unit performs all arithmetic operations, makes comparison between numbers or other characters, and takes the necessary action called for by the results in accordance with the stored program. It directs all processing operations within itself and controls the flow of incoming and outgoing information. All communications between input and output devices are directed by the CPU.

OUTPUT.—Pertaining to a device, process, or channel involved in an output process. Output

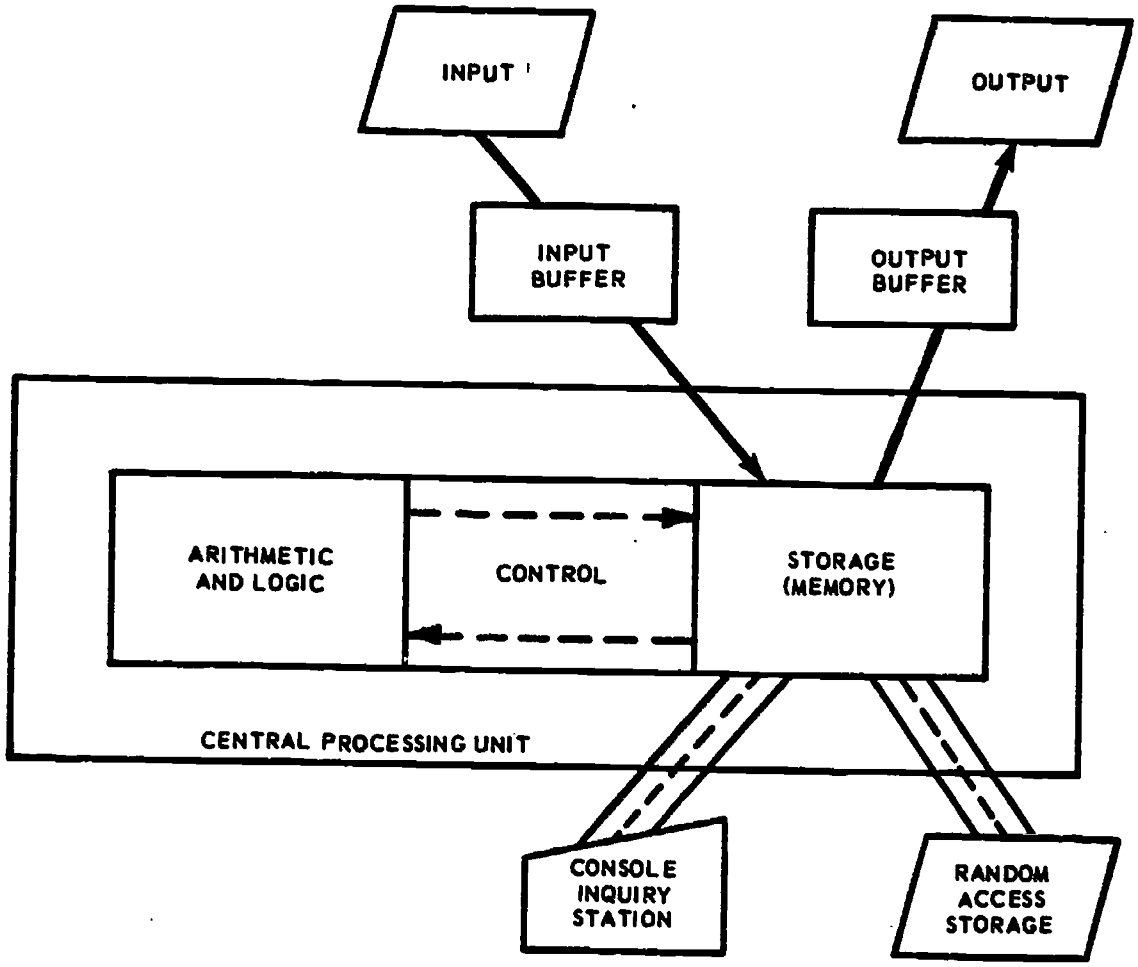

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Figure 10-1.—Functional diagram of an EDPS.

may be used when referring to either data or a device. The device may be a card punch, tape drive, paper tape punch, disk or any other piece of hardware capable of outputting data.

We can now see how these elements work together in the functional diagram. Figure 10-1 shows that data travels to memory from the input device through a buffer. (Buffers will be discussed later.) Data travels from memory to the output device. Data may also be sent to or received from auxiliary storage (random access storage). The operator can also provide or be provided with data. Once data is provided to memory, it can then be called on by control and delivered to the arithmetic/logic unit for computations or decisions. Control then directs the data back to storage and eventually to an output device.

It is important to remember that the control unit does not do all of this guidance on its own. A programmer (human) has written the instructions that are loaded into memory and retrieved one at a time by control. Control then makes available the proper channels for the data to travel. If you continue in the data processing field, you will eventually write these programs and, in fact, have your logic and brain power carried out by the computer.

COMPUTER GENERATIONS

Computers have often been compared to a man in the respect of having a brain. They also have in common with men generations. Generations in computers have to do with the internal modifications and design.

The first type computer in use was naturally labeled FIRST GENERATION. This generation had vacuum tubes and relays and was very susceptible to overheating. An example of this generation is the ENIAC computer discussed in chapter 2.

Advancements in technology within the electronics field led to the development of what is referred to as the SECOND GENERATION of computers. This generation brought about solid state components. With this transistorization the bulk associated with first generation was greatly reduced. Overheating was not the problem it had been, and data was more protected from loss.

The THIRD GENERATION is defined as having solid logic technology components. They contain what are called IC chips and modular construction. Basically, this brings about interchangeable units and reduces some repair problems by having whole circuits contained in one chip the size of a dime or less.

As each generation was introduced, design and electronic technological advancements brought reduction in size and increase in speed. The fourth generation is being sought after in the research fields. Technology today is producing smaller and smaller circuit components so that whole arithmetic and control units can be put on a single chip. LSI (large scale integrations) is producing fast memory at a cost approaching that of cores. These developments are more evolutionary than the revolutionary preceding generations and may or may not constitute a true fourth generation.

CLASS OF COMPUTERS

Computers may be classified according to their purpose. A SPECIAL purpose computer, such as the navigational computers used aboard submarines, may have the sequence of instructions or program which the machine is to follow in manipulating data permanently wired into the circuitry of the machine, so as to handle one type of data processing task as efficiently as possible. This type is most generally referred to as an ANALOG computer.

In contrast, a GENERAL purpose computer may be used for any task which can be handled by any DIGITAL computer, unless its storage capacity or speed is inadequate for a particular application. This is not to say that a general purpose computer could not be used in charting navigation, but it would not be as useful as a special purpose computer designed for that express purpose. Furthermore, even general purpose computers are frequently designed with business or scientific interest in mind. But they are complex and flexible enough to be adapted to other types of problems. Because of the variety of data processing tasks in the Navy, Data Processing Technicians will work, in most cases, with general purpose digital computers.

CENTRAL PROCESSING UNIT

We have previously described the CPU as to its general functions. This section will expand on these functions and help to further your knowledge of a computer system.

Main Storage

The storage or memory section of a CPU is usually referred to as main storage. This is the storage area that is most readily available to the control section. When the control section is to retrieve an instruction or data for processing by the arithmetic/logic unit, it will seek it out from main storage.

The physical makeup of storage will be covered in a later chapter. What is important right now is the answer to the question: What is main storage used for? It is used to store (hold) data and the program to be utilized during a run until the control unit calls for it.

Storage Size

Storage is generally referred to by its size. You will hear of 4K, 8K, 16K, etc. The K portion is usually thought of as the representation of the value 1,000. Therefore, 4K means 4,000. 4K memory is about the smallest that the Navy utilizes. Consider for a 4K memory, a job consisting of a 15,000 card input file and a program with about 180 individual instructions, each with about six characters. This is a lot of characters and you may think we are in trouble.

We are not! First of all, the entire file does not enter memory at the same time. One record (card) is processed at a time (as with EAM).

Remember, increased speed of input, processing and output is one of the significant advantages of computers over EAM.

Second, the 4K does not specifically refer to character positions but rather to addressable locations. Addressable locations will be covered later in more detail, but for now an addressable location means an area of storage capable of holding one or more characters.

Let us assume that main storage could hold five characters per addressable location. If you then wanted to know the character size, you could simply multiply 4K (4,000) by five, giving main storage a capacity of 20,000 characters.

The size of storage has much to do with the capabilities of a computer and flexibility of a command. As the amount of storage increases it gains the ability to hold larger, more complex programs and much more intermediate calculation results. (On small scale computers this intermediate result would have to become output—then input to a different program to produce the final result.)

Control Section

The control section times and directs all operations called for by the instructions of a program stored in the memory of the computer. This includes controlling the operations of all input and output devices, entering data into or writing data out of storage, and transferring data between storage and the arithmetic/logic section.

All this is not self-contained in the control unit. The control unit is like a man's nerve center. It receives messages from other areas, then analyzes the problem and starts an action.

For output, the control unit is interrupted from regular processing of data by a signal from an output device to indicate it is ready for more output.

For input, the control unit keeps checking to insure that it has a record available to be called into storage.

When the control unit determines that it needs more input or can provide output, it then calls in a set of instructions. These instructions are not part of the normal program being run. The regular program is temporarily set aside, and the input or output instructions are brought in and performed. This input/output program is usually provided by the manufacturer as software for the system.

Once input or output is completed, the control unit is signaled to return to the regular processing program. The instructions from this program are again brought in one at a time and analyzed. If it is determined that a calculation or a decision is required, then the control unit turns control over to the arithmetic/logic section and makes the required data available.

Integrated operation of the entire system is achieved automatically through the control section.

Arithmetic/Logical Section

The arithmetic/logical section is equipped to perform all arithmetic and logical operations. The circuitry for the arithmetic portion performs calculations, shifts numbers, sets the algebraic sign of results, rounds, compares, and so on. The logic portion acts as a decision making instrument to change the sequence of instruction execution, depending upon arithmetical conditions arising during the processing routine. For example, if the stored program calls for adding all X cards and subtracting all NX cards, the logical portion must decide which condition exists and pass its "decision" to the arithmetic portion of the arithmetic/logic section.

PERIPHERAL EQUIPMENT

In a data processing system, peripheral equipment is any unit of equipment, distinct from the CPU, which may provide the system with outside communication. This includes input/output devices and auxiliary devices.

Input/Output Devices

An input/output unit is a device for putting in or getting out data from storage (fig. 10-2). Generally, I/O devices must meet two basic requirements. First, the devices must be able to modify all data so that it is acceptable to the computer during the input phase of the operation and must be able to present data in usable form during the output phase. Second, the

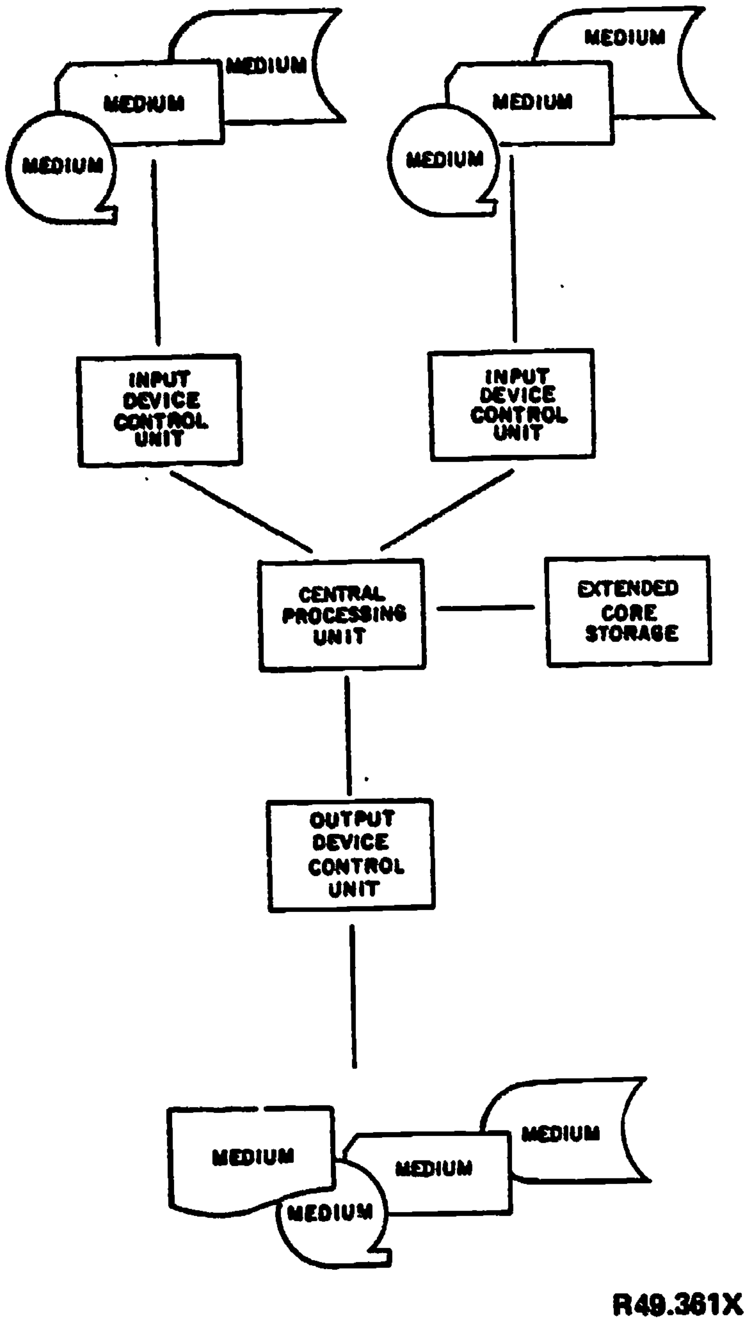

Figure 10-2.—Input/Output mediums in the data processing system.

devices must operate quickly and efficiently in conjunction with the computer.

Conventional input devices sense or read coded data from cards, magnetic tape, paper tape, magnetic ink characters inscribed on paper documents, or remote terminals via communication lines. The data is made available to the main storage of the system for processing.

Output devices record or write information from main storage in printed form, on punched cards, paper tapes, magnetic tapes, or make graphic displays. Outputs in still other forms are available for special applications.

Online Equipment

A printer that produces output by direction of the CPU is ONLINE. A tape drive that delivers data to main storage on request of the CPU is ONLINE. A disk unit that holds the master file for updating during a run is ONLINE.

When peripheral equipment or devices are under control of the CPU, they are said to be online. This is a term you will hear frequently and simply means that the device is responsive to requests from the CPU.

Auxiliary Equipment

AUXILIARY EQUIPMENT is that equipment which is not under direct control of the CPU. Examples of such equipment are: communications terminals, display units, testers and tape cleaners. These equipment types are used to assist the operational efficiency of a system but do not lend direct support.

Offline Equipment

Auxiliary equipment also includes all input, output and storage devices when they are not under direct control of the CPU. Such pieces of peripheral equipment can perform their designed function independently (or in combination with another auxiliary device). An example is a paper tape reader and card punch producing a duplicate card file. These operations that are performed by other than CPU control are AUXILIARY OPERATIONS or OFFLINE OPERATIONS.

If a storage unit is used as a supplement to the online storage, the supplement storage is classified as AUXILIARY STORAGE. This would most probably be disk or drum type storage used in case of data overflow. (Usually, only so much area of disk or drum is allocated for each file. Any storage requirements in excess of this would be directed to the auxiliary storage not by the CPU but by an involved indexing system recorded on the disk or drum surface.)

SYSTEM COMMUNICATIONS

It has been pointed out that the computer has its own internal communications. With the use of manufacturer's software and a stored program the control unit sends and receives signals to monitor, start and stop peripheral equipment.

There are times, however, prior to or during operations when there must be communication between computer and operator.

Manual Communications

The operator can communicate with the computer through consoles, console printer and keyboard (sometimes called teletype) and visual display units.

The console (figure 10-3) is full of lights, keys, switches, dials and indicators. Using these controls on the console the operator can:

1. start and stop the computation
2. manually enter and extract (or display) information from internal storage
3. determine the status of internal electronic switches
4. determine the contents of certain internal registers
5. alter the mode of operation so that, when an unusual condition occurs, the computer will either stop or indicate the condition and proceed
6. change the selection of input/output devices
7. reset certain types of computers when error conditions cause them to halt

The console usually has a keyboard and printer provided with it. This permits printout and type in communications by the operator in a much simpler manner than by utilizing the console.

An example of the use of the console with keyboard and printer could be a case of error detection during processing. A message might print out to the operator requesting that he restart the run, abort the run, provide a core dump, or record the readings present in various registers. The operator would respond by following the outlined directions in his RUN BOOK for that particular job. (A run book is documentation of all operator/computer communications that are possible for a particular run. It also contains set up procedures and distribution directions for files and reports.)

In some cases the printer may be replaced or supplemented by a visual display unit.

Most visual display units are table-top devices for displaying graphic reports that would take many times longer to produce by normal printing methods. The display units present tables, graphs, charts, and alphameric letters and figures on a cathode-ray tube screen, as shown in figure 10-4.

A visual display unit may also be used as a system operator console by using an entry keyboard to update a record immediately and return the corrected data to main storage, either locally or many miles distant from the processing unit.

I/O Channels

Signals are transmitted and received through a cable connecting the CPU and its online devices. This cable or line provides a path for the signal to travel and is called a CHANNEL. Not only signals for monitoring but also data are transmitted via channels.

For CPU and online devices there are two types of channels–input and output.

An input channel is for impressing a state on a device or logic element.

An output channel is for conveying data from a device or logic element. Channels (input and output) may be simplex or duplex. In simplex operations communication are in one direction at a time, and it is necessary to check that the line is idle before starting a transmission.

Duplex simply means that within each cable connection are two paths (lines) for transmission of data. One path is for sending, and one is for receiving.

The paths may allow serial or parallel transfer of data. In serial transmission bits are sent one after another on the same pair of wires. In parallel operation there are many wire pairs per line. Usually pairs are provided for each bit in a word so that a word at a time is transmitted.

Another term that is sometimes used in reference to channel is MULTIPLEX. Multiplexing is a means for transmission of a number

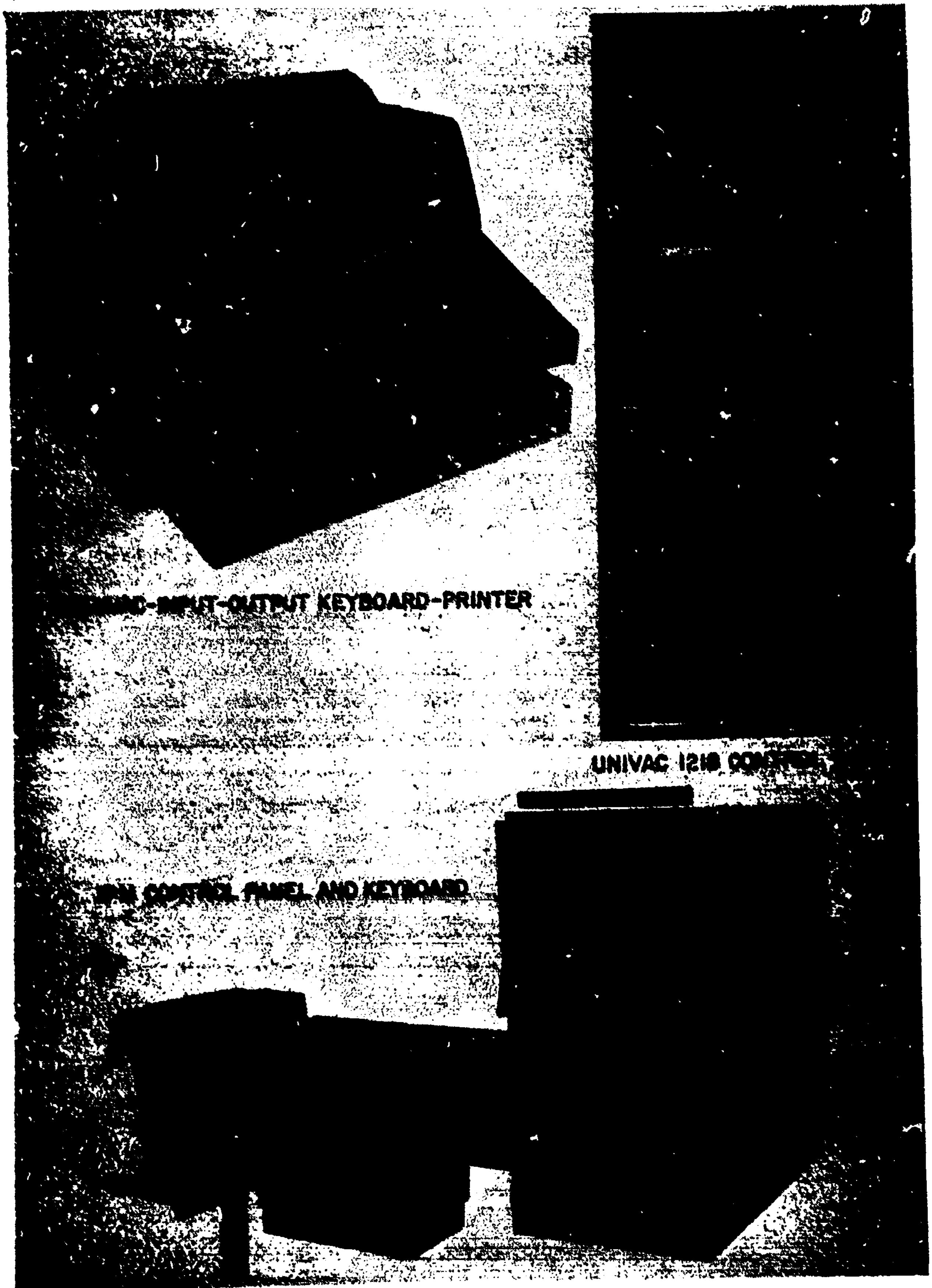

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Figure 10-3.–Control panels and keyboards.

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Figure 10-4.—Example of display screen contents.

of different messages simultaneously over a single circuit. This is accomplished by each message being sent in a different frequency with a device for separating the frequencies at the receiving end. Once the messages (data) are separated, they are directed to their proper device or storage area.

Multiplexing is used in system to system communications. It is used when many remote stations are utilizing a single central system. Multiplexing is simply another means of communications similar to the telephone.

BUFFERING

Data input and output require physical movement of a device. Data movement within the CPU is not physical but rather by electronic sensing (reading) of a state of magnetism in one location and setting of a duplicate state of magnetism (writing) in another location.

We speak of cards being input at so many per minute, tape at so many pulses per inch and other inputs measured by their characteristic method. Inches, minutes and seconds are by no means comparable to the speed of the CPU. In the CPU, speeds are referred to in PICOSECONDS (one thousandth of a nanosecond), MICROSECONDS (one millionth of a second) and NANOSECONDS (one billionth of a second).

With this type of speed difference between I/O devices and the CPU it is easy to understand that the CPU has a great deal of idle time during a complete job run.

All data processing procedures involve input, processing, and output. Each phase takes a specific amount of time. The usefulness of a

computer is often directly related to the speed at which it can complete a given procedure. Any operation that does not use the central processing unit to full capacity prevents the entire system from operating at maximum efficiency. Ideally, the configuration and speed of the various input/output devices should be so arranged that the CPU is always kept busy with useful work.

The efficiency of any system can be increased to the degree to which input, output, and internal data handling operations can be overlapped or allowed to occur simultaneously.

Input is divided into specific units or logical associations of data that enter storage under control of the program. A number of output results may be developed from a single input, or, conversely, several inputs can be combined to form one output result. Figure 10-5A shows the basic time relationship between input, processing, and output with no overlap of operations. In this type of data flow, processing is suspended during reading or writing operations. Inefficiency is obvious, because much of the available time of the central processing unit is wasted.

Figure 10-5B shows a possible time relation between input/output and computing when a buffered system is used. Data is first collected in a unit called a buffer.

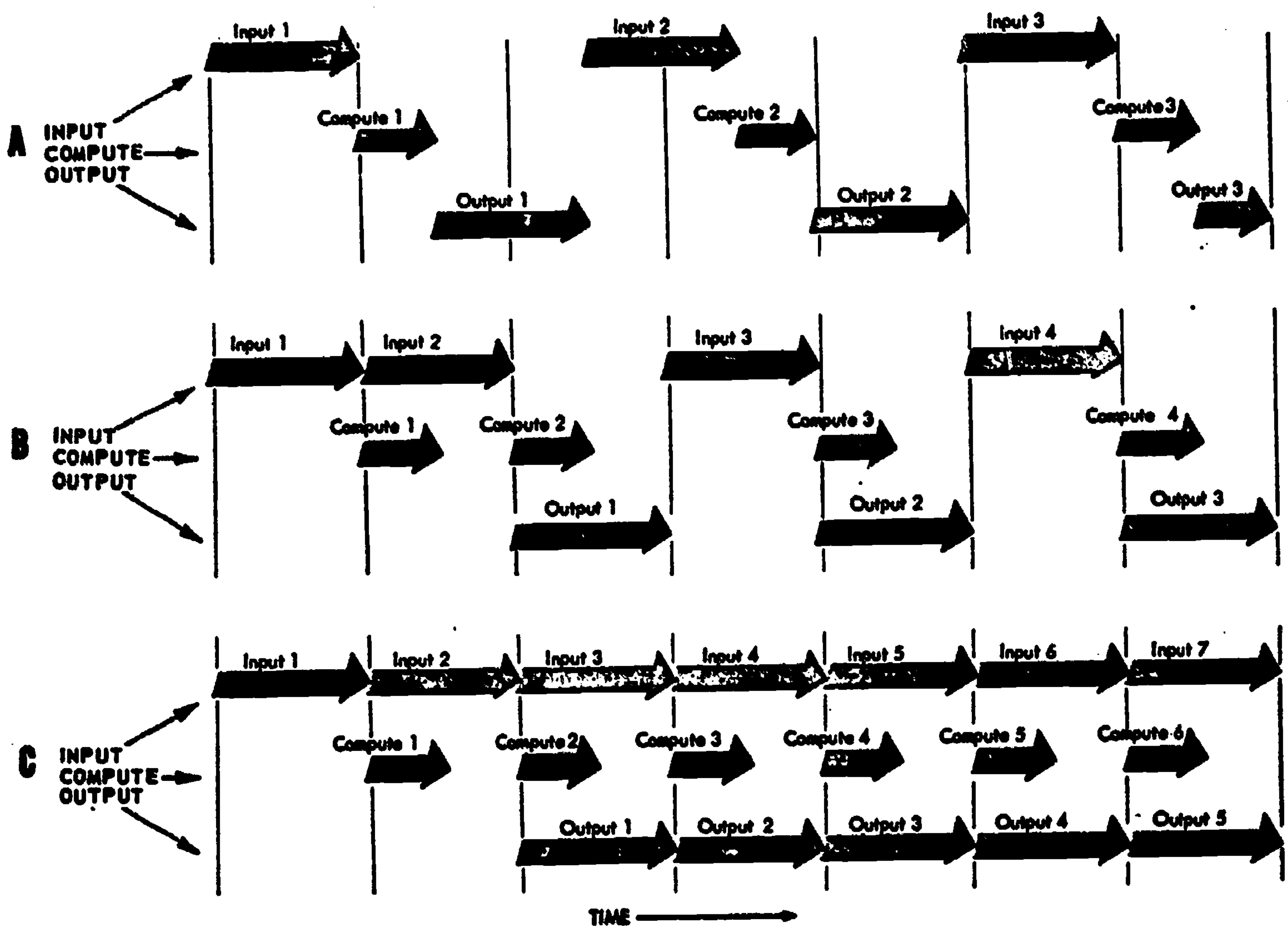

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Figure 10-5.—Data buffering.

A buffer is storage used to accumulate input data prior to transfer to main storage. For output a buffer receives data from main storage and holds it until the output device can write it. Buffers are primarily all external to the main storage and in some cases incased in the I/O device.

When summoned by the program, the contents of a buffer are transferred to the main storage unit. The transfer takes only a fraction of the time that would be required to read the data directly from an input device. Also, while data is being assembled in the buffer, internal manipulation or computing can occur in the computer. Likewise, processed data from main storage can be placed in a buffer at high speed. The output device is then directed to write out the contents of the buffer. While writing occurs, the central processing unit is free to continue with other work.

If several buffered devices are connected to the system, reading, writing, and computing can occur simultaneously (figure 10-5C).

The modern trend is to put more computing power in the peripheral so that the CPU only has to start the task, not control each step. A step toward this is the use of main storage as the primary buffer. Data is collected from, or sent to, the input/output devices in words or in fixed groups of characters.

The CPU tells the I/O device to fill or empty a certain section of main storage. While the I/O is being accomplished, the CPU can be using the rest of main storage for other processing. The effect is that of overlapping internal processing with both reading and writing. The principal advantage here is that the size or length of the data handled is restricted only by the practical limits of main storage. When external buffers are used, the amount of data handled at any time is limited to the capacity of the buffer.

CHAPTER 11

OPERATION AND CONTROL OF EDP EQUIPMENT

Computer operators are extremely important at any data processing installation. The efficiency and knowledge of the operators at any command determine the efficiency and effectiveness of the data processing installation. Skilled operators providing the correct leadership and training insure the continued success of a command.

Much has to be learned by each person before he can become a good operator. This chapter presents material that should be useful to all beginning or early career data processors in the Navy.

There are many different systems in use by the Navy today. It would be impossible to give detailed information on them all. This chapter focuses instead on good practices for all operators, regardless of the system type or manufacturer.

Specific equipment or systems refer to either a model of IBM 360 or UNIVAC 1500 (sometimes called UNIVAC 1218 or AN/UYK-5 (V)). These are the most predominant systems installed at this time.

EQUIPMENT AND AREA CLEANLINESS

One of the first impressions that registers with visitors, supervisors and repairmen is the cleanliness and neatness of a DP shop. Neatness and cleanliness are traits of good operators and shop supervision.

Spilled soft drinks, coffee, lunch crumbs and cigarettes or burns and ashes are very detrimental to proper operation of equipment. All food and beverages should be kept out of the equipment area.

Paper clips, rubber bands and related items may fall into openings and cause equipment failure. If these items must be kept near the equipment, proper receptacles should be mounted and used.

Once a tape reel or file of cards is used, it should be immediately restowed. Loose reels and stacks of card trays are simply not characteristic of good operator practices.

Partial reports (those printouts of runs that errored out and have to be rerun), carbons of reports, overflow blank sheets and all other waste paper should be disposed of in proper receptacles. When one job after another is being run and reports are stacked, they could become lost with the trash. Reports should be delivered to the supervisor or distributed by command procedures as soon as they are printed. Many reports have been lost in a shop that doesn't practice neatness and cleanliness. This is costly to your division or department in terms of system scheduling, man-hour production and supply expenditures.

On-the-job training will provide you with the required knowledge of each piece of equipment you are to operate. The controls that you utilize on the equipment should be explained to you as to their function. DO NOT depress buttons, change toggle switch settings or experiment with any other controls. If you are inquisitive, ask your supervisor or a Data Systems Technician for explanations.

Leaning is also a bad practice around computer equipment. Many devices have pressure sensitive covers which start or stop operations. In some cases what appear to be blinking lights are also buttons which may be depressed to alter operations or data in storage.

A simple rule is to observe, learn and stay away from unfamiliar or unexplained equipment.

CARD READERS/PUNCHES

Card readers and punches do basically what their name implies—read and/or punch cards.

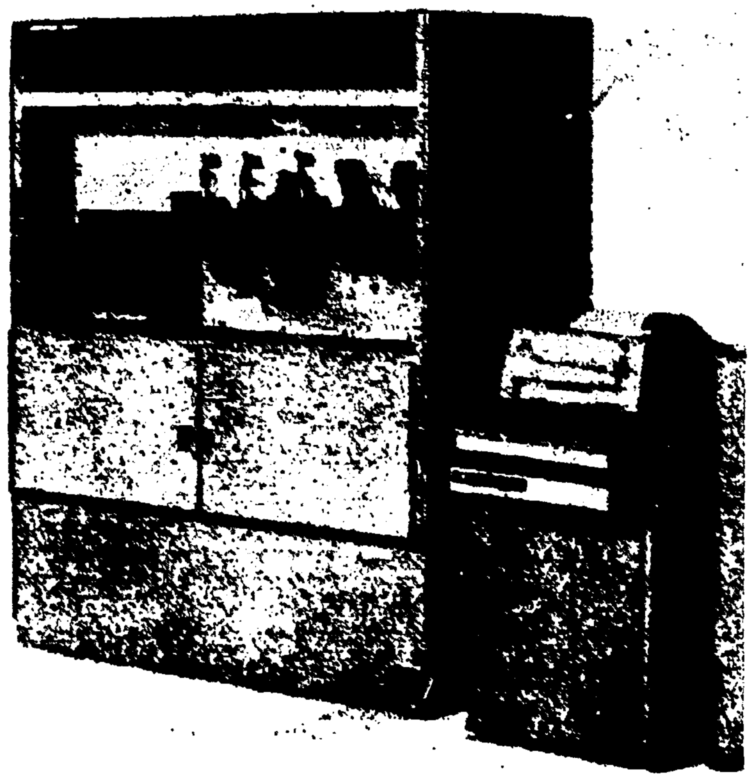
There are some models that will also interpret.

If the unit is utilized as an input, it then performs the function of reading and delivering the data to main storage. The speed at which cards are read is relatively unimportant unless you are involved at the management level of cost and analysis work. The speeds vary from manufacturer and model to model.

If the unit is utilized as an output, it then performs the function of receiving data from main storage and punching the cards. Most units are capable of punching the cards with the Hollerith Code. They may also punch in row or column binary.

Punching in binary simply means that a punch will appear for each bit (1) representation in an addressable location of storage. For each no-bit (0) present a blank will be generated in the card. This type of output is sometimes generated to produce required input for some other job or data transmission.

Your duties as an operator do not require that you know how equipment executes operations. You must know what its functions are and how to set controls to induce the proper operation for each job.



120.100.3-.4

Figure 11-1.—UNIVAC 1549 card reader-punch-interpreter (CRPI) and keyboard.

UNIVAC 1549 CARD READ-PUNCH-INTERPRET UNIT

A type of reader/punch (figure 11-1) which you will work with is the UNIVAC 1549 Card Read-Punch-Interpreter (CRPI). This is the standard card I/O unit used with the UNIVAC 1218.

Physically, the CRPI cabinet has two major units a common control unit and the punched card unit itself. The common control unit is magnetic core and consists of buffers and registers. This buffer provides temporary storage for ALL data transmitted between the CPU and the punched card unit, between the CPU and an online high-speed printer and between the CPU and the keyboard printer device (figure 11-1).

The punched card unit is your main concern with the exception of leading a conversion table into the control unit. (This will be covered later in this chapter.)

The card path for the CRPI includes several stations (figure 11-2). The first station is a card hopper. The cards are held in place by a vacuum and require no card weight. A vacuum picker and pneumatic throat picks the cards one at a time and feeds them to the first read station.

The read station consists of 12 phototransistors and 12 miniature lamps. This type of reading is similar to the type utilized by the IBM 84 card sorter.

The next station is the punch station which has a punch head capable of punching four columns at one time. There is a total of 48 individual punching dies in one punch head. The head is capable of punching 225 fully laced (960 punches per card) cards per minute.

Following the punch station is another read station consisting of the same elements as the first read station. This station is used for post-read and punch checking. This station works like a verifier in that it reads the punched card and compares the punches against storage (which contains the original reading or data sent from the CPU). If a mispunch occurs, the CRPI will halt and light an indicator for the operator.

The interpreter station is next. This station will cause cards to be printed upon. There are

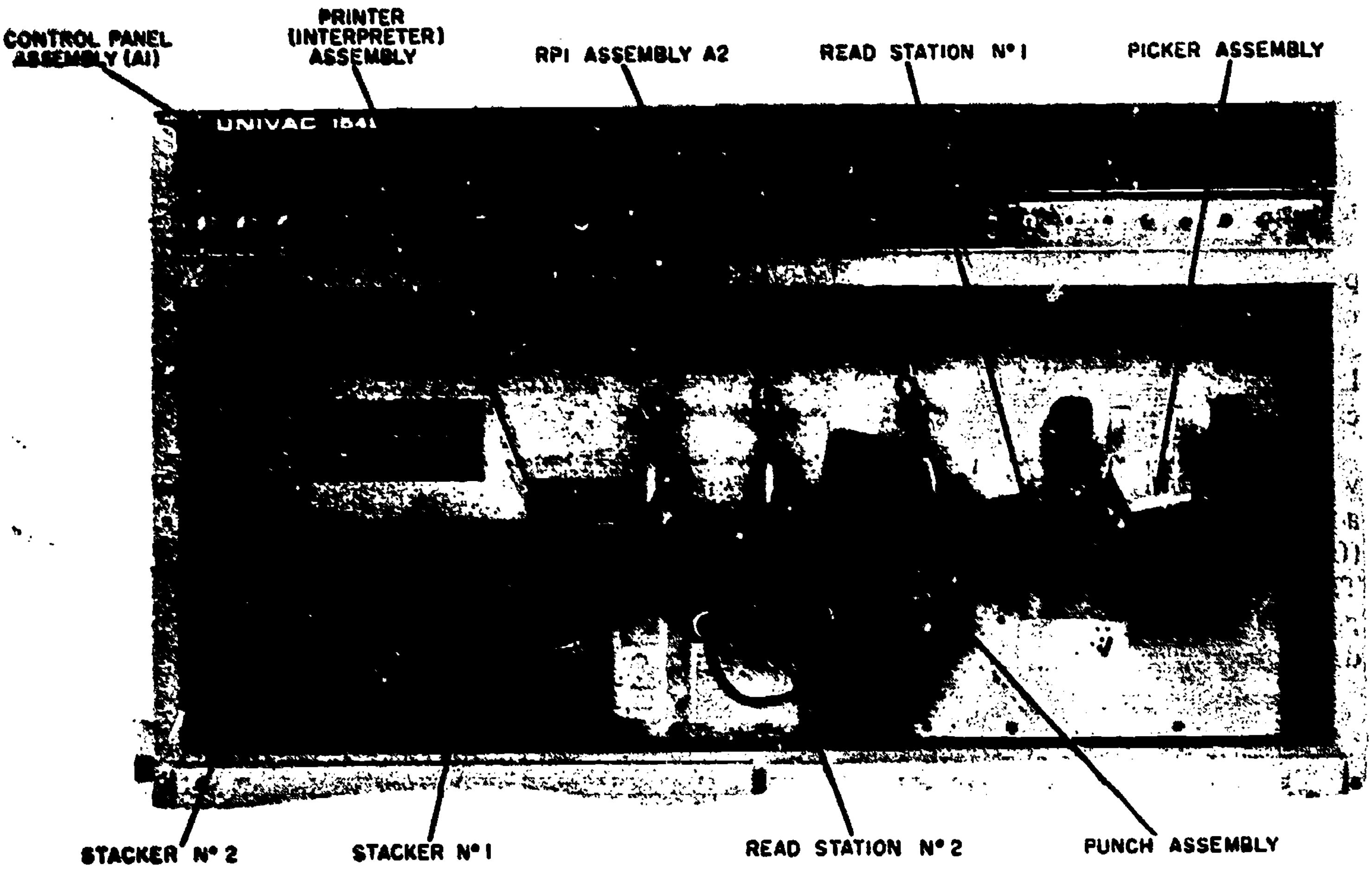


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Figure 11-2.—Control panel (A1) and RPI (A2) assemblies.

two printing lines or positions for each card. The print lines are above the eleven and twelve punching positions. The two positions allow for up to 120 alphanumeric characters to print for each card. This station may not be active on some units. The printing is done at a slow speed of 40 cards per minute; a regular EAM type interpreter would produce faster results. Whenever possible, EAM or off-line equipment is utilized to handle jobs which would otherwise slow down the computer.

Normal card handling techniques are required when utilizing the CRPI. This means fanning, joggling, checking for warpage and foreign objects like rubberbands and paperclips. The cards are placed in the hopper with the 1 edge to the throat, face down with the 12 edge toward the operator.

CRPI CONTROLS

Across the top of the CRPI unit are numerous indicators (lights) and toggle switches. The function of each of these controls, from left to right (figure 11-3), is as follows:

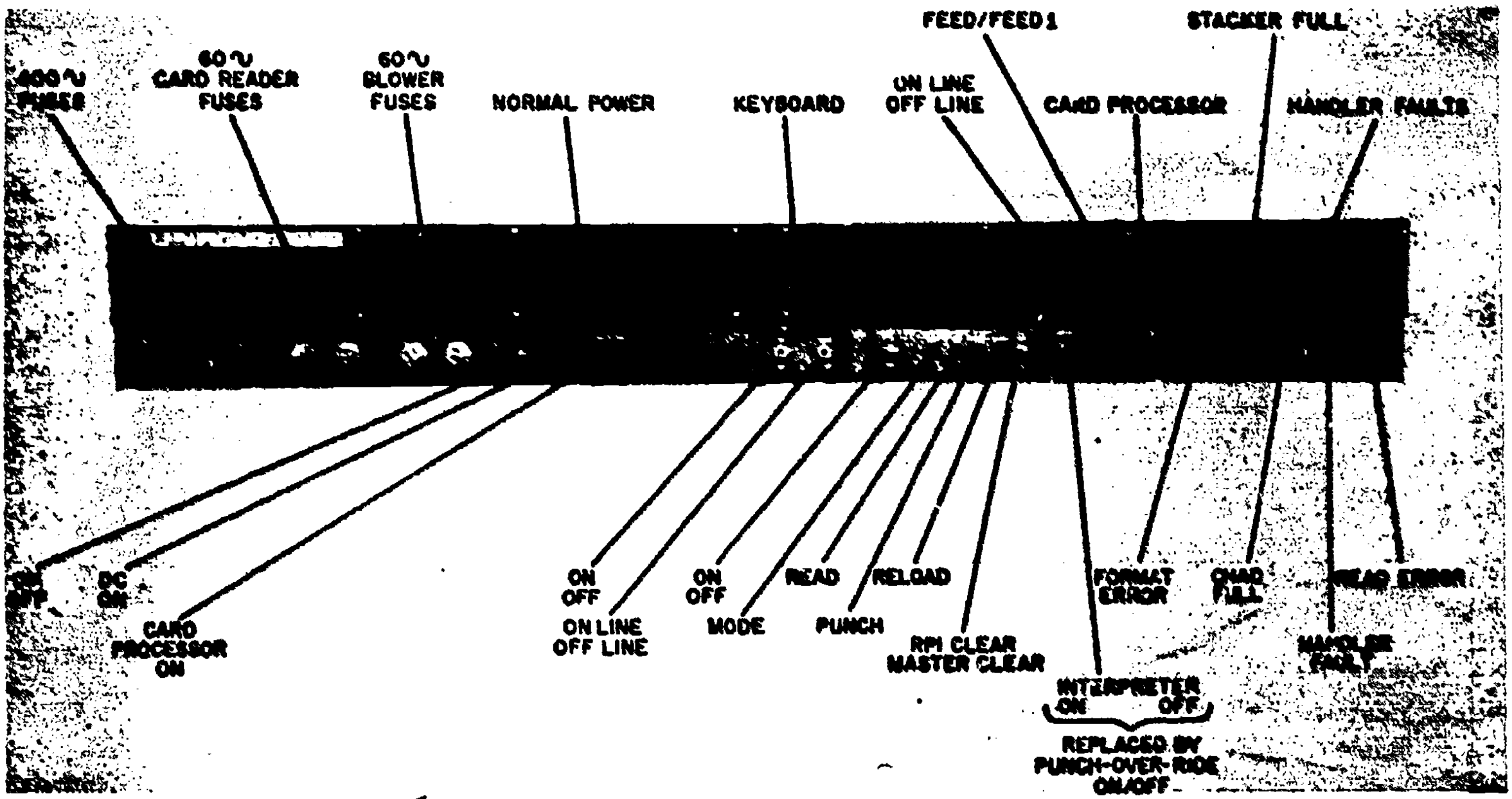

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Figure 11-3.—CRPI unit control panel.

Blown Fuse Indicators. There are three of these for indication of a blown fuse in one or more phase lines for the 400-hertz input.

Card Processor. There are two of these for indication of a blown fuse in the AC line to the RPI assembly.

Blower. There are two of these which will indicate a blown fuse in the AC line to the cabinet blower.

If any of these seven indicators come on, notify your supervisor or a Data Systems Technician (DS).

Power Switch. This is a spring loaded three-position toggle switch. If it is pushed up (ON) or down (OFF) and released, it will return to its center position. This is the main power switch and applies power to the DC supplies and blowers.

DC On. This indicator should light once the power switch is tripped on.

Card Processor On. This indicator should light once the Card Processor On/Off switch is tripped on.

Alarm Bypass Switch and Overtemp Indicating Light. These two controls for overheating are not on most models now due to modifications. On some models these have been replaced with an Hours and Tenths Meter to record the CRPI's power on time.

Keyboard On/Off. This toggle switch when turned ON (up) supplies power to the keyboard printer motor.

On Line/Off Line. This toggle switch when turned ON (up) brings the keyboard printer ON LINE.

Card Processor On/Off. This spring loaded toggle switch supplies power to the card punch, interpreter and ribbon drive motors when pressed to the ON (up) position.

Mode Indicator. This indicates if the read or punch operation is in Binary (lighted) or XS-3 (unlighted).

Read Indicator. When lighted, the read function is occurring.

Punch Indicator. When lighted, the punch function is occurring.

Reload Indicator. When lighted, the memory section is being reloaded.

RPI Clear/Master Clear. When this switch is in the up position, it causes clearing of all circuitry associated with the RPI unit only. When in the down position, it clears all circuitry associated with the keyboard printer, high speed printer and CRPI.

Interpreter On/Off. This control has been eliminated on most 1549's, as the interpreter feature is not utilized. It has been replaced with an additional control for the punch unit. The new switch is called Punch Override. In the ON (up) position the punch unit is allowed to run as long as the RPI is operating. In the OFF (down) position the punch unit does not come on until a punched output is called for by a program through the CPU.

On Line/Off Line. This toggle switch is to allow the RPI to operate on line or off line. It is turned up for on line, down for off line.

Feed/Feed 1. This spring loaded toggle switch will allow single card feeding by single pressings to the down position or continuous feeding by pressing to the up position.

The last five indicators are called HANDLER FAULTS. For halts during operations the operator is informed by these indicators just what type of a stop (fault) has happened. They indicate faults as follows:

Format Error. This is for indication that an incorrect read has happened. In most cases it is a binary card trying to be read without the correct conversion table having been loaded. The card causing this indicator to come on will be ejected to stacker 2.

Stacker Full. Indicates that one of the two output stackers is full.

Chad Full. Indicates that the RPI chad (chip) bag is full and requires emptying.

Handler Fault. Indicates that a mechanical failure in the RPI has occurred, such as a card jam or misfeed.

Read Error. Indicates that the card just read or punched has failed the post-read or post-punch check. The card is ejected to stacker 2.

IBM 2540 CARD READ PUNCH

The IBM 2540 Card Read Punch (figure 11-4) is an input/output (I/O) device for IBM System/360 Models 25 and higher. The 2540 has separate read and punch feeds with maximum reading speed of 1000 cards per minute and maximum punching speed of 300 cards per minute. The punch hopper holds approximately 1350 cards; the read hopper and file-feed magazine hold approximately 3100 cards.

The five radial stackers of the 2540 are so controlled that three stackers serve each feed: stackers R1 and R2, at the right end of the stacker group, can receive cards from the read feed only; stackers P1 and P2, the leftmost stackers, can receive cards from the punch feed only; RP3, the center stacker, can receive cards from both feeds. RP3 should not be used for both the reader and the punch at the same time. Each stacker holds approximately 1350 cards; cards can be removed from any stacker without interrupting operation of the 2540.

OPERATOR CONTROLS

The 2540 operator controls are of three types: those affecting only the reader (figure 11-4B), those affecting only the punch (figure 11-4A), and those that reflect conditions common to both feeds (see figure 11-4B).

READER CONTROLS

Keys

STOP. Depressing the reader stop key will halt card movement at the completion of an operation, turn off the reader end-of-file light, and place the reader in not ready status.

START. The reader start key may be used as follows:

1. Press to feed cards to all stations in the read feed, enter the data from the first card into read storage, and place the reader in ready status if:

   a. the read feed is clear of cards
   b. the feed magazine contains cards
   c. the power is on and all interlocks are satisfied.

2. Press and hold when the hopper is empty, the reader end-of-file light is off, and the hopper

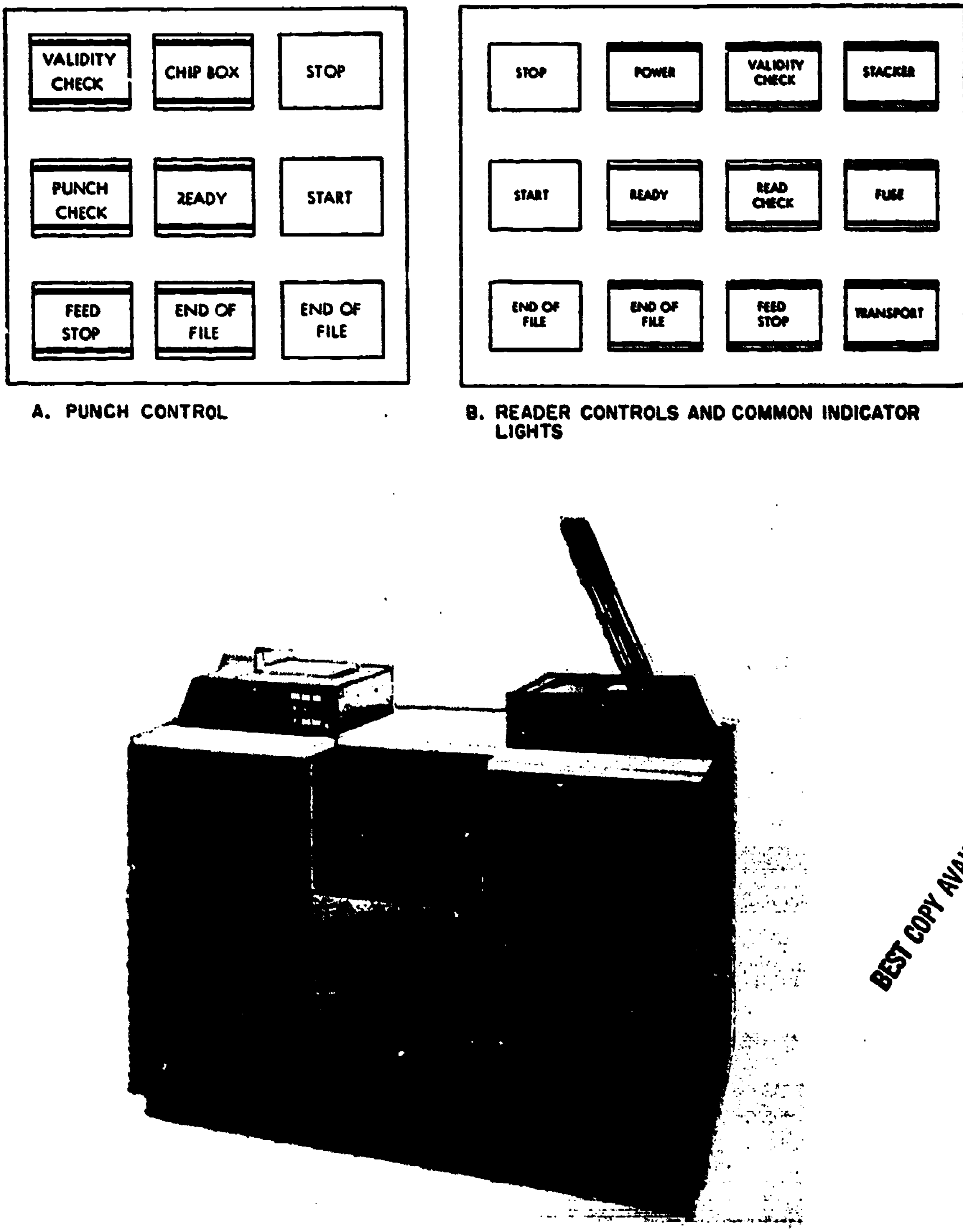

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Figure 11-4.—IBM 2540 card read punch and controls.

joggler gate is open. This will cause a nonprocess runout of any cards in the read feed into stacker R1.

3. Press after clearing an error that required operator intervention to initiate any necessary feed cycles and place the reader in a ready status.

END-OF-FILE. Press this key to condition the 2540 so that card feeding and reading will continue after the read hopper is empty until the last card has been read and stacked.

Lights

As an aid to the programmer and the operator in planning restart methods, the following descriptions of error lights include the associated 2540 sense indications.

READY indicates that the reader is in ready status.

END OF FILE indicates that the end-of-file key has been pressed and that the end-of-file circuits are active. The end-of-file light goes out and the circuits are deactivated if the stop key is pressed or if the last card has been stacked and an additional programmed read instruction, or read and feed instruction, has been received by the reader.

VALIDITY CHECK (sense bit 4, data check) indicates that an invalid punch configuration (more than one punch in rows 1-7 of a single column) has occurred in a read or the special feature of Punch Feed Read (PFR) data mode 1 operation. Validity check is turned off by the next command.

READ CHECK (sense bit 3, equipment check) signals the detection of a hold count check, a parity check, and addressing error, or a translate check read storage of the attaching unit. Read check also turns on with a read clutch failure. Read check is turned off by the next read command. If a read check is caused by a clutch error, it is turned off by a nonprocess runout operation. In the 2025 integrated attachment operation only, either a sync check or an overrun condition causes a read check.

FEED STOP (sense bit 1, intervention required) turns on when the reader motor is stopped by a card jam, a misfeed, a read clutch failure, or a failure to receive a signal from the attaching unit after a read cycle is completed. Feed stop is turned off by performing a nonprocess runout (pressing of the start key after emptying the hopper).

PUNCH CONTROLS

Keys

STOP. Depressing the punch stop key will halt card movement at the completion of the current operation and place the punch in a not ready status. If PFR is installed, press the punch stop key to turn off the punch end-of-file light.

START. The punch start key may be used as follows:

1. Press to feed cards into the punch and blank stations if the punch feed is clear of cards, the hopper contains cards, power is on, and all interlocks are satisfied. If PFR is installed, the contents of the first card enter storage in the attaching unit.
2. Press and hold the key with the hopper empty to cause a nonprocess runout of all cards in the punch feed into stacker P1. If PFR is installed, the punch end-of-file light must be off for a nonprocess runout operation.
3. Press after an error condition requiring operator intervention has been cleared to initiate any necessary feed cycles and restore the punch feed to a ready status.

END OF FILE is installed in the punch feed only when the 2540 is equipped with the PFR special feature. Press the punch end-of-file key to cause the 2540 to continue feeding and processing cards after the punch hopper is empty until the last card is read. The last card is still in the punch feed at this time, and an additional programmed write command must be issued to check and stacker select the last card.

Lights

As an aid to the programmer and the operator in planning restart methods, the following descriptions of error lights include the associated 2540 sense indications.

VALIDITY CHECK (sense bit 4, data check) indicates more than one punch in columns 1

through 7 while operating in data mode 1. This light is installed with the PFR feature only. It is reset with the next command.

PUNCH CHECK (sense bit 3, equipment check) indicates the detection of a hole count error, parity check, addressing error, or translate check in the attaching unit. Punch check also turns on if these errors occur during a PFR read operation or any time a punch clutch error occurs. This indication is reset by the next command. If the check was caused by a clutch failure, perform a nonprocess runout operation to reset the indicator. In the 2025 integrated attachment operation only, either a sync check or an overrun condition also causes a punch check.

FEED STOP (sense bit 1, intervention required) turns on when the punch motor is stopped by a card jam, a misfeed or a punch clutch failure. Feed stop is turned off by performing a nonprocess runout.

CHIP BOX (sense bit 1, intervention required) indicates that the chip box is either full or improperly positioned.

READY indicates that the punch is in a ready status.

END OF FILE (installed in the punch feed only when the 2540 is equipped with the PFR special feature) turns on when the punch end-of-file key has been pressed, activating the punch feed end-of-file circuits. If the punch stop key is pressed, the punch end-of-file light goes out and the circuits are deactivated. End of file is reset by any non-PFR command. The end-of-file light turns off when the last card leaves the punch check station.

COMMON INDICATOR LIGHTS

POWER indicates that the 2540 is being supplied with DC power.

STACKER (sense bit 4, intervention required) indicates a full stacker. (Exception: While a 2540 with the 51-80 column feature is operating in 80-column mode, cards entering R1 or R2 turn the stacker light on without any stacker being full; the sense bit is not set and the 2540 does not stop until a stacker becomes full.)

FUSE indicates that a signal fuse in the 2540 has blown. A blown fuse must be replaced by a fuse of the same size. A customer engineer should be notified whenever a fuse has blown as this could indicate a malfunction in the 2540 circuitry.

TRANSPORT (sense bit 1, intervention required) indicates a card jam in the transport area of the 2540. This light goes out when the jam is cleared and the covers are closed.

OPERATING AND RESTART PROCEDURES

INITIAL START OF 2540 READER

Perform a nonprocess runout operation by opening the joggler gate, emptying the hopper, and pressing and holding the reader start key to ensure that no cards are left in the feed. Then load the desired cards into the hopper or the file-feed magazine and close the joggler gate. Card decks less than one inch thick should be placed directly in the hopper with the card weight; larger decks can be placed in the file-feed magazine. Finally press the reader start key.

INITIAL START OF 2540 PUNCH

Perform a nonprocess runout operation by emptying the hopper and pressing and holding the punch start key. Then load the desired cards into the punch hopper and press the punch start key.

RESTARTS FROM ERROR CONDITIONS

The 2540 uses the flexible System/360 command set; therefore, each different external error condition can require different restart procedures, depending on whether the 2540 operation is reading, punching, or PFR. If the program provides some programmed message to indicate the 2540 sense conditions (typeout, printout, system console display, etc.), the operator can use this message to determine which specific restart procedure he should follow. To locate the error card for read check and validity check errors, the operator should be familiar with the type of processing used by the program: that is, whether the program is reading and stacking each card with a single command or delaying the stacker selection until the data from the card is analyzed.

Each installation will provide the training required of its operators for restart procedures.

JAM REMOVAL

The operator can gain access to the top of the read feed, transport and stacker area, and punch feed by raising the top covers of the 2540. He can remove the read check brushes, the read brushes, the punch check brushes, and the PFR brushes, as necessary, to free jammed cards.

A decal on the plastic cover over the punch clutch has instructions for the operator to follow in removing jams from the punch unit. These should not be attempted, however, until your supervisor deems you qualified.

MAGNETIC TAPE UNITS

Just as there are many types of electronic data processing systems, there are many types of magnetic tape transport units. Each unit is equipped with various dials, switches, lights, and assorted devices for controlling and operating the unit. While the devices and features differ from one unit to another, the operation of any tape unit during a data processing routine is basically the same; each is controlled almost entirely by instructions in the stored program. These instructions consist essentially of such instructions as "read," "write," "backspace," "skip," and "rewind." Other instructions, and variations of the instructions just mentioned, are used for effecting various other operations, depending upon the operations performed and the type of system used.

Feeding of magnetic tape by a tape transport unit is performed in a series of starts and stops, rather than in a steady, even flow. This is done to allow the computer time to perform the necessary operations upon an input record or record block as called for in the stored program and to perform other operations as required before the next record or group of records is read in.

Several tape transport units may be used with an EDPS for a given application, using some for input and others for output. The number of units that can operate at the same time depends upon the type of system used and the job being performed. In some systems simultaneous input from several units can be effected while other units are recording simultaneous output. In other systems, input and output may be performed simultaneously by two separate units, but only one unit at a time can be used for input or output.

Each tape unit is assigned an address so that the instructions in the stored program can reference the proper unit when needed. Each unit may have a dial containing as many numbers as the maximum number of tape units which can be used with the system. For example, if ten units can be used, the dial for each unit may contain the numerals 0 through 9. When a particular unit number is referenced in the stored program, the unit set up for the particular operation called for by the instruction must have the dial set to the number specified in the instruction (this will be indicated in the operator's run book for the job).

HANDLING TAPE REELS

Magnetic tape is a precision engineered product, manufactured and tested under conditions that are carefully controlled to ensure the greatest quality and reliability. An actual performance test is conducted by the manufacturer on each reel of tape before it is released to a customer. Rigid reliability and life tests are made to ensure that the high quality of magnetic tape is maintained with usage.

Dust, dirt, and damage are the common enemies of magnetic tape. Maximum accuracy of tape reading and writing operations can be greatly reduced or prevented by their presence. Proper cleaning of tape units, careful tape handling, clean operating spaces, and proper tape stowage can prolong the usable life of magnetic tape.

Protection of magnetic tape can be increased by observing and enforcing the following rules:

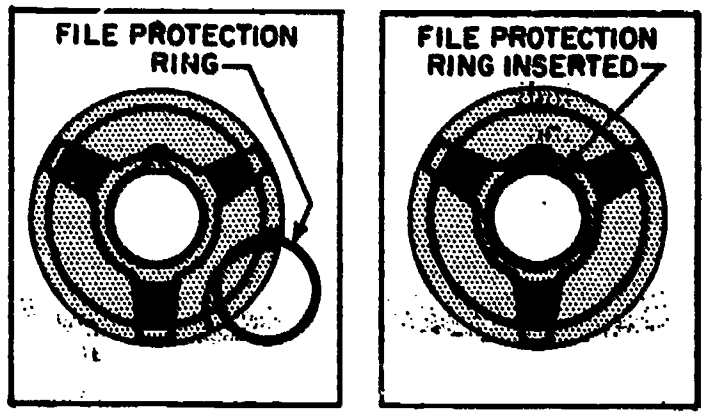
1. Tape reels should be handled near the center, or hub, of the reel.
2. Avoid contact with, and pinching of, tape edges that are exposed through the reel openings.
3. Tighten the mounting hub securely to prevent the reel from wobbling during reading and writing operations.

4. Do NOT fold or wrinkle the tape ends. This could result in uneven tape winding and resultant tape damage.
5. When storing tape reels, use the manufacturer-prescribed devices to prevent the tape from unwinding in the container.
6. Smoking should not be allowed in working spaces where magnetic tape units are installed. Smoking is NEVER permitted while handling magnetic tape, attending tape units, or working in the tape storage area. Ashes may contaminate tapes, and live ashes may cause permanent damage if they come in contact with the tape.
7. Avoid dropping tape reels.
8. Never use the top of a tape unit as a working area. Materials placed on top of the units are exposed to heat and dust from the blowers in the unit. Interference with tape unit cooling will also result.
9. Always follow the rules and procedures as established by your activity or installation.

FILE PROTECTION

A magnetic tape which has previously been used for recording data need not be erased from beginning to end prior to using it for another writing operation, since erasure of old data takes place just prior to the recording of new data. This feature of magnetic tape creates a necessity for providing a method whereby data files cannot be destroyed accidentally in the event tape reels containing valid data are mistakenly loaded for writing. Tape reels have a circular groove molded in the back of the reel (fig. 11-5), which permits the insertion of a plastic file protection ring, or adapter rim. When the reel is loaded, this protection device depresses a switch protruding from the tape reel panel, setting up the condition necessary to allow data to be written. The absence of the file protection ring from a file reel causes an indicator light on the transport unit to turn on, signaling that no writing can take place.

Either reading or writing can be performed when the file protection ring is inserted in the file reel. When the device is removed, writing is suppressed and reading only can be accomplished. An easy way to remember if a file reel should or should not have the protection device inserted is "no ring, no write."



The file protection device is a plastic ring that fits into a round groove molded in the tape reel. When the ring is in place, either reading or writing can occur. When the ring is removed, writing is suppressed and only reading can take place; thus, the file is protected from accidental erasure.

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Figure 11-5.—File protection device.

TAPE DRIVES

A device utilized to move magnetic tape past a read or write head is a tape drive. This term is synonymous with tape transport, tape unit (IBM) or servo (UNIVAC). What the device is referred to as other than the glossary (Navy accepted) tape drive is usually decided by the manufacturer.

The controls differ in name as widely as the devices. Basically, all tape drives must be capable of having keys or switches to control: power on/off, start, automatic or manual, logical channel address, rewind and reading or writing settings.

A DENSITY switch is available on some to control the reading or writing of LOW or HIGH density. Density refers to the number of bits (magnetized spots) for one track capable of being recorded per unit of length (usually an inch). This means we can produce magnetic tape output recorded at low density (e.g.—200 bits per inch) or high density (e.g.—556 bits per inch).

Indicators or lights are usually available for on/off indication of operations or for malfunctions. Some general indicators are:

An indicator that lights when the tape unit is in use by the CPU.

An indicator that lights when the tape is at LOAD POINT (beginning of read or write portion of the tape).

An indicator to show power is on.

An indicator(s) to show blown fuses.

These keys and lights may vary from manufacturer to manufacturer and from model to model. Specific operating procedures are available at each command for its particular system.

Basically, there are three types of tape drives. Type here refers to the method of tape tension or loading procedures. The types are: vacuum column, tension arm and cartridge. Cartridge is not widely used in the Navy and will not be discussed.

The vacuum column type (figure 11-6) provides for a loop of tape from the FILE REEL to the read/write head which then loops to the MACHINE REEL. The file reel is the tape reel containing data to be read or a tape to be written on and is always mounted on the left spindle. The machine reel or work reel is the reel which receives the file reel tape. When the operation is finished, it is rewound to the file reel.

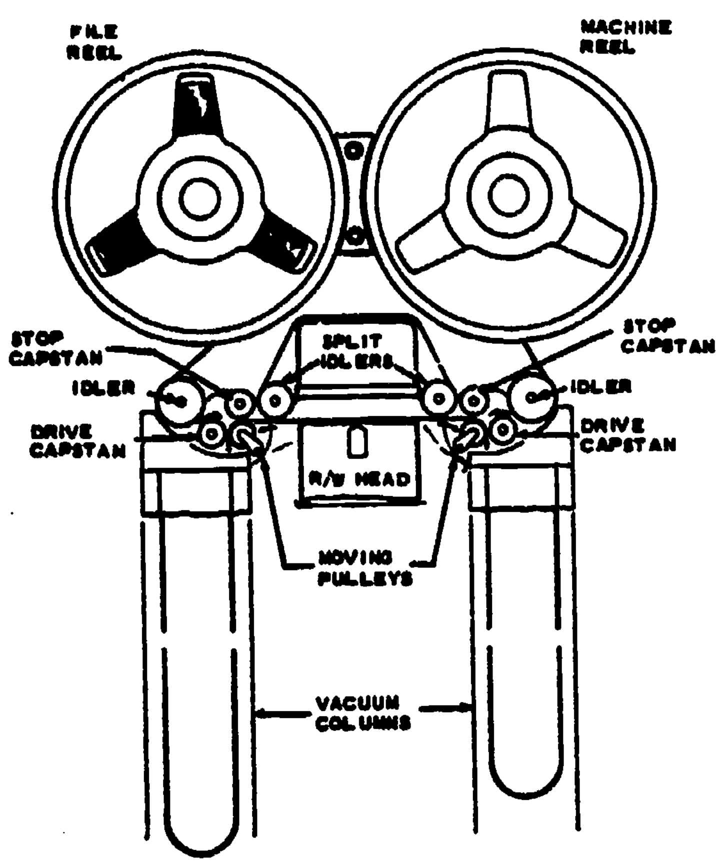

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Figure 11-6.—Tape feed unit.

The vacuum column type allows loops of tape to act as a buffer for the sudden start and stop action of the tape. Vacuum actuated switches in the columns control magnetic clutches that permit the two reels to rotate independently. The file reel feeds when the loop reaches a minimum reserve length in the left vacuum column. The machine reel winds tape when the loop reaches a point near the bottom of the right vacuum column.

The tension arm type (figure 11-7) allows for a type of back and forth looping around spring loaded tension arms before and after the read/write head. Approximately five feet of tape are looped around each tension arm. The tension arms close and open due to the tension from the tape movement to prevent tape damage during starting and stopping action.

With this type of tape drive the file reel is mounted on the top spindle and the machine reel on the bottom.

The actual steps for mounting a tape reel on either type of tape drive will not be discussed in this manual. Your supervisor or an appointed operator should closely supervise you in this training. Damage to the tapes, tension arms, vacuum columns and other parts of the tape drives can happen easily. DO NOT ATTEMPT TO MOUNT A TAPE REEL WITHOUT PROPER SUPERVISION.

UNIVAC 1240 CONTROLS

There are several lights and switches that you should be familiar with for basic operation of a 1240 tape drive. Foldout 11-1, at the end of the chapter, shows a four-handler unit (A), the power control unit (B) and the lower section of the control panel (C).

The following is an explanation of the lights and switches from left to right on the power control unit.

POWER ON/OFF.—This is a three position toggle switch. This switch when ON (up) sets relays and applies primary power to the power supplies and blower. All power is removed when the switch is tripped OFF (down).

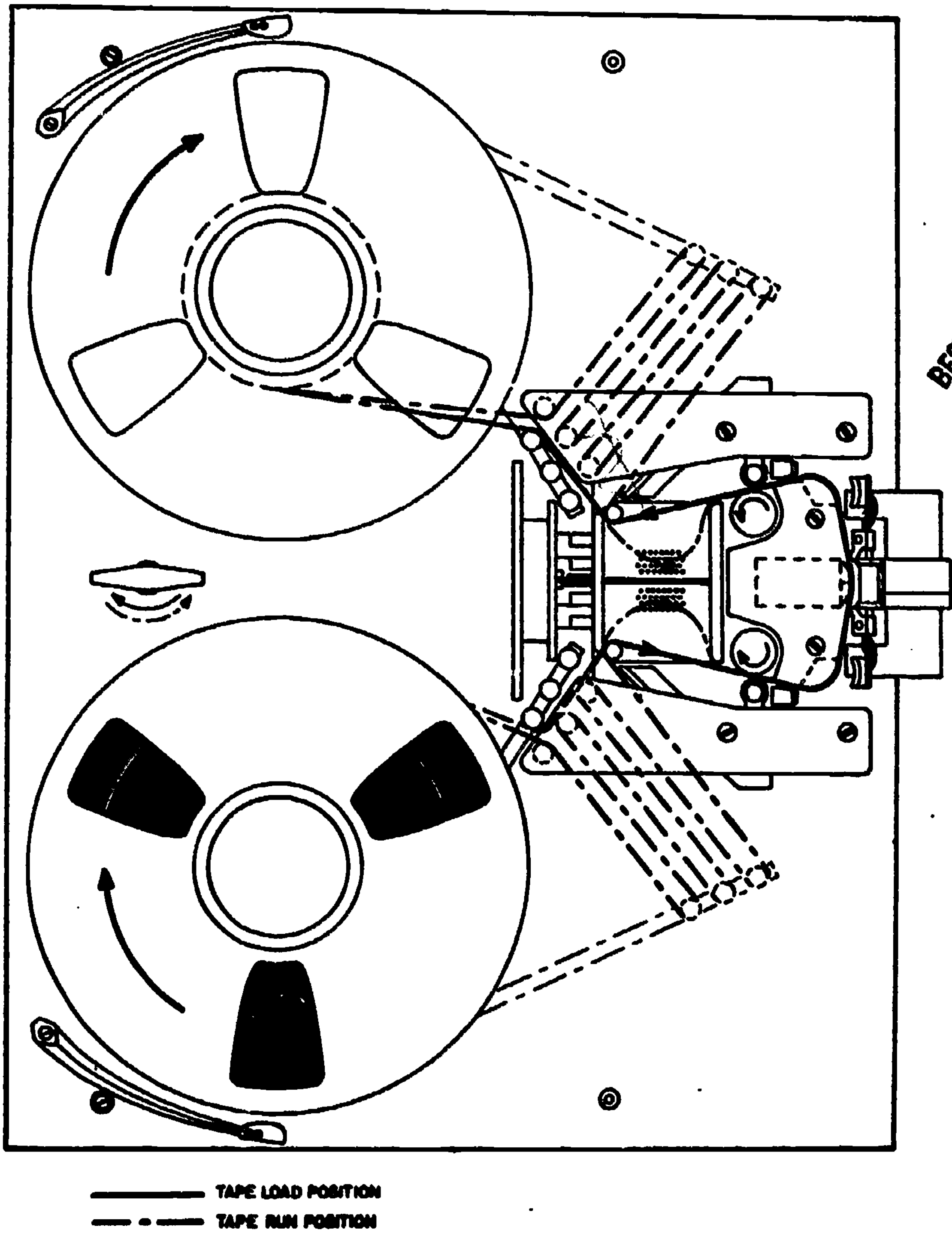

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Figure 11-7.—Magnetic tape unit using tension arms.

LOGIC INDICATOR.—A green indicator that should light when power is applied to the logic power supply.

BLOWERS INDICATOR.—A green indicator that should light when power is applied to the blower circuits.

ALARM BYPASS.—This is a two position switch. In the down position this switch allows activation of an audible alarm in case of overheating during operation. The up position disables the alarm.

OVER TEMP.—This is a red indicator that illuminates when excessive temperature occurs.

The next four switches are called HANDLER SWITCHES. There is one handler switch for each PHYSICAL TAPE DRIVE as numbered on the face of the 1240 (foldout 11-1A). Each of these switches has the same settings and operates the same way for its respective physical drive. The settings function as follows:

MAN.–This setting applies power to its respective drive and permits manual operation (loading, unloading, hand reeling).

OFF.–This setting removes power from its respective drive.

AUTO.–This setting applies power to its respective drive and permits automatic (on line or off line) operation.

OVER TEMP.–Same as the other overtemperature indicator.

The switches, lights and buttons on the lower section of the control panel (foldout 11-1C) are in four groups. Each group is for control of one physical drive. The top right is for physical drive number one, the lower right for physical drive number two, the lower left for physical drive number four and the top left for physical drive number three.

Each physical drive is capable of being set to one of four LOGICAL settings. Logical settings are for the convenience of operators in setting up for a job to ensure the program selects the right tape drives for input and output. An operator's run book will tell the operator which tapes to mount for a particular job. The operator can then mount the tapes on whichever drive he desires. Once the tapes are mounted, he then checks to see which tape (by name or number) is to be on which logical drive. By simply setting the ADDRESS switch to the proper number (1, 2, 3, or 4) for the physical drive the CPU can properly transmit or receive data.

This means physical unit two could hold the input tape and be set at logical number four, and physical unit three could hold the output tape and be set at logical number two.

There may be no duplication of settings. During an operation each drive must be set to a different logical setting.

The lights for each group are also pushbutton controls and operate as follows.

LOAD PT.–This is a pushbutton and indicator. During tape loading this will light when the load point is reached, and the tape will stop. If this is depressed while the tape is running backward in manual operation, the tape will stop.

RWD.–This is a pushbutton and indicator. When depressed, this causes the tape to move backward at a high speed rate of 225 inches per second until the last 100 feet rewind. During the last 100 feet tape movement is slowed to 112.5 inches per second and stops at load point.

REV.–This is a pushbutton and indicator. When depressed, the tape will move backward at the rate of 112.5 inches per second.

STOP.–This is a pushbutton that when depressed will stop tape motion.

FWD.–This is a pushbutton and indicator. When depressed, the tape will move forward at 112.5 inches per second. (During this forward motion the speed may be increased to 225 inches per second by depressing and holding the RWD pushbutton.)

EOT.–This is a pushbutton and indicator. This illuminates when the end of tape is detected. If operating in the manual mode and running forward, depression will cause simulation of end of tape, and the tape will stop in one-half second and light the EOT.

READY.–This is a pushbutton and indicator. It illuminates when the handler switch is set other than off.

SELECT.–This is a pushbutton and indicator. This lights to indicate that the transport has been selected for operation under AUTO setting only.

WRITE ENABLE.–This is a pushbutton and indicator. This must be depressed by the operator to permit writing on the tape. If the indicator does not light, necessary conditions are

not satisfied, and the write function cannot be performed until this is corrected.

IBM 2420 (MOD 7) CONTROLS

Refer to figure 11-8 for the location of the following operator panel indicator's and controls.

READY.–Indicates the tape unit is properly loaded, the start pushbutton pressed, and tape unit can be activated by the tape control. Turned on by pressing the start pushbutton if:

a. Tape unit is loaded and tape is in columns
b. Reel door is interlocked
c. Tape unit is not searching for load point

Pressing the start key while tape is in motion, as in a load/rewind operation, does not light the ready light until load-rewind is complete. The reel door should not be opened while the ready light is on. Manual control is indicated when light is off if the tape unit is not rewinding or loading and the reel door is closed.

SELECT.–Indicates this tape unit is addressed by the computer. An addressed tape unit must be "ready" before receiving program instructions.

FILE PROTECT.–Indicates that a loaded tape unit is file-protected (can neither write or erase) because:

a. No file reel is mounted or
b. The file reel does not contain a write-enable ring or
c. A load-rewind operation is in progress or
d. An unload operation is in progress.

CB.–Indicates that a circuit breaker tripped, the gate thermal tripped, or a fuse opened.

TAPE INDICATE.–Indicates that a light-to-dark transition at the end of the end-of-tape (EOT) marker was sensed during a forward operation. Indicator is turned off by the light-to-dark transition of the opposite end of the same marker during a backward operation.

LOAD CHECK.–Indicates a thread failure or a tape leader longer than thirty feet.

LOAD-REWIND.–Operative when tape unit is not in ready status. Moves tape to load point if the unit is loaded, or threads tape to load point and loads tape into columns if the unit is unloaded.

START.–Puts the tape unit in ready status and under computer control and turns on ready light if:

a. Reel door is closed.
b. Tape is in columns.
c. Tape unit is not rewinding.

Disables all manual controls except 'reset.'

REWIND-UNLOAD.–Operative if the tape unit is not in ready status or rewinding and tape is in columns. Rewinds tape to load point and unloads tape onto the file reel. Closes cartridge (if used). Opens power window at the end of an unload operation. Opens power window if tape unit is unloaded.

RESET.–Removes tape unit from ready status and computer control. Performs the following:

a. Stops tape during low-speed rewind or
b. Reduces high-speed rewind to low-speed rewind or
c. Stops tape motion during load or unload operations or
d. Turns off load check light and
e. Raises power window

LOADING AND UNLOADING TAPE DRIVES

There are a few things you should look for while handling tapes.

IRREGULAR WINDING

As tape is wound on reels, it is normal for some of its edges to protrude slightly. These irregularities usually result from high-speed rewinding. The speed at which tape moves, during high-speed rewinding, produces the slightly irregular wind due to air being trapped between adjacent layers of tape. This in itself will not

cause improper operation of the tape, but it requires that proper care in handling be exercised by all operators.

REEL WARPAGE

When not being used, tape reels must be properly supported. The plastic container is designed to fully support the reel. A tape reel that is supported in any other manner may become warped.

If a reel is not seated properly on the tape drive hub during use, it will wobble or appear to be warped. If the file protection ring is not completely inserted, it produces the same effect. In either case, the reel behaves as though it were warped, and the edges of the tape can be damaged.

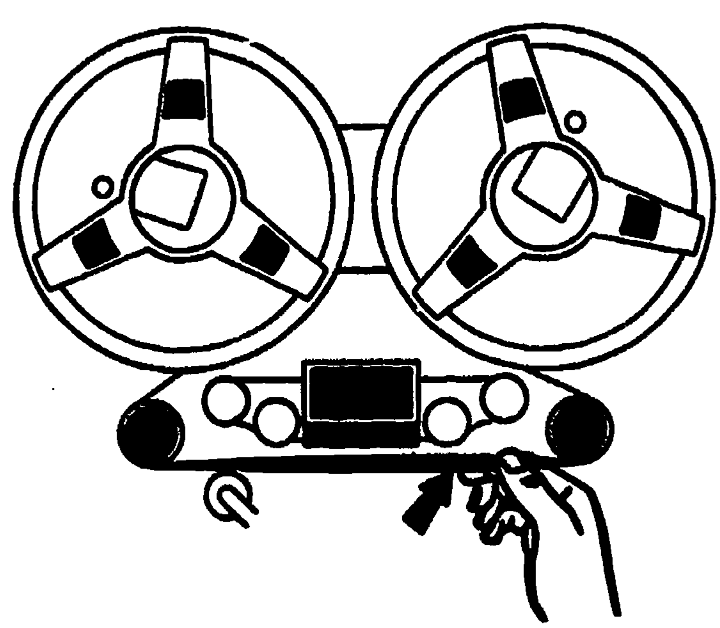
TAPE MARKERS

If, during the mounting of a tape you discover that there is no load-point marker, one must be put on the tape. There also must be an end-of-tape marker at the other end of the tape. The markers are small pieces of transparent plastic with a thin film of aluminum on one side. Pressure-sensitive adhesive covers the aluminum film so that the markers can be pressed onto the tape.

The load-point marker (fig. 11-9) is placed at least 10 feet or more from the beginning of the

49.445

Figure 11-8.–IBM 2420 model 7 magnetic tape unit.

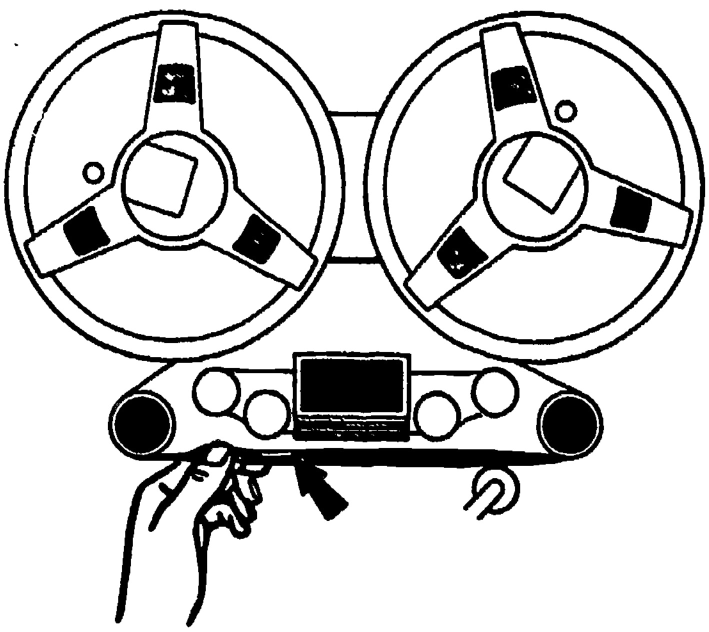


49.367

Figure 11-9.–Load point marker.

tape to provide a leader for threading the tape on the tape unit. This marker is placed on the uncoated (shiny) side of the tape, parallel to, and not more than 1/32 of an inch from, the edge of the tape which is nearest the operator when the reel is loaded.

The end-of-tape marker (fig. 11-10) is placed at least 14 feet from the end of the tape to provide 10 feet of leader and four feet for the recording of data after the end-of-tape marker is sensed. This marker is placed on the uncoated side of the tape, parallel to, and not more than 1/32 of an inch from, the edge of the tape which is nearest the tape unit when the reel is loaded.



49.368
Figure 11-10.—End-of-tape marker.

TAPE CLEANING

Tape failures on your activity's computer can be extremely costly. Careful maintenance of magnetic tape will minimize or even possibly eliminate lost computer time.

The first step in every magnetic tape maintenance program is obviously careful cleaning. The majority of all tape errors result from contaminants which collect on all magnetic tape in normal computer use. This debris is composed mainly of fragments of oxide or backing material dislodged from the tape itself. These particles of "self dirt" cause loss of contact between the computer read/write heads and the surface of the tape. The largest source of such surface dirt is the tape edge.

An effective method of cleaning tape is by using a Magnetic Tape Cleaner similar to the tabletop model shown in figure 11-11, which will clean a 2400-foot tape in approximately six minutes.

A rotating cleaning blade skims off imbedded oxide lumps, dirt, and other foreign particles. Loosened dirt is removed from the tape by wiping assemblies on each side of the blade, which are mounted on turrets. When the end-of-tape marker is sensed by the photoelectric switch, the tape automatically reverses and the wiper turrets adjust to the new tape travel direction and clean the entire length of tape in the opposite direction. The wiping tissue is made of a special texture fabric and mounted on spools.

It is important that wiping material be changed frequently at the point of contact with the tape in order to avoid entrapment and retention of abrasive dirt particles at the tape surface being wiped.

MAGNETIC TAPE LIBRARY

Each computer center that utilizes magnetic tape records should have a tape library for proper control and storage of magnetic tapes. A tape library may contain relatively few reels of magnetic tapes or it may contain several thousand. In any case, these reels contain vital records, and an adequate system of control is essential in the filing and maintenance of tape records. A tape librarian, as designated, is the custodian of all tape reels in the library.

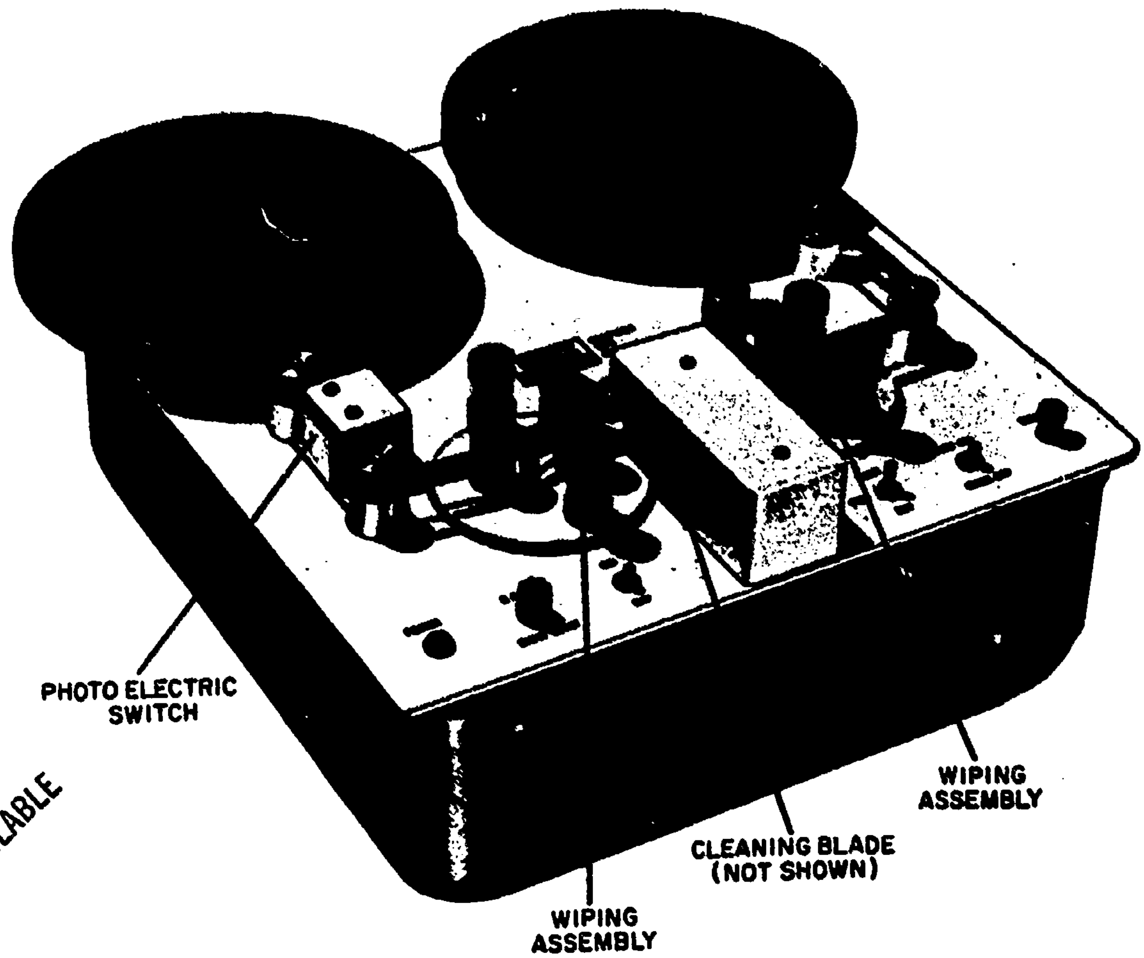
As the tape librarian you should be familiar with the procedures in maintaining a tape library. Before the types of records and controls are discussed, let's get an idea of some of the duties a tape librarian may be required to accomplish:

Retrieve and file magnetic tapes in accordance with schedule.

Maintain and physically inventory tape files.

Control tape reels on a rotational basis.

Prepare tape usage reports.



49.369X

Figure 11-11.–GKI magnetic tape cleaner.

Maintain tape reel use logs, tape labels, and associated files.

Maintain control of certain required data and program files.

Test tapes for quality, clean tapes, and degauss tapes according to schedule or upon release by programmers.

Make recommendations concerning the disposition of faulty or damaged tapes.

File all library material in a neat organized, uniform manner.

LIBRARY CONTROLS

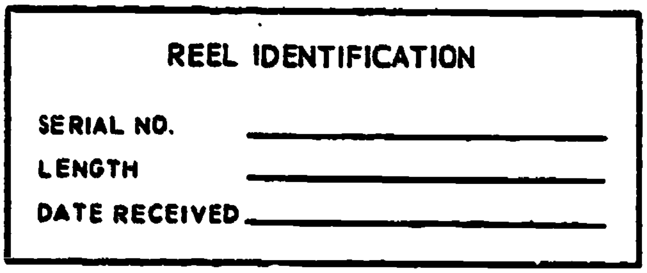
Library controls for magnetic tapes may be set up in various ways as long as they provide the proper control of all tape reels in the computer center. It must be remembered, however, that each time the tape status changes, all records pertaining to that tape must be changed accordingly. Following is one system which may be used to meet these requirements, and is intended only to provide basic ideas and guide lines for maintaining a magnetic tape library.

Every reel of magnetic tape must be correctly labeled. This is accomplished by two external labels which every reel must have. These are called permanent reel and temporary file labels.

Permanent Reel Label

The permanent reel label, in this case, is a paper label with adhesive backing that is physically attached to the side of new reels. An example of this type of label is shown in figure 11-12. Information included on this label is:

Serial number of the reel.
Current length of the tape.
Datè received from the manufacturer.



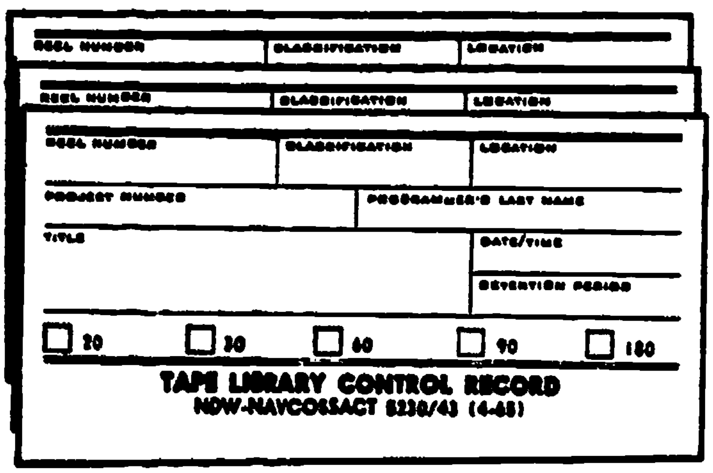
49.319

Figure 11-12.—Permanent reel label.

This label is never removed from the reel. Each tape is assigned a sequential cabinet slot number which shows the permanent storage position for that tape.

Temporary File Label

The temporary file label (figure 11-13) may be a three-part form consisting of one buff copy, one colored copy, and a white tape label with adhesive backing.



49.320

Figure 11-13.—Temporary file label.

The form is hand prepared on all newly generated tapes, showing the reel number, classification, cabinet slot number, programmer's name, identification, the date the tape was created, and the retention period, which is the number of days the tape must be saved before it can go back into the scratch pool. (A scratch tape is a reel of tape on which new information may be written.)

The white tape label is affixed to the reel of magnetic tape, the programmer receives the buff copy for his records, and the tape librarian gets the colored copy.

The tape librarian uses his copy as a source document to be keypunched and interpreted. Once keypunched, the card is filed in the master card file and the document may be kept for historical records, or destroyed. In order to keep the file up to date, this procedure should be followed every day, in order to provide easy and prompt access to any tape by the tape librarian.

A reel which has a temporary file label on it must have the file protect ring removed immediately.

AVAILABILITY OF TAPES

In a data processing application involving punched cards, the method employed in obtaining blank card stock is quite simple; the operator merely draws the required quantity from the blank card storage area. Little control over blank cards is required except to ensure that demand never exceeds the supply. In applications involving magnetic tape the operator cannot draw from a file of new tape reels each time he is to perform a writing operation. This may be the case in newly established systems, but once a system has reached an operational status, procurement of new tapes is limited to those needed for expanded or new operations, or to meet requirements unforeseen in the original planning. The principal source of magnetic tapes, for writing operations in an operational system, is provided through scratch (nonrecord) tapes containing data no longer needed.

One method of controlling available tapes for writing operations involves setting up the tape records on punched cards and maintaining all cards representing record tapes in one file and all cards for scratch tapes in a separate file. Periodic listings for audit and control purposes can be obtained when library records are in the form of punched cards.

It is essential that each tape reel or file be made available when its contents are outdated or

no longer required if an adequate supply of scratch tape is to be assured.

Whenever a programmer wants to release a tape saved by him, he can sign the buff colored form that he received as his record when the tape was created and give it to the tape librarian to delete.

Your involvement in control of tapes as an operator is to ensure that when a scratch tape is used for output that it is properly identified. To do this you must properly mark the tape as to its title in the run book and with the current date. You will then return it to either the programmer or tape librarian for update of the tape library.

TAPE SECURITY

Data on tape must be handled according to its classification the same as paperwork. The responsibility for its stowage may rest with the librarian or the programmer. While it is being utilized, however, the operator must assume the responsibility of not only the tape but whatever output is produced.

The output should be marked with the same grade of classification as the input unless otherwise directed. If signatures are required for its custody, always obtain a signature from whomever you release it to.

Don't forget the carbon paper used in multiple copy printouts or the partial run printouts that have to be restarted.

HIGH SPEED PRINTERS

High speed printers are relatively simple in their function and the associated operator controls. The function is to print information as output. The printing is controlled as to number of lines per page and the body format by the program and the carriage tape. The carriage tape (foldout 11-2F) is similar to that used on the IBM 407 Accounting Machine.

Regardless of the system or the manufacturer, the high speed printers have about the same pushbutton control and light indicators. The controls are usually for turning power on or off, causing paper to skip to the top of the next page and for spacing the paper a line at a time. The lights are usually for indication that the printer is ready for use and to let the operator know that the end of paper supply has been reached.

The operator's major responsibilities are to:

1. Ensure the right carriage tape is installed
2. Ensure the right paper is provided (width or form number and correct carbon numbers)
3. Ensure that each report is started at top of form.

IBM 1403 PRINTER

The IBM 1403 Printer is shown in foldout 11-2A.

The control keys and lights are shown in foldout 11-2B and function as follows:

START.–Pressing the start key places the printer in a ready status if the following conditions are met:

Power on
Forms guide plates closed
Feed-clutch control properly positioned
Carriage-control tape installed
Carriage-brush assembly closed
No error conditions, such as print-check, sync-check, form-check, or end-of-form, exist

The start key on a 1403 attached to the System/360 also permits operating the printer after the end-of-form light is on, until channel 1 of the carriage tape is sensed.

A duplicate start key is located at the rear of the printer for operator convenience.

CHECK RESET.–The check reset key resets a printer error indication. the start key is used to restart the operation.

STOP.–The stop key stops the printer at the completion of the current operation. A duplicate stop key is located at the rear of the machine for operator convenience.

PRINT READY.–The print ready light indicates that the printer has been conditioned by the operator to accept initial instructions and subsequent commands from the system. This light turns off when:

The stop key is pressed
The carriage stop key is pressed
An end-of-form is indicated
An error condition, such as form-check, sync-check or print-check, occurs.

PRINT CHECK.–The print check light indicates a malfunction in the printer circuits. The operation may be retried and, if unsuccessful, service may be required.

END OF FORM.–The end-of-form light turns on and the machine stops when an end-of-form condition occurs.

If an end-of-form occurs during a skip or while spacing within the last form in the printer, the operator should single-cycle print until the next skip to a new form occurs.

FORM CHECK.–The form check light is turned on for any of the following conditions:

Forms not feeding properly through the forms tractors
Forms guide plates open
Carriage-control tape not installed
Carriage brush assembly open
Feed-clutch manual control not properly positioned
Carriage stop key pressed.

SYNC CHECK.–The sync check light turns on when the chain or train is not in synchronization with the compare circuits for the printer. The timing is automatically corrected. Pressing the check-reset key turns off this light.

A sync check may result if the forms cart is not in contact with the grounding straps attached to the base of the machine. (Not applicable to Model N1.)

CARRIAGE SPACE.–Pressing the carriage space key (when printer is not ready) advances the carriage form one space if the clutch is engaged. On System/360 this key is operable only when the printer is not in a not-ready condition.

CARRIAGE RESTORE.–Pressing the carriage restore key positions the carriage at channel 1 (home position) of the carriage tape. If the carriage feed clutch is disengaged, the form does not move. Model N1 also has a duplicate carriage restore key located at the rear for operator convenience.

Note: This key must not be pressed when the printer is printing. Printer operation is unpredictable; carriage runaway may occur. On System/360, this key is operable only when the printer is in a not-ready condition.

SINGLE CYCLE.–Pressing the single-cycle key operates the printer for one line. Pressing the start key returns the printer to normal continuous operation. If an end-of-form condition exists, single-cycle operation can occur only until channel 1 of the carriage tape is sensed.

Note: When the single-cycle key is pressed, control and diagnostic commands are processed (if issued by the processing unit) until a write command is executed. The printer then enters single-cycle mode.

For further details, check the appropriate system publication.

This key is not installed on 1403 printers attached to a System/360 Model 20, except a 2020 submodel 5.

CARRIAGE STOP.–Pressing the carriage stop key stops the carriage operation and turns on the form check light. The form may need to be realigned with the program. Press the check reset key to turn off the form check light.

INDICATOR PANEL LIGHTS

This indicator panel (foldout 11-2G), located below the manual feed clutch control, can enable the operator to easily locate and rectify common trouble sources.

GATE INLK.–The gate interlock light indicates that the print unit is not in position. The print-unit release lever locks this unit in position.

BRUSH INLK.–The brush interlock light indicates that the carriage tape brushes are not latched in position for operation.

SHIFT INLK.–The shift interlock light indicates that the manual feed clutch control is not properly positioned.

THERMAL INLK.–The thermal interlock light indicates that a fuse has burned out and service is required.

HS START.–The high-speed start light indicates that a high-speed skip has been initiated. (This light is not operative on Model 6 and models attached to System/360.)

LS START.–The low-speed start light indicates that a low-speed skip or line spacing has been initiated. (This light is not operative on models attached to System/360.)

HS STOP.–The high-speed stop light indicates that a high-speed skip stop has been initiated. The light is also on when the carriage is not in motion. (This light is not operative on Model 6 and models attached to System/360.)

LS STOP.–The low-speed stop light indicates that a low-speed skip stop has been initiated. The light is also on when the carriage is not in motion. (This light is not operative on models attached to System/360.)

OPERATOR PROCEDURES

For the following procedures refer to foldout 11-2. Only the letters A through I will be given for indication of which specific illustration depicts the item being referenced.

CARRIAGE-CONTROL TAPE INSERTION

1. Raise the printer cover.
2. Turn the feed clutch (E) to neutral.
3. Press the latch on the side of the brush holder (F), and raise the assembly.
4. With the printing on the outside of the tape loop, place the loop over the pin-feed drive wheel so that the pins engage the holes in the tape. Be certain that the line-position numbers are on the right side of the tape loop, as seen from the front of the printer.
5. Place the other end of the loop around the adjustable carriage-control tape idler.
6. Adjust the idler by loosening the locking knob (F) and moving the idler in its track. No noticeable slack should be in the tape, but the tape should not be under tension. Test the tape by pressing the sides of the loop together. There should be some "give." If the tape is too tight, the pinfeed holes will be damaged. Be sure to retighten the locking knob on the idler.
7. Lower brush assembly. A click can be heard when the latch engages.
8. Press the restore key (B). When the tape has returned to the home (channel 1) position, engage the feed clutch.
9. Close the printer cover.

RIBBON CHANGING

To change the ribbon (H) on the 1403 Printer.

1. Raise the printer cover.
2. Pull back and unlock the print unit release lever (C,D). Swing the print unit out.
3. Open the top ribbon cover (D,H).
4. Unlatch the print-line indicator ribbon shield and swing it away from the ribbon, against the forms area. (This is located between the two sets of tractor covers (I) just in back of the ribbon cover (D).)
5. Push the top ribbon roll (H) to the right (hinged side of print unit), lift out the left end of the ribbon roll, and remove the roll from the drive end of the mechanism. (Gloves may be provided with the ribbon.)
6. On printers without the auxiliary ribbon feeding, slip the ribbon from under the ribbon correction roller (H).
7. To remove the bottom roll, press the ribbon roll to the right, lower the left end of the ribbon roll, and remove it from the mechanism.
8. Place the new full ribbon spool on the bottom spindle. Hand-tighten the ribbon to remove slack from in front of the printing mechanism.

FORMS INSERTION

1. Raise the front cover of the printer to gain access to the print unit and forms area.
2. Turn the feed clutch (E) to neutral.

3. Unlock and swing back the print unit by pulling the print-unit release lever (C,D) toward you.

4. Set both the left-hand forms tractors (I) slightly to the left of the first printing position. Pull the tractor until it latches in the appropriate notch.

5. Open the left-hand tractor covers and place the forms over the pins. Close the covers.

6. Open both right-hand tractor covers (I).

7. Move the right-hand tractors to the desired location to line up the right side of the forms. Pull out the tractor pin-latch, and slide the tractor until the pin snaps into the appropriate position.

8. Place the forms over the tractor feed-pins and close the tractor covers.

9. Tighten the tension on the form, using the right-hand tractor vernier (E).

10. To position the form, turn the paper advance knob (E) until the block, line, or area on which the first line of print is to occur is just visible above the ribbon guide bar (except Models 3 and N1). Align the desired hammer position to the form with the lateral print-alignment lever and vernier. Observe the relationship of the markings on the ribbon guide-bar to the form. Now, turn the paper advance knob backward three line spaces (if in six-line neutral, or four line spaces if in eight-line neutral). The form is now properly positioned.

Note: If your printer is a Model 3 or N1, turn the paper advance knob backward four line spaces for six-line operation and five line spaces for 8-line operation. These models have a plastic ribbon shield that is one line-space higher than the ribbon shields of other models of the 1403 printer. The top surface of the extreme left and right ends of the plastic ribbon shield may still be used for vertical forms alignment when the ribbon shield is unlatched from the print unit and swung against the forms.

11. Close and lock the print unit. Be sure to push the print-unit release lever as far back as it can go.

12. Restore the carriage tape to the first printing position by pressing the carriage restore button (B).

13. Set the feed clutch to drive (E). Set it for either six or eight lines per inch depending on the form to be printed.

14. Close the cover of the printer.

15. Position the paper supply on the input-paper cart so that the forms feed straight up into the machine.

16. When printing begins, operator attention is required behind the printer. The first form must be guided between the forms stacker-guide and the machine. Then, the first forms must be adjusted in the stacker so they fold flatly.

UNIVAC 1569 PRINTER

The printer control panel (figure 11-14) contains all the controls and indicators required to operate and monitor the printer once paper and ribbon have been properly installed. The controls and indicators are described as follows:

POWER ON/OFF.–This pushbutton switch is an alternate action indicator/switch. In one case,

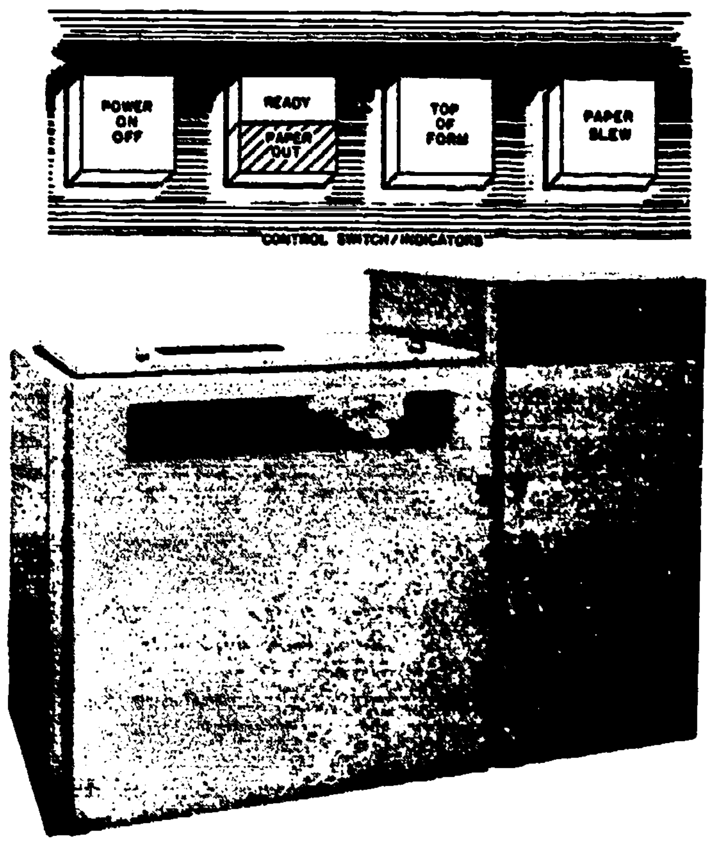


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Figure 11-14.–UNIVAC 1569 high speed printer and controls.

pressing the switch applies power and lights up. In the other case, pressing the switch removes power and extinguishes the indicator.

READY/PAPER OUT.–This is an alternate action pushbutton switch and an indicator capable of signaling two conditions.

As a switch, in one case depression will place the printer in a ready condition, light the top half of the indicator (green) and send a ready signal to the CRPI unit. In the other case, pressing the switch extinguishes the indicator and places the printer in standby.

As an indicator it will light the top half (green) when in a ready condition and the bottom half (red) when an out of paper or torn paper condition exists. If the red indicator lights, the green (ready) indicator will extinguish and the printer will be in a standby condition. With paper reloaded, depression of this switch will extinguish the red (paper out) light, light the green (ready) light and resignal the CRPI unit.

TOP OF FORM.–This is a single action indicator/switch. When depressed, it will light and signal the CRPI to cause paper advance to the next top-of-form position (as indicated by the punched carriage tape).

PAPER SLEW.–This is a single action indicator/switch. When momentarily depressed, it will light and signal the CRPI to cause single spacing paper advance.

PAPER POSITIONING CONTROLS

The paper is positioned in the printer mechanism by three controls; the tractor clamps, the horizontal position control, and the vertical position control. The tractor clamps position the tractors (and paper) horizontally. The horizontal position control provides for making fine horizontal adjustments of plus or minus one character width. The vertical position control provides for positioning the paper vertically, one line up or down.

PAPER TENSIONING CONTROLS

The paper is tensioned by two types of controls: the vertical tension controls and the tractor fine adjustment controls. The vertical tension control is used to tauten the paper between the upper and lower tractors. The fine adjustment controls are adjusted together to tauten the paper between the left and right tractors.

OPERATING INSTRUCTIONS

The printer should be prepared for operation by following the general procedure outlined as follows. Detailed instructions for performing steps 2 through 6 of the following procedure should be provided by on-the-job training.

STEP 1. Perform a visual check of the printer system, making certain that all printed circuit cards are securely in place, fuses are in place and intact, and the air filter is installed and free of dirt.

STEP 2. Check the condition of the ribbon, replacing it if necessary.

STEP 3. Check the paper supply and replenish if necessary.

STEP 4. Check the paper positioning and tensioning controls for proper adjustment.

STEP 5. Make certain the drum gate is closed and secured.

STEP 6. Make certain the tape loop, if one is required, is in good condition and is properly installed in the tape reader.

STEP 7. Apply power to the printer by pressing POWER ON/OFF switch and check each blower to make certain it is operating.

STEP 8. Press the READY switch. When the READY indicator lights, the printer is in a ready condition and will, on command from the CRPI Unit, begin operation.

SYSTEM SETUP

For an example of system setup the UNIVAC 1500 system will be referenced. The controls for all but the CPU (1218) have previously been illustrated and listed. Refer to the previous illustrations for each piece of hardware in the following procedures.

The choice of which device to power up first is up to the operator; therefore, the machine sequence that follows is not mandatory.

TAPE DRIVE

To set up the tape drive (1240) ensure that the handler switches are OFF and then press the POWER LOGIC toggle switch up (ON) and release (foldout 11-1B). The green indicators for logic and blower power should then light.

In the top two control panels next to physical unit 1 are three controls that should be checked (foldout 11-1A). The INACTIVE/NORMAL toggle switch should be set to NORMAL (down); the MODE switch should be dialed to T1; the CLOCK CONTROL switch should be dialed to NORMAL.

The MASTER INSTRUCTION TAPE (MIT–discussed in a later chapter) is then mounted on any one of the physical drives. Once the MIT is threaded through the tension arms and past the read/write head, ensure that enough winds have been taken on the machine reel to go past the load point marker. Set the tension arms, close the buffer cover, close the read/write head cover and secure the unit cover.

If the tape is mounted on physical drive 1, set the logical switch (foldout 11-1C) for that drive to 1. Switch the handler switch for physical drive 1 to MAN. Depress the RWD button for the corresponding drive. The tape then runs backward until loadpoint is reached, and the LOAD PT indicator will light. Turn the handler switch to AUTO. This will cause the READY indicator to come on and finish the 1240 setup.

HIGH-SPEED PRINTER

Setup for the 1569 printer is accomplished by the following procedure. Ensure first that the proper carriage tape is mounted and that there is a sufficient paper supply.

Push the POWER ON/OFF switch. This should cause the indicator to light. Next press the READY/PAPER OUT which will cause the green READY indicator to come on. Depress the TOP OF FORM switch to advance the paper to the top of a new page.

CARD READER-PUNCH-INTERPRETER UNIT

The 1549 (CRPI) and the keyboard printer are both powered up from the controls on the CRPI (figure 11-15). Ensure that the printer

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Figure 11-15.—CRPI unit control panel.

keyboard has a sufficient paper supply. If it does not, a new roll should be mounted.

Push up on the POWER ON/OFF toggle switch; this should light the green DC ON indicator and (in this case) the amber HANDLER FAULT indicator. Set the KEYBOARD ON LINE/OFF LINE and the CARD PROCESSOR ON LINE/OFF LINE switches to OFF LINE. Press the CARD PROCESSOR ON/OFF to ON. This should light the CARD PROCESSOR ON indicator, and the RPI operation should be audible. The handler fault indicator should extinguish.

Set the KEYBOARD PRINTER ON/OFF to ON. Set the PUNCH OVERRIDE switch to OFF Push the MASTER CLEAR/RPI CLEAR to MASTER. Set both ON LINE/OFF LINE switches to ON LINE. Reset the MASTER CLEAR/ RPI CLEAR to MASTER. This second depression of the clear switch should extinguish any fault indicators erroneously lighted. If one or more remain lit, retrace your steps or seek help from your supervisor.

In about five seconds the track motor should shut down.

Loading the Conversion Table

Once you have successfully powered up the CRPI, a conversion table for read in must be loaded into the CRPI memory. The Hollerith Code and special character set to be used should be punched in a card and accessible for the operator.

Place the conversion table card in the card hopper. Depress the CARD PROCESSOR ON LINE/OFF LINE switch to OFF LINE. Depress the RPI CLEAR/MASTER CLEAR switch to MASTER.

Open the left-hand cabinet door under the stackers and you will see two buttons The top button is labeled PUNCH SWITCH, and the bottom one is labeled LOAD TABLE and MODE SWITCH. Push in and HOLD the load table and mode switch with the left hand, and with the right hand reach up and depress the FEED/FEED 1 to FEED 1. Release the load table and mode switch and depress the RPI CLEAR/MASTER CLEAR to MASTER.

The conversion table should now be loaded into the 1549 memory. To ensure it loaded properly, place a blank card in the card hopper and depress and hold the two buttons load table and mode switch and PUNCH. With the right hand again depress the FEED 1. The card that punches out can be sight checked against the original card. If it does not compare correctly, reload the conversion table card.

Once it is correctly loaded, close the cabinet door and reset the card processor to ON LINE. The CRPI is now completely ready for operation.

UNIVAC 1218 CPU

In order to complete the system setup it is necessary to power up the CPU and accomplish a procedure called BOOTSTRAPPING. Before bootstrapping is discussed, it is necessary that the power panel for the 1218 be explained. Figure 11-16 shows the 1218 Power Control Panel.

HOURS METER.–Cumulatively records the time that power is supplied to the computer. Range of meter is 0 to 999.99 hours and cannot be reset.

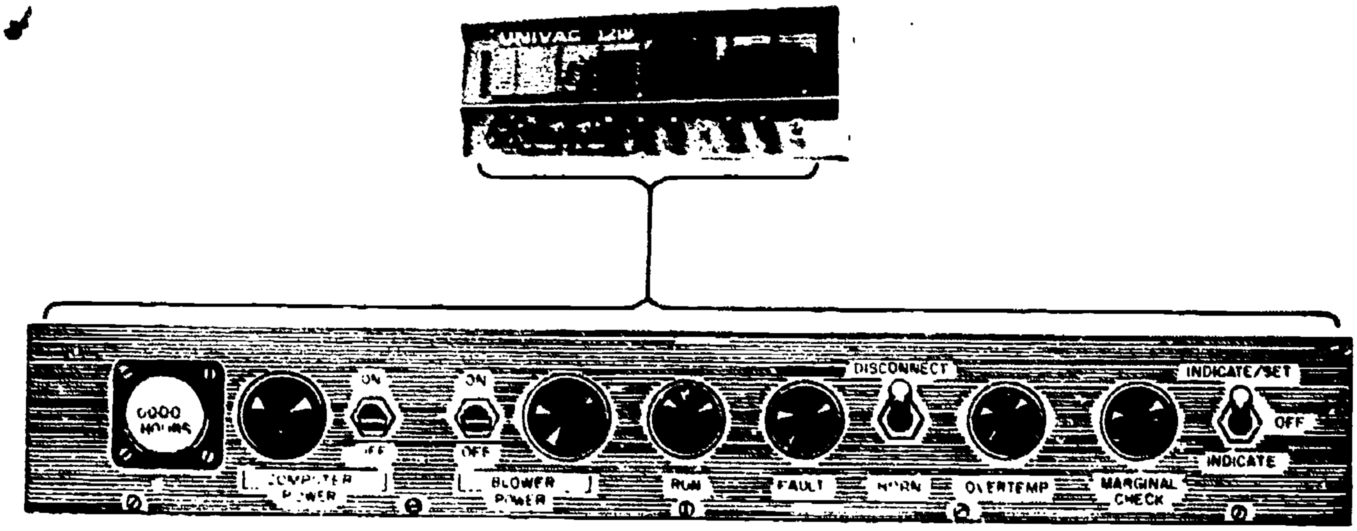
COMPUTER POWER ON INDICATOR.–Lights whenever power is being supplied to the computer.

COMPUTER POWER SWITCH.–Momentarily in the ON position, supplies power to the computer if blower power is on.

BLOWER POWER SWITCH.–Momentarily in the ON position, supplies power to the blowers and enables computer power. In the OFF position extinguishes computer power.

BLOWER POWER ON INDICATOR.–Lights whenever power is being supplied to the blowers.

FAULT INDICATOR.–Lights whenever the computer detects an illegal function code of 00,01 (FORMAT I or II) or 77 in the F register. It is extinguished by placing MASTER/CLEAR/ I/O/CLEAR switch to the MASTER CLEAR position, whether the computer is running or not.



120.100.2(49C)A

Figure 11-16.—1218 power control panel.

MARGINAL CHECK INDICATOR.—Lights whenever Marginal Check Switch is at High or Low position.

FAULT DISCONNECT/HORN SWITCH.—Placing this switch in the Disconnect position shuts OFF horn. In the Horn position, switch enables horn for all faults.

OVERTEMP INDICATOR.—Lights when computer is in an overtemperature condition. Computer should not be operated in this condition. Overtemperature exists when temperature of computer interior exceeds 115°F.

INDICATE/OFF/INDICATE SET.—Indicate Set supplies power to lamps and allows data to be entered in lamps. (Lamps are the dual purpose pushbutton/ indicators.)

Indicate Set supplies power to lamps only. Off does not supply power to lamps; no data can be entered.

RUN INDICATOR.—Lights when the computer is in any mode of operation other than phase step.

To power up the CPU the four switches on the power control panel should be set as follows:

Computer Power—ON.
Blower Power—ON.
Disconnect/Horn—The setting of this switch is arbitrary and will vary with each activity.
Indicate Set/Indicate—Indicate set.

Bootstrap

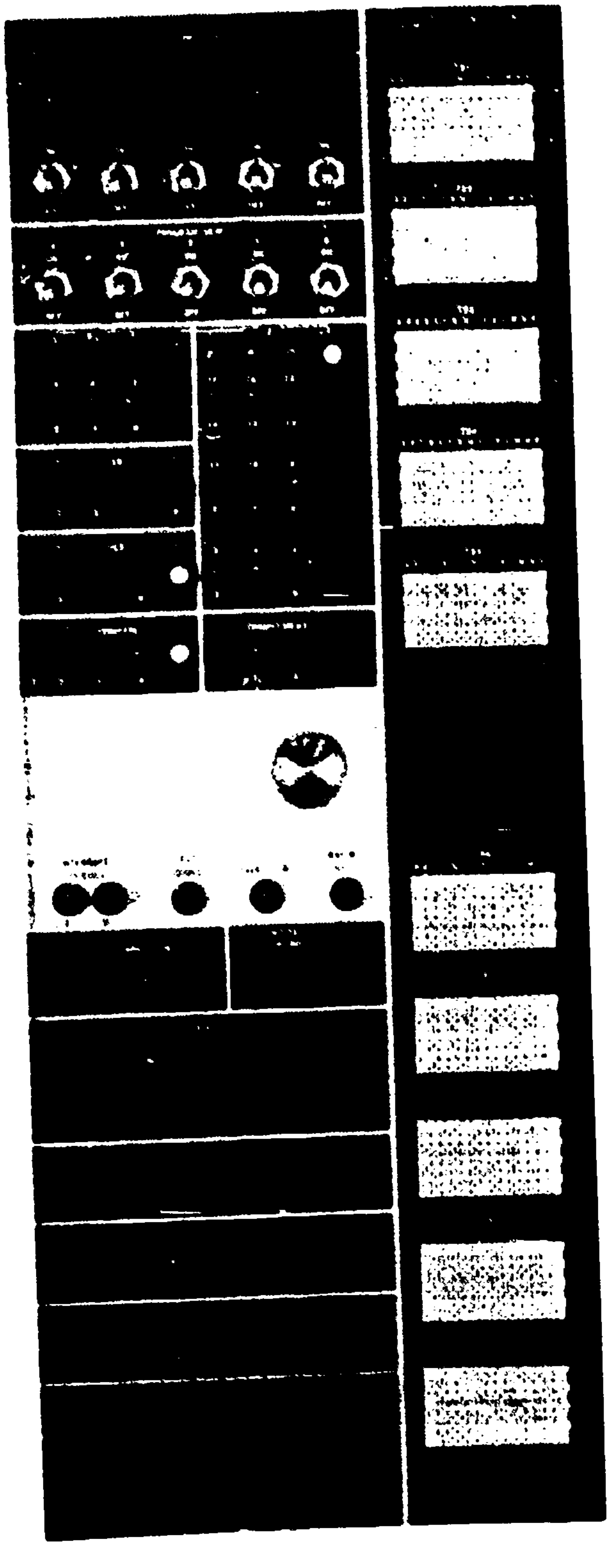
Bootstrap is defined as: A technique or device designed to bring itself into a desired state by means of its own action, e.g., a machine routine (in this case hard wired into the CPU) whose first few instructions are sufficient to bring the rest of itself into the computer from an input device (MIT on logical drive 1).

The operator has only to press the right controls on the CPU control panels to activate the hard wired program (bootstrap). To do this correctly on the 1218 the following procedure is recommended.

On the lower right control panel (figure 11-17) are five PROGRAM STOP and five PROGRAM SKIP toggle switches. Ensure that all ten of these are in the OFF position.

On the bottom portion of the upper right control panel (figure 11-18) are some toggle switches and (in the second set of pushbutton/ indicators up, labeled MODE) one button labeled LOAD that are involved in bootstrapping.

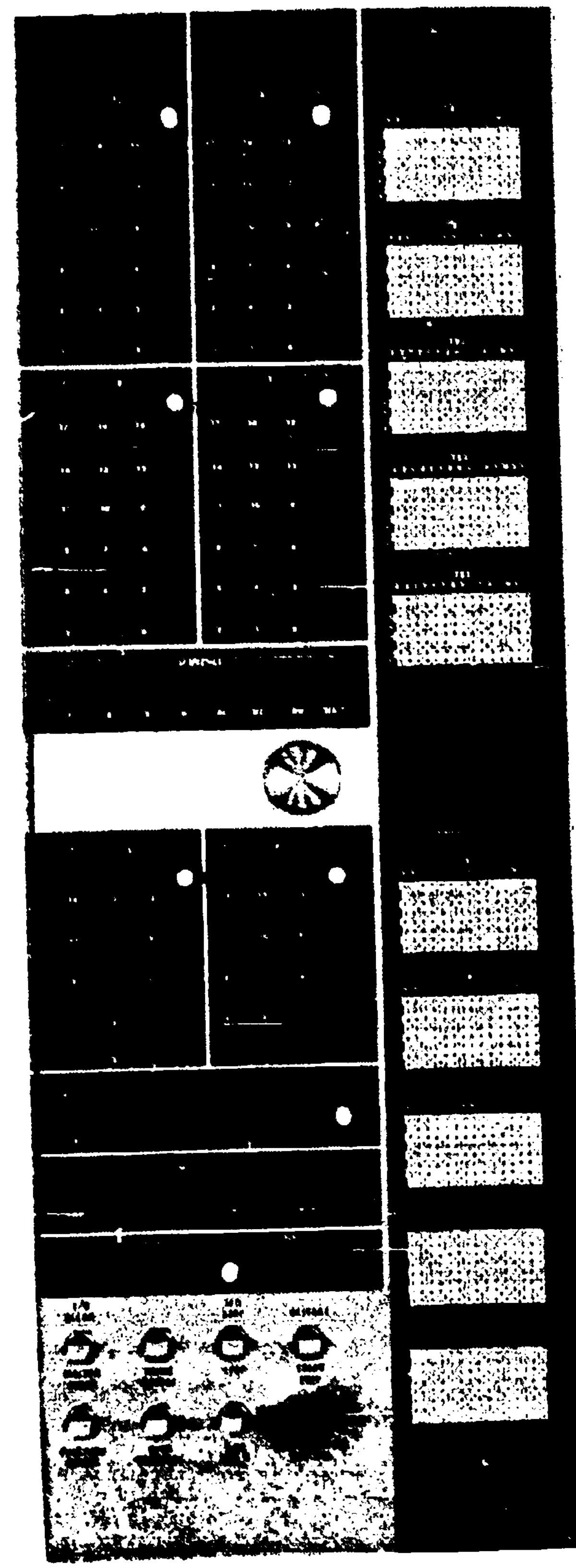
Depress the SEQ STOP/STOP switch to STOP. Depress the I/O CLEAR/MASTER CLEAR to MASTER CLEAR. Push in on the LOAD pushbutton/indicator. Depress the RESTART/START STEP switch to START STEP.



120.100.2(49C)B

Figure 11-17.–1218 lower right control panel.

When this has been completed, the utility programs from the MIT are loaded into memory. These programs (software) are the controlling programs needed in memory to assist and make possible the correct execution of all other programs to be run on the system.



120.100.2(49C)C

Figure 11-18.–1218 upper right control panel.

Once the bootstrap is completed, the following type-out will occur on the keyboard printer:

EXEC 07
DATE?

The operator will then type in the current four-position Julian date followed immediately with a commercial-at (@) sign (e.g., 4196@).

JOB-TO-JOB

From this point on, the job-to-job transition is a matter of calling in the different programs from the MIT by use of the keyboard printer.

There will be instruction sheets (procedures or runbooks) for each job. These instructions will specify the input (card or tape) file names, what logical drive (if tape input) settings are required, keyboard printer type-outs and operator responses required, and the type output to produce.

PROCESSING WITH THE CONSOLE

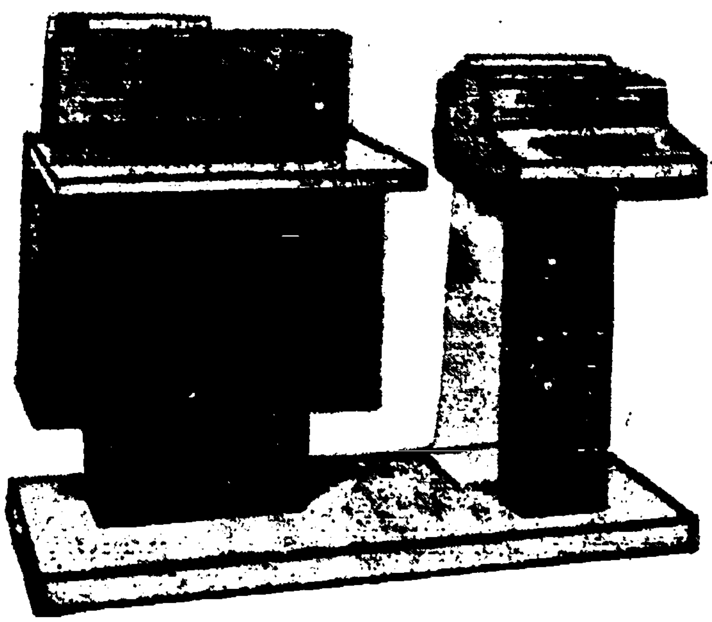
Though external to the central processing unit, the console is frequently referred to as a logical part of it. The computer console has four main functions.

1. Type, or key-in data, special operating instructions, and inquiries for the program during the production run.
2. Determine the contents of special registers and memory locations.
3. Revise the memory location contents.
4. Monitor the status of peripheral devices.

In a data processing system, the console and the program are the communicative links between the computer and the operator. The devices on the console provide the means to start and stop the computer, initiate computations, to select and set the proper magnetic tape units, and to control other input-output devices; and they enable the operator to check computer voltage and current levels, power input, temperature, and so on. There are wide variations in the consoles for different computers. In this section some of the features common to most consoles will be described. A small computer console is shown in figure 11-19.

MONITORING OPERATIONS

Through the lights and signals on the console the computer informs the operator as to its internal state. There are in general three types of messages issued by these lights and signals. The first explains computer stoppage during the course of processing the program; the second presents a visual display of the contents of the various registers and storage locations; the third presents the state of the electrical power circuits. Some consoles display all conditions via a typewritten message. When a computer stops or halts, one or several lights come on, indicating the cause or causes of the halt, a final stop, or stop instruction has been executed, or an erroneous operation code in the instruction being processed, or an invalid address, or a check stop. Most consoles are constructed to display the contents of certain registers by means of rows of lights when the computer processing stops. For instance, there may be a set of neon lights to represent the contents of the instruction register, the accumulator, or of some storage location, and so on. The value of register/storage



49.446
Figure 11-19.—IBM 2150 console with printer keyboard.

content is represented by the lighted or unlighted lights.

MANUAL CONTROL

The buttons and switches on the console provide the only means that the computer operator has to control the machine, other than the program itself. In addition to the on-off-switch for the electrical power, there is a start button which initiates the computations. For example, the machine may automatically take as the first instruction the contents of address 0000 when the start button is pushed. In addition, there is a stop button that causes computations to cease when pushed. There may also be a run button in addition to the start button, which is used to resume computations after a halt has occurred in the middle of a computation. The difference between the start and run button is that the run button tells the computer to continue to perform the instruction that it has in the instruction register, whereas the start button tells the computer to return to the first instruction in the program.

Generally, computers can be operated in several modes. For example, by setting the proper switch a computer can be set to execute only a single instruction each time the run or start button is depressed. By successively depressing the run button in this way, a sequence of instructions can be "stepped through" slowly. This would be done if examination of several instructions and their results, as displayed on the console, were desired. The computer can be made to sequence itself through the program instructions at a considerably reduced speed by a different setting of the mode switch. The mode switch can be set to allow the computer to operate at full speed. On many consoles there is a phase selector switch which makes the computer proceed through a single phase for each depression of the run button.

One of the most important uses of the operator's console is to enable the operator to insert data manually into particular storage locations. This may be done when it is necessary to correct one or two words in a long program that has already been entered into storage. To accomplish this, several methods are used. One method involves having one button associated with each bit position in the registers so that each bit may be displayed by lights on the console. The contents of the register may be changed by means of these buttons, once the computer has been halted. For each register that has a clear button, the contents of that register can be set to zeros, when the respective clear button has been pushed. Then 1's are inserted in the desired bit locations when the bit buttons of that register are depressed. In this case, the procedure for inserting a word into a particular storage location would be as follows: halt the computer; manually insert the desired word in the accumulator; insert an instruction in the instruction register that will transfer the contents of the accumulator into the desired storage location; set the mode switch for a single instruction, and push the run button. The inserted instruction will then be executed, and the word will be inserted into the specified address.

Another method for inserting corrected data involves the use of an on-line typewriter, by which words and instructions are typed in the format prescribed for the particular system and introduced automatically into the computer.

INQUIRY STATIONS

Inquiry stations are the connecting links between remote operators and information stored in a centrally located computer. The computer can be queried by an operator on site, via operator's console, or by an operator at a remote point, via a console inquiry station. To use a hypothetical situation, assume that you are working at an issue counter in a naval supply depot that has a data processing system with remote console inquiry stations. As requisitions are brought to you to be filled, you may wish to know if your warehouse has a particular item in stock, and, if so, how many. To get this information without making a trip to the warehouse, all you have to do is type the part number or numbers on an on-line typewriter. This information is transmitted to the data processing center where a paper tape is punched and read into the computer. The computer then selects the proper storage files and transmits all information keyed to the part number or numbers back to the console inquiry station where

the message is typed out automatically. In this way, information is supplied in a matter of a few minutes, enabling fulfillment of requisitions to be expedited.

DATA CONTROL CHECKS

Data control checks consist of methods developed to control the information flow into and out of a data processing system. These checks also give assurance that all information received was correctly included in the required output. These controls also include methods devised to establish an audit trail should an omission or duplication occur. Without an established audit trail, retracing an entire procedure may be necessary to locate an error.

Every data processing application must have some form of data control checks. Because individual activities may require different control checks, we will not go into a detailed discussion of them. The control and method used will be determined by the requirement of each activity; however, in all instances the following areas should be covered:

Assurance that all input data are accurate.

Arrangement of data in a form best suited for use by the computer.

Assurance that all data are complete and not duplicated.

Provide a means of auditing the steps of the procedure so that in the event of error or inconsistency the trouble may be located with minimum lost time.

SYSTEM CHECKS

Systems checks are controls, within the computer system, designed to control the overall operation of a data processing procedure. Systems checks ensure that all data required for processing are received and that all output data are complete and accurate.

Controls may be included to ensure that all input records are for a current processing period and unrelated or incorrect records are excluded. Distribution of detail transactions to update master records, when distribution is made by coding, may also be verified by these checks.

With each computer application, systems checks vary, as do the types of systems checks with each particular type of computing equipment. Particular attention should be paid to incorporating systems checks during the early stages of planning the application, because such controls can be fitted into the program more effectively at this time. In some cases the procedure must be modified to incorporate the most efficient controls; usually this is less costly than designing a procedure without the required controls.

Procedures requiring strict accounting controls with provision for audit trails requires that the program for the application be designed to take full advantage of the data processing system's built-in reliability.

In some systems, built-in checking features make detailed systems checks unnecessary, while data manipulation in the CPU of others is less stringently checked.

In computer applications checking is a form of quality control. It follows that, when errors can be tolerated to a degree, systems checks may be used more sparingly. Some specific systems checks are discussed in the following paragraphs.

Record Counts and Control Totals

Record counts and control totals are established when the file is assembled or first calculated as the case may be.

A record count is a total of the number of records contained in a file. A record count is established when the file is assembled, or in the case of magnetic tape, the count is established when the file is written. At the end of the file or reel the number of records is carried as a control total. Adjustments are made to the control total as records are added or deleted. A recount of the records is performed each time the file is processed and this count is compared or balanced against the original or adjusted total as the case may be. If the counts are in agreement, it is accepted as proof that all records have been run.

Utilizing the record count as a control, it is very difficult to determine the cause of an error if the counts are not in agreement. This is because the record count does not identify the missing record nor does it indicate which record

has been processed more than once. Therefore, the records must be checked against the source records, a duplicate file, or a listing containing all of the original records.

On magnetic tape the record count that does not agree usually indicates a read error because once written on tape, a record is not usually misplaced or lost.

Control totals are usually composed of accumulated amounts or quantity fields in a group of records. When the file is originated or first calculated, either manually or by machine, the control totals are established or accumulated. The control can be on the level of a grand total, but would be more convenient on a major, intermediate, or more minor total.

During processing the fields are again accumulated and the results are compared against the control total. If in agreement, they serve as proof that all records have been processed.

An efficient checking system can be developed using control totals when they are used to predetermine a calculation or update procedure. For example, in a payroll application, employees' total hours worked can be preestablished from clock or job-card records. This figure then becomes the control total for all subsequent reports. Totals may be broken down into different control groups, such as work centers and clock stations, but the sum of all totals must balance back to the complete original total.

Normally control totals are established by batches, in convenient size, such as department, work center, and activity. By this method, each group may be balanced and/or corrective action taken as the records are processed. Errors are normally limited to small, easily checked groups rather than to one grand total.

Tape and Disk Labels

Information recorded at the beginning and/or ending of a reel of magnetic tape are called the header label and the trailer label, respectively. They are used for proper file identification. The label may specify or identify the job total and/or number, the last processing date, reel number, and so on.

While tapes may have both a header and a trailer label located physically before and after the data, disk labels can appear physically anywhere on the volume, as long as the user specifies where it is located.

As an added control, to ensure that the proper records have been processed, the labels are read into storage at the beginning and/or end of a program. The labels may also be used to ensure a true end-of-file or end-of-job and may also include a record count.

Housekeeping Checks

Every program of any value must contain a housekeeping routine. This routine is normally established at the beginning, or first instructions, of every program and is intended to perform housekeeping functions prior to processing. These functions may include: setting program switches, moving constants, setting up print area, clearing accumulators or registers, et cetera. Also systems checks may be performed by housekeeping instructions. These include testing to determine if all required input-output devices are attached to the systems and are ready for operation. Housekeeping instructions may calculate constant factors, file labels may be updated and checked, and other information pertinent to the proper operation of the system may, through programmed instructions, be brought to the attention of the operator.

Checkpoints and Restart Procedures

A programmed checking routine is performed at designated processing intervals or checkpoints. The purpose of this routine is to determine if processing has been performed correctly up to a designated checkpoint. Once a checkpoint has been reached by the machine and processing up to that point has been performed correctly, the status of the machine is recorded, usually on magnetic tape (scratch). The normal processing procedure is then continued until the next checkpoint is reached.

Checkpoint procedures are used to break up a long job into a series of small jobs. In this way each portion of the work is run as an independent and separate part, and each part checked once completed. If processing to this point is correct, enough information is written out to make it possible to return automatically

to the last point where a check started. If not, the system restarts from the checkpoint at which the work is known to be correct, and the portion that was not performed correctly is discarded.

A restart procedure:

1. Restores the computer's storage to its status at the preceding checkpoint. This may include reloading the program itself, resetting switches and counters, restoring constants, and making adjustments to accumulated totals.
2. Backs up an entire computer system to the specified point in the procedure, normally to a checkpoint. Card units and printers must be manually adjusted; tape files are rewound or backspaced automatically.

The proper use of checkpoint and restart procedures contributes to the operating efficiency of a computer system. For example, many hours of machine time may be saved after a power failure or serious machine malfunction by simply rerunning a small part of the job (by reloading the data from the tape of the last good checkpoint and restarting the operation).

Interruption of a job that requires immediate or emergency attention is provided through restart procedures. Thus, the operator may interrupt any procedure and replace it with another job if necessary. Restart provisions are also convenient at the end of a work period or shift, when the job must be terminated without loss of production time.

MACHINE CHECKS

Procedures used for machine checks have a twofold function:

1. They accomplish useful work.
2. They control quality and accuracy of work.

Useful work in a data processing procedure consists of sorting, collating, calculating, reading, and printing operations. Operations controls are necessary, to establish and maintain accounting controls, calculation checks, and machine checks. These checking devices are used by the programmer at his own discretion. Basically, two types of checks may be written: first, checks on the validity of data handled by the input-output devices, and second, checks on the data handled within the computer. These include checking for arithmetic overflows, valid signs of numeric quantities, legitimate instruction codes, and other check indicators.

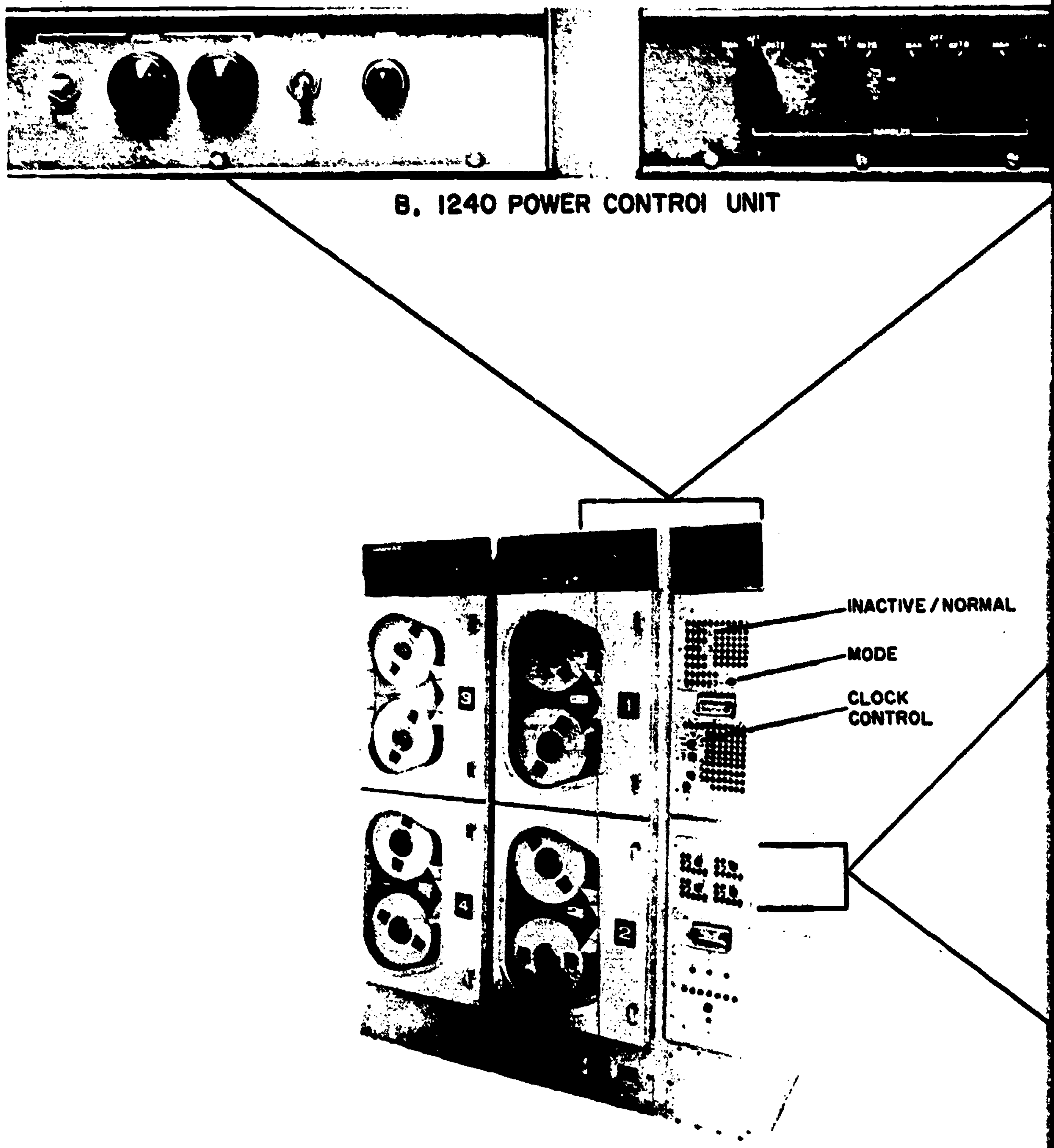
The programmer may insert into the program special branch or transfer instructions designed to handle certain types of errors as exceptions. These instructions prevent unnecessary interruptions of computer operations (halts) upon detection of an error. For example, he may program the machine to backspace the tape and reread the record upon an indication of an error during the reading of a record from tape. At this point if the record is read correctly, normal operations are continued. If not, operations can be interrupted, or the incorrect record can be noted and operations continued. In all systems, however, the interrogations and interruptions of a data processing system are under the control of the programmer.

All processing is halted immediately under some machine check indicators. These indicators include conditions such as: blown fuses, air or humidity conditions beyond the prescribed limits, broken magnetic tapes, or card jams. All these cases must be brought to the operator's attention immediately and, therefore, cause the system to halt.

Summary

Most of these checks are either programmer or operator choices. If the programmer chooses to implement any of the check procedures in his programs, he will include the necessary instructions in his program and ensure correct documentation is available in the run book. If the program is correctly documented, the operator can ensure the proper controls are set (if required) prior to running the job.

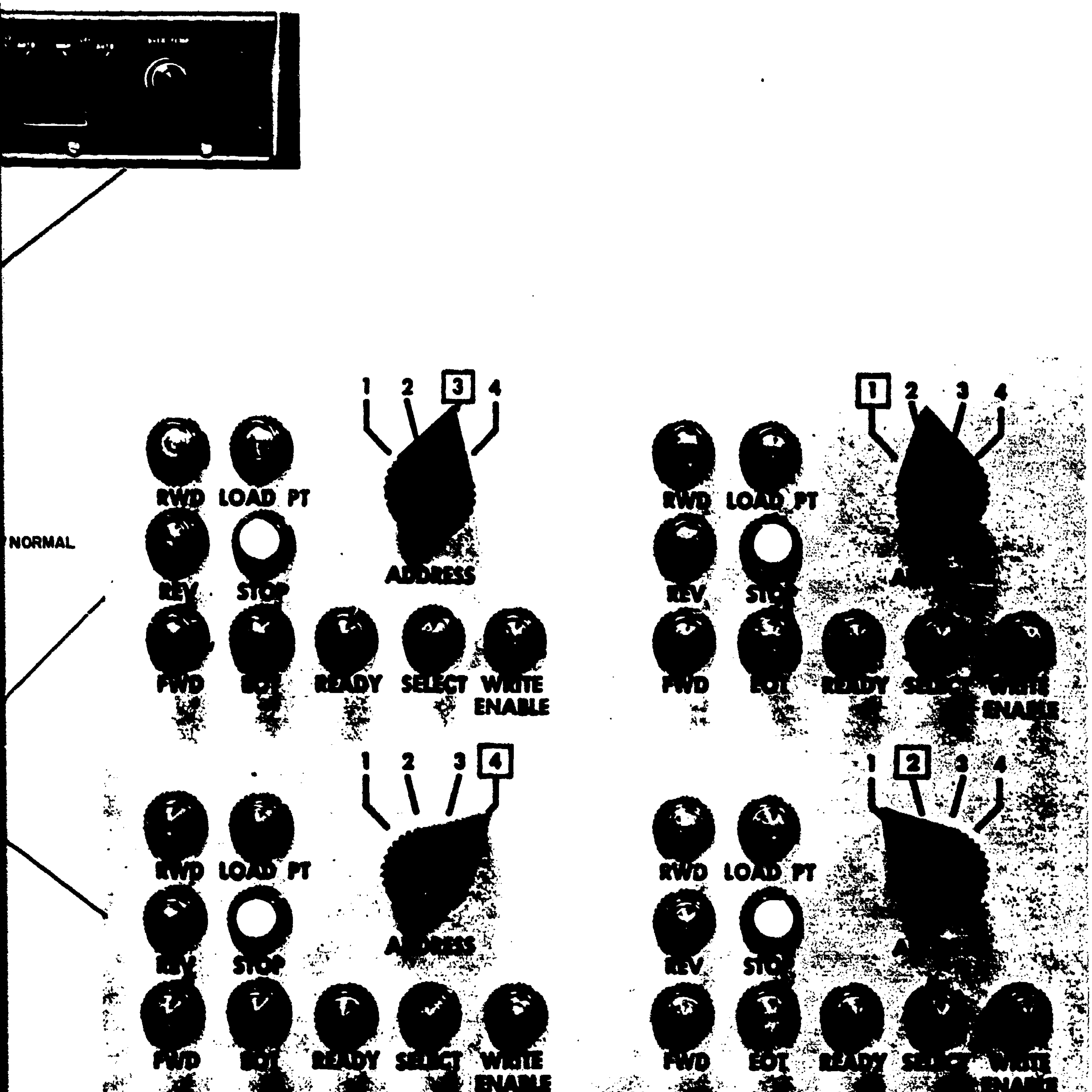
On the other hand, the operator may find certain precautions are required due to system or power peculiarities and implement certain checks as standard practice. These checks should also be recorded in the run book by the operator so that other operators will be able to successfully complete jobs.



B. 1240 POWER CONTROL UNIT

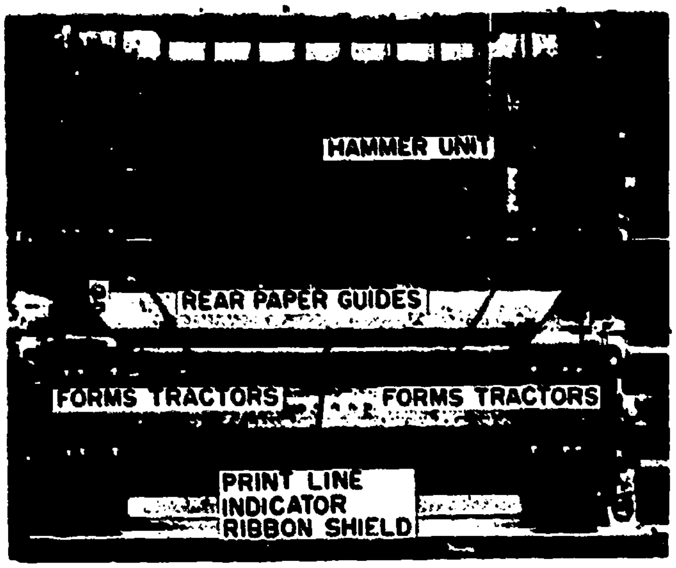
A. UNIVAC 1240 MAGNETIC TAPE UNIT

Foldout 11-1.—UNIVAC Magnetic T

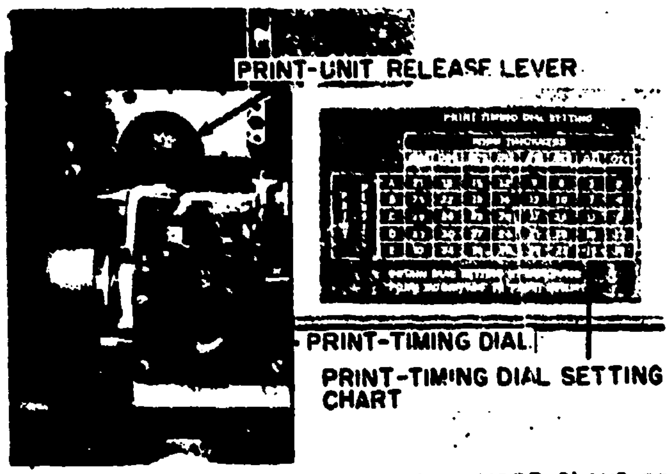


120.100.1(49C)
C Magnetic Tape Unit and controls.

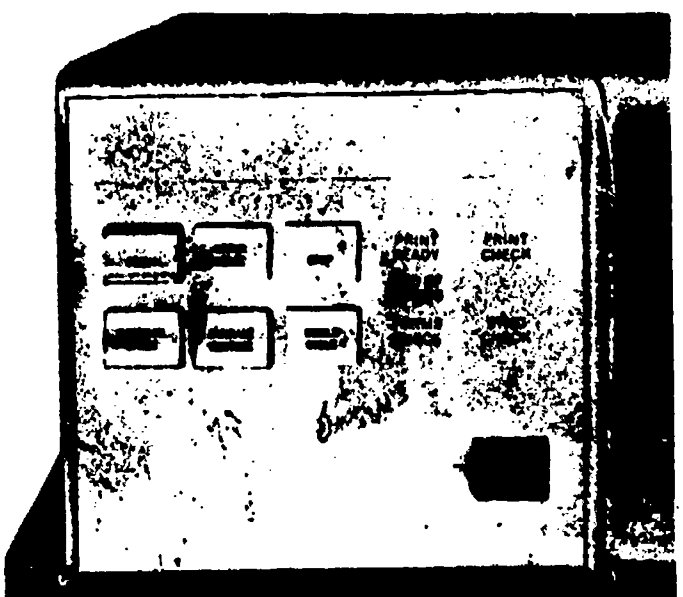
B



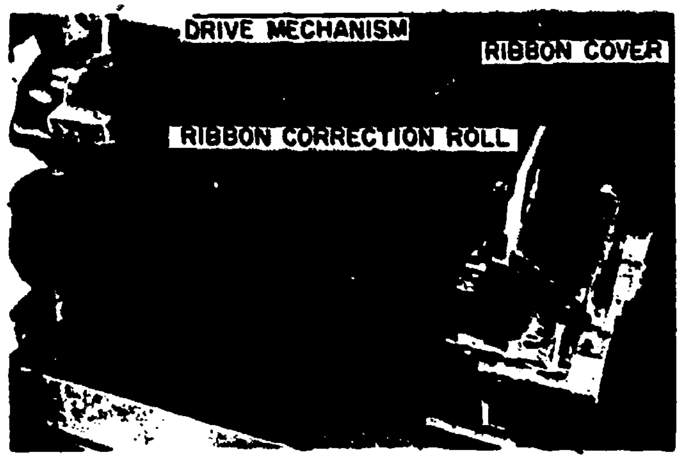
I. FORMS TRACTORS, MODELS 1,2,4,5,6,7



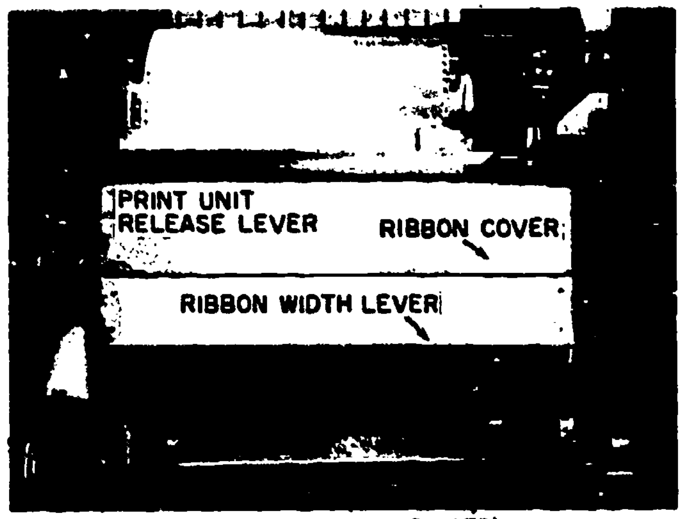
C. PRINT-UNIT RELEASE LEVER (ALL MODELS) AND PRINT-TIMING MODELS 1,2,4,5,6,7



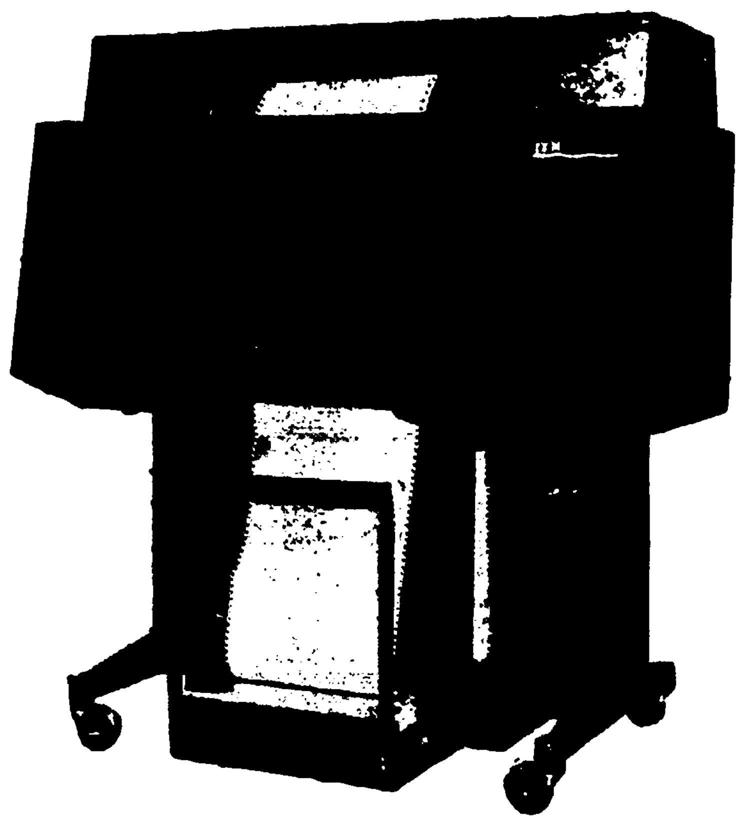
B. OPERATING KEYS AND LIGHTS, MODELS 1 THROUGH 7



H. RIBBON MECHANISM



D. FRONT OF PRINTER (COVER RAISED)

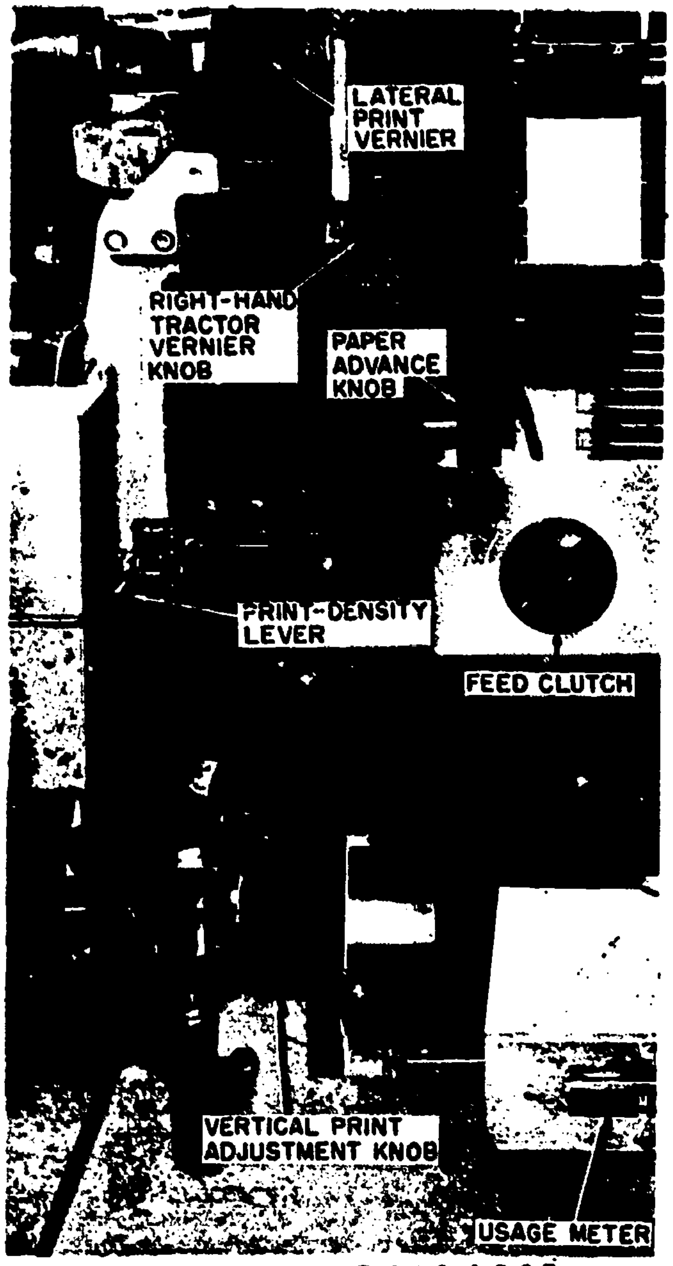


A. 1403 PRINTER

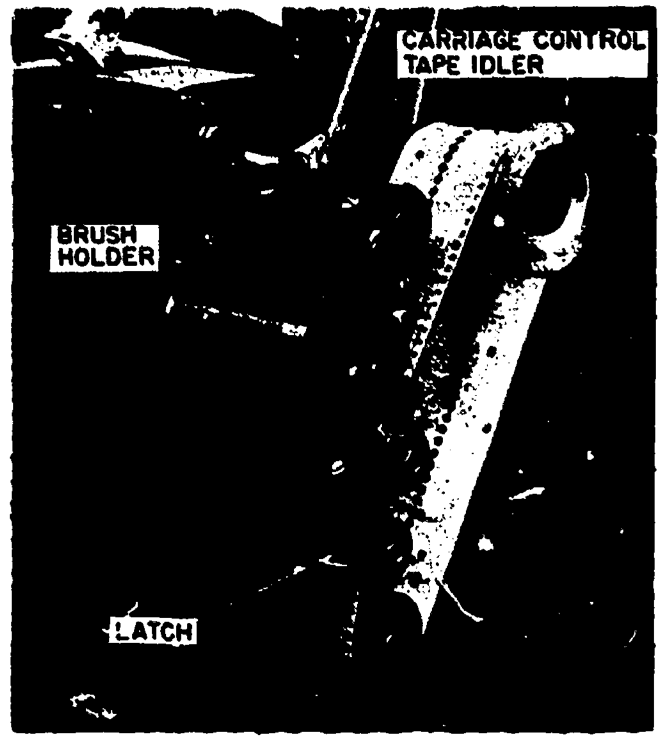
49.166

Foldout 11-2.—IBM Printer Mo

C



E. MANUAL CONTROL, MODELS 1,2,4,5,6,7



F. CARRIAGE CONTROL

G. INDICATOR PANEL

49.166(49C)

1-2.—IBM Printer Model 2.

CHAPTER 12

STORAGE CONCEPTS

Electronic data processing was made possible, in a large way, by the realization that a two-state (on or off—present or not present) condition of material or a similar condition in a device could be grouped together and interpreted (converted) into readable letters and numerals. Eventually the tube type storage (on/off) gave way to the electrically sensed magnetic (present/not present) type of storage.

Today's modern fast memory and input/output (magnetic tape, drum and disk) storage uses this two-state magnetic principle. This means that presence or nonpresence of a magnetic state is sensed for reading and induced for writing.

Most data processing is performed on numerical data, and even alphabetical data are recorded in a numerical code. These coded data within storage are represented by a varying method of grouping (for entry and printout) a few of the numerous positions of a large string of magnetizable elements. This breakup or grouping makes it possible for faster display or entering of data to storage.

These elements of storage capable of having two magnetic states are called CORES. The two-state representation is expressed as BINARY.

NUMBER SYSTEMS

The binary system is a number system as is DECIMAL. We use the decimal system everyday and express values which are readily understood and easy to use. Each position of a written number can have ten different symbols appearing in it (0, 1, 2, 3, 4, 5, 6, 7, 8, or 9). This is not possible in one element (core position) of storage. Therefore, the decimal system must be broken down (converted) to allow it to be used in storage. By the same token, it is important that we understand how a number system is constructed so that we have an idea of how our decimal number appears in storage.

UNIT.—A single object or thing.

NUMBER.—An arbitrary symbol or group of symbols.

RADIX OR BASE.—The number of symbols a number system possesses, including the zero.

QUANTITY.—A number of units (implies both a unit and a number).

MODULUS.—The total number of different numbers or stable conditions that a counting device can indicate. For example, the odometer on most automobiles has a modulus of 100,000 since it indicates all numbers from 00,000 to 99,999. The modulus of the hour hand on most watches is 12, and that of the minute hand is 60.

All numbering systems can be interpreted (converted back to decimal) through POSITIONAL VALUE. This means that each single number (symbol) has a known quantity according to where it appears in the whole number multiplied by that position's value. For example, (in the decimal system) the number 7 in the number 1,754 is representative of the value 700 because 7 times that position's value (100) is 700. This same method applies to all number systems, and once the positional value is determined, a number from any number system can be easily converted to decimal (or from decimal to another system).

THE DECIMAL SYSTEM

The decimal system is most common. Usually, the only problem encountered in determining

the expressed quantity is where the comma appears.

If there is a quantity to be counted, the units involved are usually counted by one's. These one's are accumulated by advancing through the symbols for one position until exhausted. A CARRY then occurs to the next position to the left. The symbol in this carry position represents the number of times the radix or base has been PASSED in the position to its right. For example, the 1 in the TENS position of the numbers 10 through 19 indicates that the ten symbols in the UNITS position (far right) plus one have been utilized (0,1,2,3,4,5,6,7,8,9 PLUS 1 = 10). This holds true for each position to the left of the position that is advancing through the radix. Thus, in the base of ten, the positional value of each position is representative of ten times more than the position to its right.

The positional value for the units position of all number systems is one (1). The values to the left of the units position are arrived at by multiplications of the radix or base. The following example shows some of the positional values for base ten (decimal).

←etc.	10000	1000	100	10	1

Broken down by positional values, the number 7346 can be looked upon as meaning:

$$\begin{array}{rcrcr} 6 & \times & 1 & = & 6 \\ 4 & \times & 10 & = & 40 \\ 3 & \times & 100 & = & 300 \\ 7 & \times & 1000 & = & \underline{7000} \\ & & & & 7346 \end{array}$$

Although the decimal system is familiar to all of us and is not really too difficult to manipulate arithmetically, there are some decided disadvantages to its use in performing calculating operations. Because ten different digits are required to express all possible numbers, a gear or shaft used to express numbers must be able to stop in ten different degrees of rotation. No method has yet been developed whereby any processing means can have ten different and discrete stopping positions and still operate at any appreciable rate of speed.

Another disadvantage of the decimal system is the need for a relatively extensive table for additions and multiplications. There are 100 entries in each table, counting, for instance, 4 X 6 and 6 X 4 as two entries. Although most of us are adept in the use of the tables, this ability has been acquired largely through repeated drills and applications in addition and multiplication tables during our years in school until the tables have become second nature to us.

THE BINARY NUMBER SYSTEM

In searching for a means of performing computations rapidly, scientists discovered ferrous materials could be magnetized or demagnetized at high rates of speed. Such devices as these have only two stable states; magnetized or demagnetized, positive or negative, ON or OFF, or as they are more commonly called, BIT or NO BIT. Thus, by assigning a value to each of these two states, 0 for NO BIT and 1 for BIT, a number system was developed with a base of 2 rather than 10. This is known as the BINARY NUMBER SYSTEM. Such a system, used in all electronic data processing systems, has two definite advantages over the decimal system; it affords simplicity in processing data since only two digits are required, and it enables electronic devices to process data at fantastic speeds.

As the base of the binary system is two rather than ten, two things are immediately evident. There are only two symbols (0 and 1), and the positional values are found by starting with a value of one in the units position and the rest by multiplications of two. The following example shows some of the positional value of base two.

←etc.	128	64	32	16	8	4	2	1

Computers use a set number of magnetic cores as one storage position. Each of these sets (words) holds one element of data. Therefore, each word can be thought of as a binary word. That is, each core of the word is one binary position, and all the positions in one word represent one value.

If a word is 12 binary positions (bits) in length, the positional values would be (from left to right) 2048, 1024, 512, 256, 128, 64, 32, 16,

8, 4, 2 and 1. The total decimal value that could be contained in this word is 4,095. This is one less than the next binary positional value to the left (which holds true for all positional values of all number systems).

If an input card contains the Hollerith coded decimal value of 952, it would appear in a 12-bit position word as

001110111000

The positional values of the binary word containing a bit (1) can be added together, and the sum will equal decimal 952.

The original conversion of decimal 952 to binary was accomplished by subtraction. 952 was less than the binary positional value of 1024 but greater than the positional value of 512, therefore, a bit is placed in the 512 position. By subtracting 512 from the original 952 a value of 440 still has to be represented and is determined by further subtraction as follows:

```
 952
-512   (=1)
 440
-256   (=1)
 184
-128   (=1)
  56
- 32   (=1)
  24
- 16   (=1)
   8
-  8   (=1)
   0
```

All decimal values can be converted to a binary representation in the same manner.

Binary Addition

Binary addition is really quite simple once the rules are learned, because there are so few possibilities. The complete binary addition table is as follows:

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 0 with a 1 carried

The following example illustrates the principle of binary addition:

```
 011000111100
+010100101001
=001100010101
+1   1 1          (Carry)
=101101000101
+       1         (Carry)
=101101100101
```

Binary Subtraction

The table for binary subtraction is not much more complicated than that for addition. The complete binary subtraction table is as follows:

0 - 0 = 0
1 - 1 = 0
1 - 0 = 1
0 - 1 = 1 with 1 borrowed from the next digit

Binary subtraction is illustrated in the following example:

```
 011000111100
-010100101001
=001100010101
-  1        1     (borrowed)
=000100010111
-           1     (borrowed)
=000100010011
```

THE OCTAL NUMBER SYSTEM

One of the major reasons that number systems are required knowledge for Data Processors is for reading CORE DUMPS. Core dumps are printouts of what is actually in memory. This is an extremely useful tool for programmers in determining what went wrong with a program. The printout shows what data was in the computer. This includes data from the input area, counters, registers, output areas, etc.

As this core dump actually depicts the data in core, it seems reasonable that it would consist of pages of 1's and 0's. Because this would be extremely difficult to read and tremendously lengthy, a method was devised to print one value for every so many binary positions. This code or

breakup of a binary word brought about use of the octal number system.

The octal number system is base eight, meaning there are eight symbols (0-7) for each position. This is the minimum and maximum value for the first three positions of a binary word (4,2,1). The following are the possible combinations:

BASE TWO		BASE EIGHT
000	=	0
001	=	1
010	=	2
011	=	3
100	=	4
101	=	5
110	=	6
111	=	7

Therefore, if each 12 position binary word is split into four groups of three binary positions (each group has its positions assigned the positional values 4, 2 and 1), four octal numbers can represent 12 binary positions. Figure 12-1 depicts one 12-bit binary word and its equivalent octal value.

Once the octal core dump has printed out, it is necessary to further convert it to a meaningful decimal value. The programmer (or operator) could convert it back to base two and obtain the decimal value, but the octal system is a number system itself. It has positional values and can be converted directly to decimal.

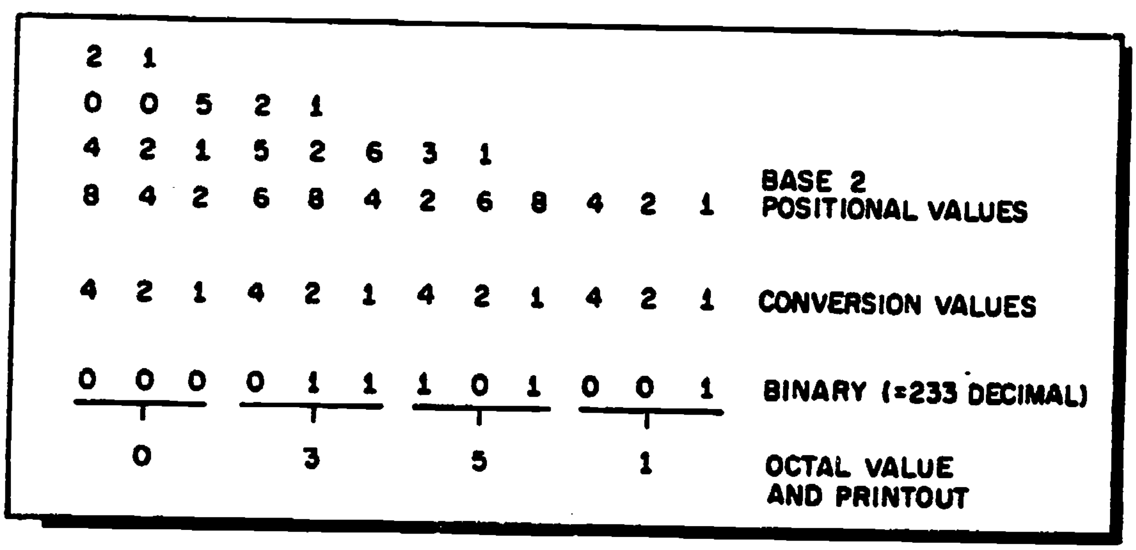
The positional values are determined in the same manner as base two and base ten. Start with a positional value of 1 in the units position and multiply by the base eight for the other positional values. The following example shows some of the positional values for base eight (octal).

←etc.	32768	4096	512	64	8	1

Broken down by positional values, the octal number 351 is converted to a decimal number as follows:

$$\begin{array}{rcrcr} 1 & \times & 1 & = & 1 \\ 5 & \times & 8 & = & 40 \\ 3 & \times & 64 & = & \underline{192} \\ & & & & 233 \end{array}$$

Consequently, 351 (base 8) equals 000011101001 (base 2) equal 233 (base 10), as is shown in figure 12-1. The highest value that may be expressed in one position of octal is 7. (In binary it is 1 and in decimal it is 9.)



49.420

Figure 12-1.—Binary grouping to octal.

Octal Addition

Octal addition is performed in the same manner as addition in any number system. The units positions are added to produce a sum. If this sum exceeds the highest symbol for the base, a carry occurs and is added to the next position to the left. This process continues with each position until the final sum has been found.

As 7 is the highest symbol in octal, when we add 6 and 2 in octal, we count 6, 7, 0 with a carry. In octal, therefore, 6 plus 2 equals 10, which is not TEN but rather one, zero, base eight. Examples of octal addition are as follows:

$$\begin{array}{r} 146 \\ \underline{423} \\ 571 \end{array} \qquad \begin{array}{r} 34 \\ 62 \\ \underline{77} \\ 215 \end{array} \qquad \begin{array}{r} 7210 \\ \underline{570} \\ 10000 \end{array}$$

It can be seen from these examples that if only the written totals were available, one would not know the value represented. That is, the written numbers 571 and 215 by themselves do not indicate a base. They could be base ten or base eight (or any base larger than base eight). The written number 10000 could be base ten, eight or two.

A method of identifying the base is called SUBSCRIPTING. A subscript is a number appearing to the immediate right (and slightly lower) of the units position. This identifies the base in which the number is written. The subscript is NOT part of the value. The following examples illustrate subscripting.

10000_2 (indicates base two) = 16_{10}
10000_8 (indicates base eight) = 4096_{10}
10000_{10} (indicates base ten) = 10000_{10}

By using subscripting it is possible to recognize the number system and convert it to a base useful to you. Numbers in different bases can be indicated and arithmetic functions performed with the resultant sum, product, quotient or whatever answer written in a chosen base. For example:

$$\begin{array}{lclclcr} 1723_8 & = & 1723_8 & = & 1111010011_2 & = & 979_{10} \\ +\ 477_{10} & = & 735_8 \text{ OR} & = & 111011101_2 \text{ OR} & = & 477_{10} \\ +10101_2 & = & 25_8 & = & 10101_2 & = & 21_{10} \\ \hline & & 2705_8 & & 101110001011_2 & & 1477_{10} \end{array}$$

Octal Subtraction

Subtraction of octal numbers follow the same standard rules as decimal subtraction. The number to be subtracted from is called the minuend. The number to be subtracted is the subtrahend. Subtraction is finding the difference between two numbers. If, when subtracting one position of a set of numbers, the minuend is smaller than the subtrahend, a BORROW must occur. When borrowing, the base of the number is taken from the next position to the left (providing it has a value greater than zero). The position borrowed from is reduced by one. The following examples illustrate octal subtraction:

REDUCED BORROWED REDUCED BORROWED

$$\begin{array}{rrrr} & 6 & 8 & \\ 1 & \cancel{7} & 0 & 4 \\ - & 6 & 7 & 2 \\ \hline 1 & 0 & 1 & 2 \end{array} \qquad \begin{array}{rrr} & 7 & \\ 4 & \cancel{8} & 8 \\ \cancel{5} & 3 & 1 \\ - & 7 & 3 \\ \hline 4 & 3 & 6 \end{array}$$

PROOF

$$\begin{array}{r} 1012 \\ +\ \underline{672} \\ 1704 \end{array} \qquad \begin{array}{r} 436 \\ +\underline{73} \\ 531 \end{array}$$

Remember that the borrowed value in octal is eight, which is decimally added to the number in the position of the minuend requiring a borrow. The subtraction is actually done in decimal with the exception of the amount borrowed.

THE HEXADECIMAL NUMBER SYSTEM

The hexadecimal number system is base sixteen. This is most widely associated with the IBM 360 computer system.

Hexadecimal is used with computers because it is a multiple of the base two as is octal. This means that a grouping of the cores (bits) can be utilized to produce a printout (core dump). For hexadecimal each group consists of four binary positions rather than three, as with octal.

Each group of four bits retains the values of binary (8,4,2,1). This means the total quantity that can be represented is fifteen (8+4+2+1). As base sixteen means there are sixteen symbols, one new element requires introduction.

A single printable character for each four bits and the value they can hold requires 16 single characters. In HEX (hexadecimal) the ten symbols of the decimal system are used as the first ten symbols (0 through 9). After the nine any single printable symbols could have been utilized to represent the values 10 through 15. The first six characters of the alphabet were chosen for these representations. Therefore, if an A appears in a core dump, it equates to a decimal value of 10, B equals 11, C equals 12, etc. Figure 12-2 shows some of the counting structure of base 16 and its equivalent in other bases.

By utilizing a 12-bit word it is possible to see the relationship between the bases. If a Hollerith coded card with a field punched with 2503 were read and entered into storage, it would appear as follows (with the two groupings for core dumps indicated):

OCTAL	4	7	0	7
BINARY	1 0 0	1 1 1	0 0 0	1 1 1
HEX	9	C		7

With the use of positional values any or all of the preceding illustrated numbers can be converted to their decimal equivalents as follows:

OCTAL

$$\begin{array}{r}512\\ \times\ 4\\ \hline 2048\end{array}\quad \begin{array}{r}64\\ \times\ 7\\ \hline 448\end{array}\quad \begin{array}{r}8\\ \times 0\\ \hline 0\end{array}\quad \begin{array}{r}1\\ \times 7\\ \hline 7\end{array} = 2503$$

BINARY

$$2048 + 256 + 128 + 64 + 4 + 2 + 1 = 2503$$

HEX

$$\begin{array}{r}256\\ \times\ 9\\ \hline 2304\end{array}\quad \begin{array}{r}16\\ \times\ C\\ \hline 192\end{array}\quad \left(\begin{array}{r}16\\ \times 12\end{array}\right)\quad \begin{array}{r}1\\ \times 7\\ \hline 7\end{array} = 2503$$

HEX	BINARY (FOR HEX)	BINARY (FOR OCTAL)	OCTAL	DECIMAL
0	0000	000	0	0
1	0001	001	1	1
2	0010	010	2	2
3	0011	011	3	3
4	0100	100	4	4
5	0101	101	5	5
6	0110	110	6	6
7	0111	111	7	7
8	1000	001 000	10	8
9	1001	001 001	11	9
A	1010	001 010	12	10
B	1011	001 011	13	11
C	1100	001 100	14	12
D	1101	001 101	15	13
E	1110	001 110	16	14
F	1111	001 111	17	15
10	0001 0000	010 000	20	16
11	0001 0001	010 001	21	17
12	0001 0010	010 010	22	18
13	0001 0011	010 011	23	19
14	0001 0100	010 100	24	20
15	0001 0101	010 101	25	21
16	0001 0110	010 110	26	22
17	0001 0111	010 111	27	23
18	0001 1000	011 000	30	24
19	0001 1001	011 001	31	25
1A	0001 1010	011 010	32	26
1B	0001 1011	011 011	33	27
1C	0001 1100	011 100	34	28
1D	0001 1101	011 101	35	29
1E	0001 1110	011 110	36	30
1F	0001 1111	011 111	37	31
20	0010 0000	100 000	40	32

49.421

Figure 12-2.—Comparative counting table.

Hex Addition

To add numbers in hexadecimal it is simplest to mentally convert the alphabetic symbols to decimal quantities and remember to carry after exceeding F (15).

			CARRY 1	
9A3F	9	(10)	3	(15)
+21B3	2	1	(11)	3
BBF2	(11)	(11)	(15)	2

Hex Subtraction

Subtraction of hexadecimal numbers can be accomplished with the same simple procedure. Remember when borrowing, borrow the base.

		REDUCED	BORROWED	
		9	16	
9A3F	9	~~(10)~~	3	(15)
-21B3	2	1	(11)	3
788C	7	8	8	(12)

POWERS OF A BASE

A mathematical way of expressing or indicating which multiple (power) of a number you are working with is by use of power indication. An example would be 2 to the 4th power. This means that 2 (the base) is used as a multiplier four times with the beginning multiplicand being 1.

$$
\begin{array}{rr}
2^4 = & 1 \\
& \underline{\times\ 2} \\
& 2 \\
& \underline{\times\ 2} \\
& 4 \\
& \underline{\times\ 2} \\
& 8 \\
& \underline{\times\ 2} \\
& 16
\end{array}
$$

Note the position of power indicator. In an equation if the power were unknown (and had to be solved), it would be indicated as a lower case letter n (16^n).

All bases to the zero power are equal to one.

A relationship of powers and bases can be seen as follows:

$2^{12} = 4096_{10} \quad 8^4 = 4096_{10} \quad 16^3 = 4096_{10}$

COMPUTER ARITHMETIC METHODS

Computers are designed to utilize complicated formulas at a high rate of speed. The length of time required for a man to utilize these formulas would be prohibitive. To utilize these formulas effectively the computer must be capable of performing addition, subtraction, multiplication, and division as all formulas may be broken down into these four arithmetic functions. Multiplication and division may be broken down still further in that multiplication is merely a series of additions, and division is merely a series of subtractions. Therefore, the computer need only be designed to add and subtract. Designing a computer which will add and subtract is not economical, so most computers have the ability to add or subtract, but not both. A computer which is capable of addition only is referred to as an additive machine. One which performs subtractions is a subtractive machine.

Additive machines perform all four arithmetic functions by adding. Addition is performed in a straightforward manner, that is, just as is normally done with paper and pencil. Subtraction, however, must be performed in an additive manner.

Subtractive machines perform the four arithmetic functions exactly as an additive machine, except that subtraction is carried out in the usual manner, and addition is accomplished by complementing the addend and subtracting.

Radix-Minus-One Complement

It is not necessary that you understand fully how arithmetic functions are performed by the two methods. It is, however, necessary that complementation be understood to a degree.

Radix-minus-one complementation is a complement (number) obtained by subtracting each digit of a number (of a certain base) from one less than its radix. This means to find the complement of a number simply subtract each digit of a given number from the base's highest symbol (radix-minus-one). For binary subtract from one. For octal, subtract from seven. For hexadecimal subtract from F. For decimal subtract from nine.

When input is read and delivered to storage, software performs many functions. One of the functions is to convert the input code (e.g., Hollerith) to binary ones and zeros.

If a card input field is numeric and contains a negative number (predesignated overpunch in the field), it is not only converted to base two but also complemented. This means that if a core dump is requested and a negative 11 had been read from a card, it would print out as 7764 (for an octal dump). So when reading the core dump, you should be able to determine that 7764 (base 8) is not an error in storage but rather a negative number.

Let's follow this and see how it happens. If the field containing 11 (base 10) had entered storage as a positive number, it would have appeared as follows:

000000001011

which, if dumped in octal, would have printed as 0013. However, on readin it was determined to be negative and was complemented. In binary, complementation is accomplished by making the zeros ones and the ones zeros (sometimes called flip-flop). This means it would have appeared in storage as:

111111110100

which, when dumped in octal, is 7764.

Rather than converting the octal to base two and recomplementing to find the decimal value from a core dump, complementation with base eight can be performed.

$$\begin{array}{lrl} & 7777_8 & \text{highest symbol base 8} \\ \text{core dump} & \underline{-7764_8} & \\ & 13_8 & = 11_{10} \end{array}$$

As can be seen in the preceding example the complementing factor for base 8 is a 7. In octal core dumps, negative numeric quantities can usually be spotted by the high order 7's.

In a computer providing a hexadecimal core dump the same binary structure would have been present for a negative 11 readin. The difference would appear in the core dump printout. It would have occurred as follows:

In the card	1J (J being a 1 and 11 overpunch)
In binary (complemented)	111111110100
HEX core dump	FF4

In a HEX core dump, negative numbers are usually identified by high order F's. If FF4 were printed out, it could be complemented to its true value as follows:

$$\begin{array}{lrl} & FFF & \text{highest symbol base 16} \\ \text{core dump} & \underline{-FF4} & \\ & B_{16} & = 11_{10} \end{array}$$

End-Around-Carry

Complements are also used by the computer for some arithmetic functions. Because complementation is required to perform some of the arithmetic functions, and end-around-carry must be provided. End-around-carry can be thought of as a machine function which happens automatically. In some computers it is accomplished by software and in others by hard wiring.

End-around-carry is a process of taking a carry bit from an imaginary high order position and adding it to the low order position of a counter. This is done before the result of the arithmetic function is delivered to storage. Therefore, a core dump of the result will appear as previously described. Without end-around-carry the core dump and the report printout would be erroneous.

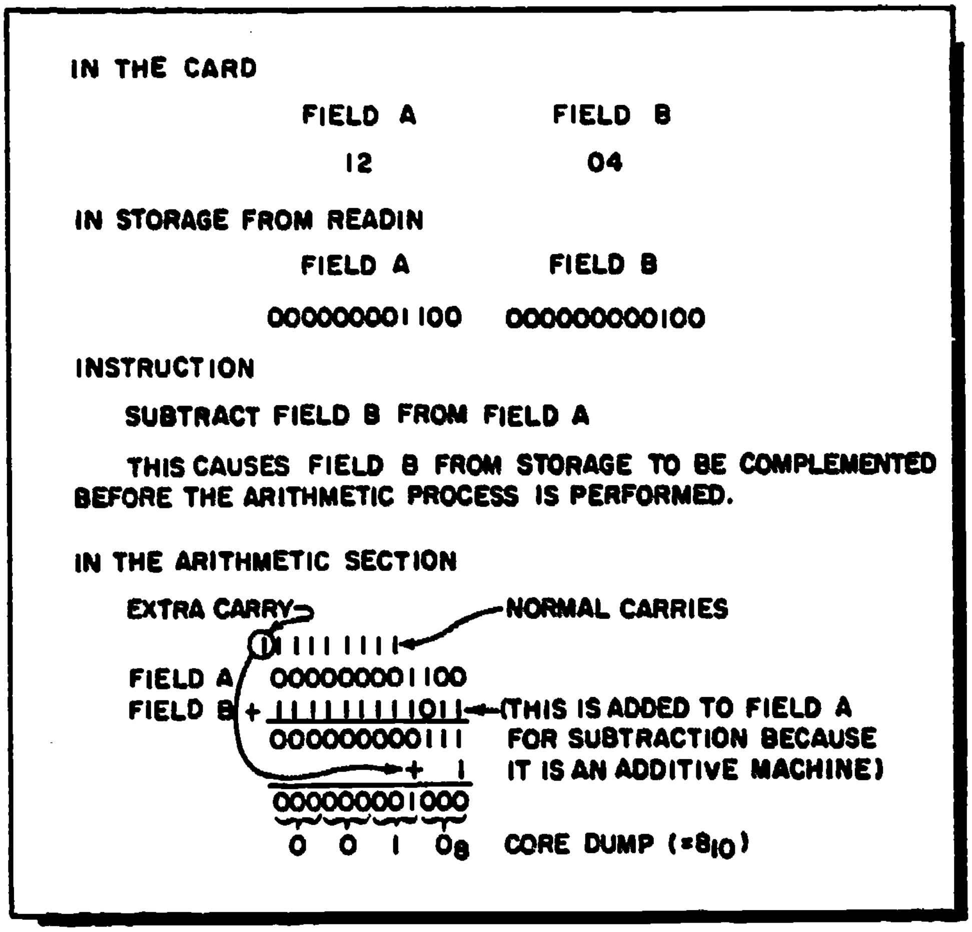
Figure 12-3 shows how end-around-carry is performed in an additive machine for subtraction of two positive numbers.

COMPUTER CODING SYSTEMS

As has previously been explained, numeric data can be held, manipulated and printed from storage. Alphabetic information must also be entered into storage. In the Hollerith code for punched cards it is possible to indicate alphanumeric data (alphabetic, numeric and special characters). This data must also be converted to a binary code for use by the computer.

In order to distinguish numeric from alphabetic and special characters in storage there must be a coding structure used. The previous examples using 12 bits are typical of counters or registers in a computer that usually are only for arithmetic functions. A coding structure for storage of data doesn't require the 12 bits used in the register examples.

The method used for symbolizing data is known as a code or a system. In computers, the code relates data to a fixed number of binary



49.422

Figure 12-3.—End-around-carry.

positions. By proper arrangement of the binary notations (bit and not bit) and with each positional notation having a specific value, each character can be represented by a combination of bits which is different from any other combination.

Perhaps the most popular coding scheme for data representation is binary coded decimal, or 8-4-2-1 scheme. Note that the decimal digits 0 through 9 are expressed by four binary digits (fig. 12-4).

The system of expressing or coding decimal digits in an equivalent binary value is known as binary coded decimal (BCD). For example, the decimal value 3246 would appear in BCD form as shown in figure 12-5.

SIX-BIT ALPHAMERIC CODE (BCD)

The six-bit alphameric code is just an extension of BCD. Instead of using just the 8-4-2-1 scheme, this code uses six positions of binary notation (plus a parity bit position) to represent all characters (alphabetic and numeric), as

PLACE VALUE				DECIMAL VALUE
8	4	2	1	
			0	0
			1	1
		1	0	2
		1	1	3
	1	0	0	4
	1	0	1	5
	1	1	0	6
	1	1	1	7
1	0	0	0	8
1	0	0	1	9

49.158

Figure 12-4.—Binary coded decimal.

3	2	4	6	DECIMAL DIGITS
0011	0010	0100	0110	BINARY VALUE
8421	8421	8421	8421	PLACE VALUE

49.277

Figure 12-5.—3246 in binary coded decimal.

opposed to only numeric characters. These positions are divided into three groups, as shown in figure 12-6.

There are four positions for representing numeric data, assigned the decimal values of 8, 4, 2, and 1; two positions, called B and A zone bits, for denoting zones; and one position, called the C or CHECK position, for checking the validity of codes. There is a close parallel between the binary coded decimal system used in computing devices and the Hollerith code used to represent data in punched cards. That is, numeric values 0 through 9 are represented by a numeric bit or combination of numeric bits; the 12 zone is represented by B and A bits; the 11 zone by a B bit; and the zero zone by an A bit. Thus, through the various combinations of zone and numeric bits, any numeric, alphabetic character, or special character can be represented.

The purpose of the C position, or CHECK bit, is to provide the computer with an internal means for checking the validity of code construction. That is, the total number of bits in a character, including the check bit, must always be even or always odd, depending upon the particular system or device used. Therefore, the binary coded decimal system is said to be either an EVEN or ODD parity code, and the test for bit count is called a PARITY CHECK.

CHECK BIT	ZONE BITS		NUMERIC BITS			
C	B	A	8	4	2	1

49.278

Figure 12-6.—Six bit alphameric code.

The check bit is automatically added to each input character that requires an extra bit to bring it into consonance with the total-bit requirement. Check bits remain with their particular character throughout all data manipulation within the processing unit, providing a system for checking the validity of each character each time it is used.

While the failure of a character to pass the parity check always indicates an error, successful passing does not in itself certify that a character actually represents what was intended. That is, the accidental dropping of one bit constitutes an invalid code, but the dropping of two bits could result in the representation of some other valid code. However, dropping of two bits in one character occurs so seldom it is not of particular concern.

Figure 12-7 represents a typical binary coded decimal chart, arranged in ascending sequence. This particular scheme represents character coding in a system based on an odd parity check. The same coding arrangement could be used in systems having an even parity check by simply changing the check bit from characters with an even number of bits to those with an odd bit construction.

EXCESS-THREE CODE (X-S3)

The excess-three binary coded decimal is a variation of the 8-4-2-1 scheme. It is so called because the binary equivalent of decimal 3 (0011) is added to the binary value of each decimal digit in the 8-4-2-1 code. For example, the value of decimal 6 in 8-4-2-1, which is 0110, is increased by 0011 to get 1001, as follows:

DECIMAL DIGIT		BINARY CODED DECIMAL	
6	=	0110	
+		+	
3	=	0011	
9		1001	(Excess-three)

Thus, the bit configuration of an excess-three binary coded decimal digit is three in excess of its 8-4-2-1 counterpart.

PRINTS AS	DEFINED CHARACTER	CARD CODE	BCD CODE	PRINTS AS	DEFINED CHARACTER	CARD CODE	BCD CODE
	BLANK		C	G	G	12-7	BA 421
.	.	12-3-8	BA8 21	H	H	12-8	BA8
⌑	⌑	12-4-8	CBA84	I	I	12-9	CBA8 1
	(Left Parenthesis (Special Character)	12-5-8	BA84 1	—	! (Minus Zero)	11-0	B 8 2
	< Less Than (Special Character)	12-6-8	BA842	J	J	11-1	CB 1
	≢ Group Mark	12-7-8	CBA8421	K	K	11-2	CB 2
&	&	12	CBA	L	L	11-3	B 21
$	$	11-3-8	CB 8 21	M	M	11-4	CB 4
*	*	11-4-8	B 84	N	N	11-5	B 4 1
	) Right Parenthesis (Special Char.)	11-5-8	CB 84 1	O	O	11-6	B 42
	; Semicolon (Special Character)	11-6-8	CB 842	P	P	11-7	CB 421
	Δ Delta (Mode Change)	11-7-8	B 8421	Q	Q	11-8	CB 8
—	—	11	B	R	R	11-9	B 8 1
/	/	0-1	C A 1	‡	‡ Record Mark	0-2-8	A8 2
,	,	0-3-8	C A8 21	S	S	0-2	C A 2
%	%	0-4-8	A84	T	T	0-3	A 21
	= Word Separator	0-5-8	C A84 1	U	U	0-4	C A 4
	' Apostrophe (Special Character)	0-6-8	C A842	V	V	0-5	A 4 1
	" Tape Segment Mark	0-7-8	A8421	W	W	0-6	A 42
‡	¢ Cent (Special Character)		A	X	X	0-7	C A 421
#	#	3-8	8 21	Y	Y	0-8	C A8
@	@	4-8	C 84	Z	Z	0-9	A8 1
	: Colon (Special Character)	5-8	84 1	0	0	0	C 8 2
	> Greater Than (Special Character)	6-8	842	1	1	1	1
	√ Tape Mark	7-8	C 8421	2	2	2	2
&	? (Plus Zero)	12-0	CBA8 2	3	3	3	C 21
A	A	12-1	BA 1	4	4	4	4
B	B	12-2	BA 2	5	5	5	C 4 1
C	C	12-3	CBA 21	6	6	6	C 42
D	D	12-4	BA 4	7	7	7	421
E	E	12-5	CBA 4 1	8	8	8	8
F	F	12-6	CBA 42	9	9	9	C 8 1

78.10X

Figure 12-7.—Binary coded decimal chart.

EXTENDED BINARY CODED DECIMAL INTERCHANGE CODE (EBCDIC)

Figure 12-8 depicts the EBCDIC coding structure. The three groups illustrate the entire EBCDIC coding system. The first column of each group lists the HEX (core dump) symbols that would print out (OO-FF). In the third column of each group is the graphic. A graphic is what would print out on a report. At this time, what appears under the BCDIC part of this column is not important, only what appears under EDBDIC.

The fourth column of each group explains the punches that would be required in a card to enter the correct binary code for the graphic. The last column of each group shows the bit structure that would appear in storage.

For this code eight bits are required for each graphic. This gives us the two HEX characters.

Hexadecimal	Mnemonic	Graphic & Control Symbols BCDIC	EBCDIC	Punched Card Code	System/360 8-Bit Code
00			NUL	12-0-9-8-1	0000 0000
01				12-9-1	0000 0001
02				12-9-2	0000 0010
03				12-9-3	0000 0011
04	SPM		PF	12-9-4	0000 0100
05	BALR		HT	12-9-5	0000 0101
06	BCTR		LC	12-9-6	0000 0110
07	BCR		DEL	12-9-7	0000 0111
08	SSK			12-9-8	0000 1000
09	ISK			12-9-8-1	0000 1001
0A	SVC			12-9-8-2	0000 1010
0B				12-9-8-3	0000 1011
0C	(EBCDIC +)			12-9-8-4	0000 1100
0D	(EBCDIC -)			12-9-8-5	0000 1101
0E				12-9-8-6	0000 1110
0F				12-9-8-7	0000 1111
10	LPR			12-11-9-8-1	0001 0000
11	LNR			11-9-1	0001 0001
12	LTR			11-9-2	0001 0010
13	LCR			11-9-3	0001 0011
14	NR		RES	11-9-4	0001 0100
15	CLR		NL	11-9-5	0001 0101
16	OR		BS	11-9-6	0001 0110
17	XR		IL	11-9-7	0001 0111
18	LR			11-9-8	0001 1000
19	CR			11-9-8-1	0001 1001
1A	AR			11-9-8-2	0001 1010
1B	SR			11-9-8-3	0001 1011
1C	MR			11-9-8-4	0001 1100
1D	DR			11-9-8-5	0001 1101
1E	ALR			11-9-8-6	0001 1110
1F	SLR			11-9-8-7	0001 1111
20	LPDR			11-0-9-8-1	0010 0000
21	LNDR			0-9-1	0010 0001
22	LTDR			0-9-2	0010 0010
23	LCDR			0-9-3	0010 0011
24	HDR		BYP	0-9-4	0010 0100
25			LF	0-9-5	0010 0101
26			EOB	0-9-6	0010 0110
27			PRE	0-9-7	0010 0111
28	LDR			0-9-8	0010 1000
29	CDR			0-9-8-1	0010 1001
2A	NADR		SM	0-9-8-2	0010 1010
2B	NSDR			0-9-8-3	0010 1011
2C	NMDR			0-9-8-4	0010 1100
2D	NDDR			0-9-8-5	0010 1101
2E	AWR			0-9-8-6	0010 1110
2F	SWR			0-9-8-7	0010 1111
30	LPER			12-11-0-9-8-1	0011 0000
31	LNER			9-1	0011 0001
32	LTER			9-2	0011 0010
33	LCER			9-3	0011 0011
34	HER		PN	9-4	0011 0100
35			RS	9-5	0011 0101
36			UC	9-6	0011 0110
37			EOT	9-7	0011 0111
38	LER			9-8	0011 1000
39	CER			9-8-1	0011 1001
3A	NAER			9-8-2	0011 1010
3B	NSER			9-8-3	0011 1011
3C	NMER			9-8-4	0011 1100
3D	NDER			9-8-5	0011 1101
3E	AUR			9-8-6	0011 1110
3F	SUR			9-8-7	0011 1111
40	STH		SP	no punches	0100 0000
41	LA			12-0-9-1	0100 0001
42	STC			12-0-9-2	0100 0010
43	IC			12-0-9-3	0100 0011
44	EX			12-0-9-4	0100 0100
45	BAL			12-0-9-5	0100 0101
46	BCT			12-0-9-6	0100 0110
47	BC			12-0-9-7	0100 0111
48	LH			12-0-9-8	0100 1000
49	CH			12-8-1	0100 1001
4A	AH		¢	12-8-2	0100 1010
4B	SH	.	.	12-8-3	0100 1011
4C	MH	⌑)	<	12-8-4	0100 1100
4D		[	(	12-8-5	0100 1101
4E	CVD	<	+	12-8-6	0100 1110
4F	CVB	‡	|	12-8-7	0100 1111
50	ST	&	&	12	0101 0000
51				12-11-9-1	0101 0001
52				12-11-9-2	0101 0010
53				12-11-9-3	0101 0011
54	N			12-11-9-4	0101 0100
55	CL			12-11-9-5	0101 0101
56	O			12-11-9-6	0101 0110
57	X			12-11-9-7	0101 0111
58	L			12-11-9-8	0101 1000
59	C			11-8-1	0101 1001
5A	A		!	11-8-2	0101 1010
5B	S	$	$	11-8-3	0101 1011
5C	M	*	*	11-8-4	0101 1100
5D	D	]	)	11-8-5	0101 1101
5E	AL	;	;	11-8-6	0101 1110
5F	SL	Δ	¬	11-8-7	0101 1111
60	STD	-	-	11	0110 0000
61		/	/	0-1	0110 0001
62				11-0-9-2	0110 0010
63				11-0-9-3	0110 0011
64				11-0-9-4	0110 0100
65				11-0-9-5	0110 0101
66				11-0-9-6	0110 0110
67				11-0-9-7	0110 0111
68	LD			11-0-9-8	0110 1000
69	CD			0-8-1	0110 1001
6A	NAD			12-11	0110 1010
6B	NSD	,	,	0-8-3	0110 1011
6C	NMD	% (	%	0-8-4	0110 1100
6D	NDD	⋎	_	0-8-5	0110 1101
6E	AW	\	>	0-8-6	0110 1110
6F	SW	⧻	?	0-8-7	0110 1111
70	STE			12-11-0	0111 0000
71				12-11-0-9-1	0111 0001
72				12-11-0-9-2	0111 0010
73				12-11-0-9-3	0111 0011
74				12-11-0-9-4	0111 0100
75				12-11-0-9-5	0111 0101
76				12-11-0-9-6	0111 0110
77				12-11-0-9-7	0111 0111
78	LE			12-11-0-9-8	0111 1000
79	CE			8-1	0111 1001
7A	NAE	‡	:	8-2	0111 1010
7B	NSE	#	#	8-3	0111 1011
7C	NME	@ '	@	8-4	0111 1100
7D	NDE	:	'	8-5	0111 1101
7E	AU	>	=	8-6	0111 1110
7F	SU	√	"	8-7	0111 1111
80	SSM			12-0-8-1	1000 0000
81			a	12-0-1	1000 0001
82	LPSW		b	12-0-2	1000 0010
83	(Diagnose)		c	12-0-3	1000 0011
84	WRD		d	12-0-4	1000 0100
85	RDD		e	12-0-5	1000 0101
86	BXH		f	12-0-6	1000 0110
87	BXLE		g	12-0-7	1000 0111
88	SRL		h	12-0-8	1000 1000
89	SLL		i	12-0-9	1001 1001
8A	SRA			12-0-8-2	1000 1010
8B	SLA			12-0-8-3	1000 1011
8C	SRDL			12-0-8-4	1000 1100
8D	SLDL			12-0-8-5	1000 1101
8E	SRDA			12-0-8-6	1000 1110
8F	SLDA			12-0-8-7	1000 1111
90	STM			12-11-8-1	1001 0000
91	TM		j	12-11-1	1001 0001
92	MVI		k	12-11-2	1001 0010
93	TS		l	12-11-3	1001 0011
94	NI		m	12-11-4	1001 0100
95	CLI		n	12-11-5	1001 0101
96	OI		o	12-11-6	1001 0110
97	XI		p	12-11-7	1001 0111
98	LM		q	12-11-8	1001 1000
99			r	12-11-9	1001 1001
9A				12-11-8-2	1001 1010
9B				12-11-8-3	1001 1011
9C	SIO			12-11-8-4	1001 1100
9D	TIO			12-11-8-5	1001 1101
9E	HIO			12-11-8-6	1001 1110
9F	TCH			12-11-8-7	1001 1111
A0				11-0-8-1	1010 0000
A1				11-0-1	1010 0001
A2			s	11-0-2	1010 0010
A3			t	11-0-3	1010 0011
A4			u	11-0-4	1010 0100
A5			v	11-0-5	1010 0101
A6			w	11-0-6	1010 0110
A7			x	11-0-7	1010 0111
A8			y	11-0-8	1010 1000
A9			z	11-0-9	1010 1001
AA				11-0-8-2	1010 1010
AB				11-0-8-3	1010 1011
AC				11-0-8-4	1010 1100
AD				11-0-8-5	1010 1101
AE				11-0-8-6	1010 1110
AF				11-0-8-7	1010 1111
B0				12-11-0-8-1	1011 0000
B1				12-11-0-1	1011 0001
B2				12-11-0-2	1011 0010
B3				12-11-0-3	1011 0011
B4				12-11-0-4	1011 0100
B5				12-11-0-5	1011 0101
B6				12-11-0-6	1011 0110
B7				12-11-0-7	1011 0111
B8				12-11-0-8	1011 1000
B9				12-11-0-9	1011 1001
BA				12-11-0-8-2	1011 1010
BB				12-11-0-8-3	1011 1011
BC				12-11-0-8-4	1011 1100
BD				12-11-0-8-5	1011 1101
BE				12-11-0-8-6	1011 1110
BF				12-11-0-8-7	1011 1111
C0		?		12-0	1100 0000
C1		A	A	12-1	1100 0001
C2		B	B	12-2	1100 0010
C3		C	C	12-3	1100 0011
C4		D	D	12-4	1100 0100
C5		E	E	12-5	1100 0101
C6		F	F	12-6	1100 0110
C7		G	G	12-7	1100 0111
C8		H	H	12-8	1100 1000
C9		I	I	12-9	1100 1001
CA				12-0-9-8-2	1100 1010
CB				12-0-9-8-3	1100 1011
CC				12-0-9-8-4	1100 1100
CD				12-0-9-8-5	1100 1101
CE				12-0-9-8-6	1100 1110
CF				12-0-9-8-7	1100 1111
D0		!		11-0	1101 0000
D1	MVN	J	J	11-1	1101 0001
D2	MVC	K	K	11-2	1101 0010
D3	MVZ	L	L	11-3	1101 0011
D4	NC	M	M	11-4	1101 0100
D5	CLC	N	N	11-5	1101 0101
D6	OC	O	O	11-6	1101 0110
D7	XC	P	P	11-7	1101 0111
D8		Q	Q	11-8	1101 1000
D9		R	R	11-9	1101 1001
DA				12-11-9-8-2	1101 1010
DB				12-11-9-8-3	1101 1011
DC	TR			12-11-9-8-4	1101 1100
DD	TRT			12-11-9-8-5	1101 1101
DE	ED (4)			12-11-9-8-6	1101 1110
DF	EDMK (4)			12-11-9-8-7	1101 1111
E0		‡		0-8-2	1110 0000
E1				11-0-9-1	1110 0001
E2		S	S	0-2	1110 0010
E3		T	T	0-3	1110 0011
E4		U	U	0-4	1110 0100
E5		V	V	0-5	1110 0101
E6		W	W	0-6	1110 0110
E7		X	X	0-7	1110 0111
E8		Y	Y	0-8	1110 1000
E9		Z	Z	0-9	1110 1001
EA				11-0-9-8-2	1110 1010
EB				11-0-9-8-3	1110 1011
EC				11-0-9-8-4	1110 1100
ED				11-0-9-8-5	1110 1101
EE				11-0-9-8-6	1110 1110
EF				11-0-9-8-7	1110 1111
F0		0	0	0	1111 0000
F1	MVO	1	1	1	1111 0001
F2	PACK	2	2	2	1111 0010
F3	UNPK	3	3	3	1111 0011
F4		4	4	4	1111 0100
F5		5	5	5	1111 0101
F6		6	6	6	1111 0110
F7		7	7	7	1111 0111
F8	ZAP (4)	8	8	8	1111 1000
F9	CP (4)	9	9	9	1111 1001
FA	AP (4)			12-11-0-9-8-2	1111 1010
FB	SP (4)			12-11-0-9-8-3	1111 1011
FC	MP (4)			12-11-0-9-8-4	1111 1100
FD	DP (4)			12-11-0-9-8-5	1111 1101
FE				12-11-0-9-8-6	1111 1110
FF				12-11-0-9-8-7	1111 1111

49.423

Figure 12-8.—IBM System/360 eight-bit code.

Each of these eight bit groups is referred to as a BYTE of storage.

Note that in the first group of figure 12-8 the HEX value of 40 is produced by a blank card column. In the third group the HEX value of FO is produced by a zero punch in a card column. This distinction between blanks (spaces) and zeros (for arithmetic functions) is one of the reasons for having left zero fill required when keypunching numeric fields.

This eight-bit EBCDIC code would require a nine track tape (unless converted) for recording from or into storage. The ninth track would be for the check bit as in the six-bit alphameric code requiring seven track tape.

MAGNETIC INK CHARACTERS

A language readable by both man and machine is produced by printing magnetic ink characters on paper media for machine processing, as seen in figure 12-9A. The magnetic property of the ink allows reading by machine, and the shape of the characters permits visual interpretation.

Once information has been inscribed on the paper documents, they are ready to ' read by a reader-sorter which reads the inscribed information from the document and converts it to a machine language. After this is completed, the information is entered directly into the data processing system.

OPTICALLY READ CHARACTERS

Another method of input to a data processing system is optically readable characters on paper documents (fig. 12-9B). Included in these characters are all letters of the alphabet, digits 0

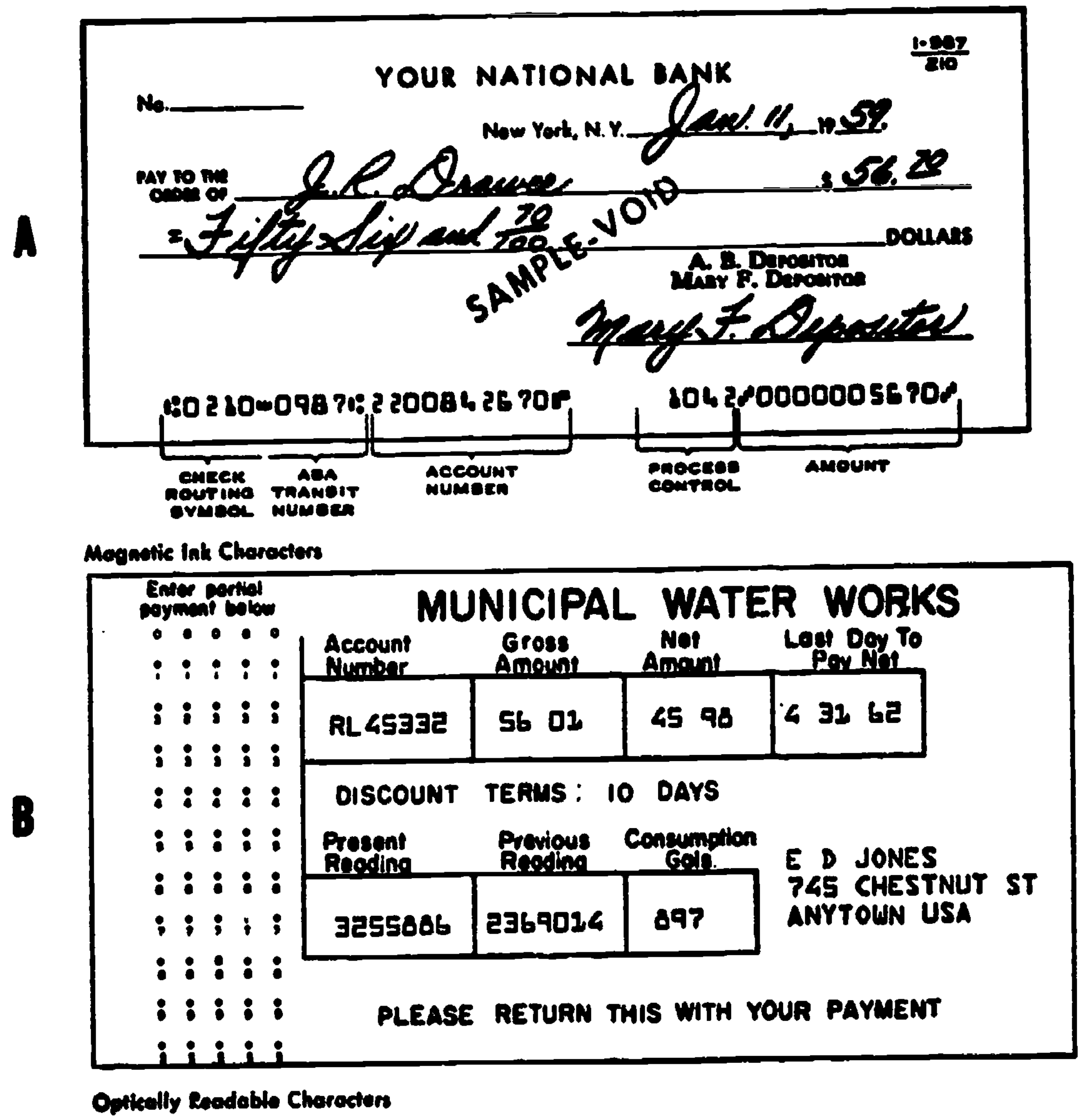


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Figure 12-9.—Magnetic ink and optically read character documents.

through 9, and special characters. Ordinary pen or pencil marks placed in certain locations on the document can also be read.

PAPER TAPE

Developed for transmitting telegraph messages over wire, paper tape is now used for data processing communication as well. For long distance transmission, machines read paper tape at one location, transmit electrical impulses over telephone or telegraph wires to produce a duplicate paper tape at the other end of the wire, for later processing.

Paper tape is bulky, not very durable, and inconvenient to store, but the cost is practical. Paper tape is a strip of paper of indefinite length and may be either five-eighths of an inch or an inch wide. The paper base may range from something that looks like a heavy newsprint to a high-quality plastic impregnated opaque cardboard, very light in weight and flexible. A reel of paper tape ranges in length from a few feet to several hundred feet.

Data are represented on paper tape by a special arrangement of precisely punched holes along the length of the tape (figs. 12-10 and 12-11). Paper tape is a continuous recording medium and can be used to record data in records of any length, the capacity of the storage medium into which the data is to be placed or from which the data is received, being the only limiting factor. A tape punching device transcribes information from source documents to paper tape, which is then read or interpreted by a paper tape reader.

Eight Channel Code

In an eight channel tape the data are recorded (punched) and read as holes located in eight parallel channels along the tape. Figure 12-10 illustrates the eight channel tape and several coded characters. These characters consist of numeric, alphabetic, special, and function characters. Each character is coded in one column across the width of the tape.

The four channels labeled 1, 2, 4, and 8, excluding the feed holes, are used to record numeric characters. In these four positions the numeric values 0 through 9 are represented as a punch or combination of punches. The value of the numeric character is indicated by the sum of the position values. For examples, holes in the number 4 and 2 tracks would represent the numeric 6.

The X and O channels are similar to the zone punches in cards, and are used in combination with the numeric channels to record alphabetic and special characters.

The eight channel tape is said to be of odd parity. That is, the checking feature checks to be sure that each column of the tape is punched with an odd number of holes. Any time the basic (X, O, 8, 4, 2, 1) code consists of an even number of holes, a check hole must be present.

The tape feed code consists of punches in the X, O, 8, 4, 2, and 1 channels and is used to indicate blank character positions. A punch in the EL (end of line) channel is a special function character used to mark the end of a record. Areas of the tape punched with the tape feed code are automatically skipped by the tape reader.

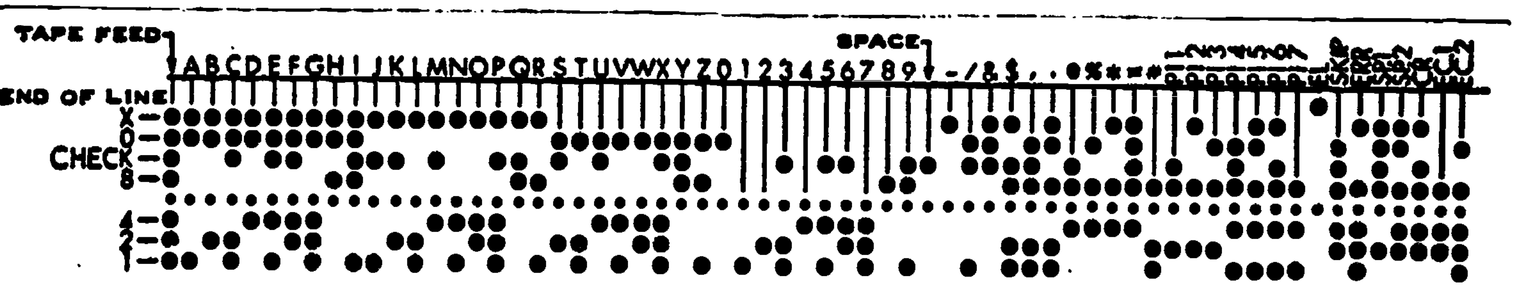

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Figure 12-10.—Eight channel paper tape code.

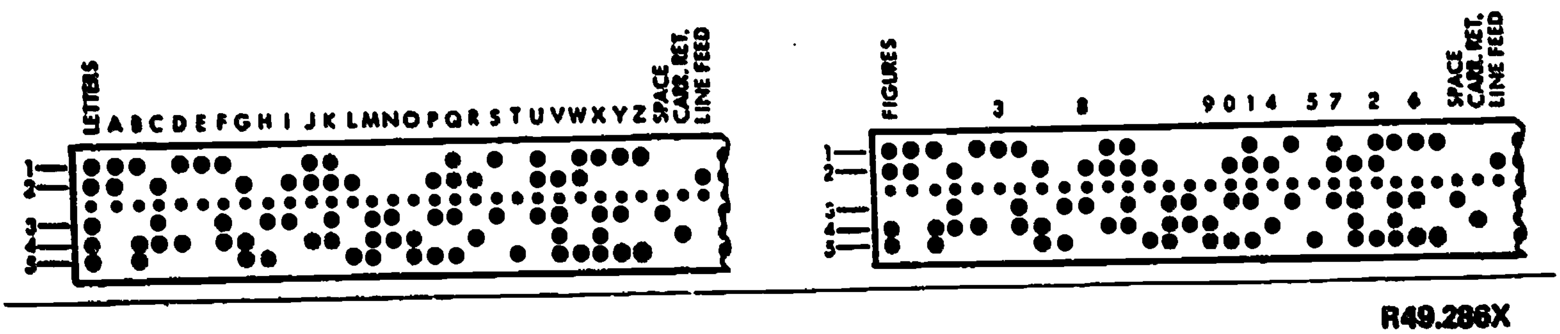

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Figure 12-11.–Five channel paper tape code.

Five Channel Code

As opposed to the eight channel tape, the data are recorded (punched) and read as holes in five parallel channels along the length of the paper tape. All numeric, alphabetic, special, and function characters are represented across the width of the tape by one column of the five possible punching positions. Figure 12-11 shows a section of a five channel tape with several coded characters.

Using the five punching positions, only 31 combinations of the holes are possible. Therefore, a shift system is used to expand the number of available codes. When the figures (FIGS) code precedes a section of tape, the coded punches are interpreted as numeric or special characters (fig. 12-11). When preceded by the letters (LTRS) code, a section of tape is interpreted as alphabetic characters (fig. 12-11).

Ten of the 31 codes are used for coding both alphabetic and numeric characters. The interpretation depends on the shift code, FIGS or LTRS, which precedes the characters. These characters are P, Q, W, E, R, T, Y, U, I, and O and the decimal digits 0 through 9. Likewise, the code for special characters is identical to some of those used for other alphabetic characters.

The function characters–space, carriage return (CR), and line feed (LF) are the same in either FIGS or LTRS shift. The space code is used to indicate the absence of data on the tape.

Like the card code, paper tape code is compatible with the codes that are used by a computer.

DATA ORGANIZATION

Data recorded in or on magnetic storage media is normally organized through makeup of bits, characters, words, records and files. A bit is the smallest portion of data. A bit is a binary digit (0 or 1). A string of these binary digits comprises the rest of data organization in storage.

Once a code has been determined by the manufacturer for use by the system, characters can then be assigned. A character is a unique, standard (for one system) grouping of bits which can represent a letter, digit or other symbol that is used as part of the organization, control, or representation of data.

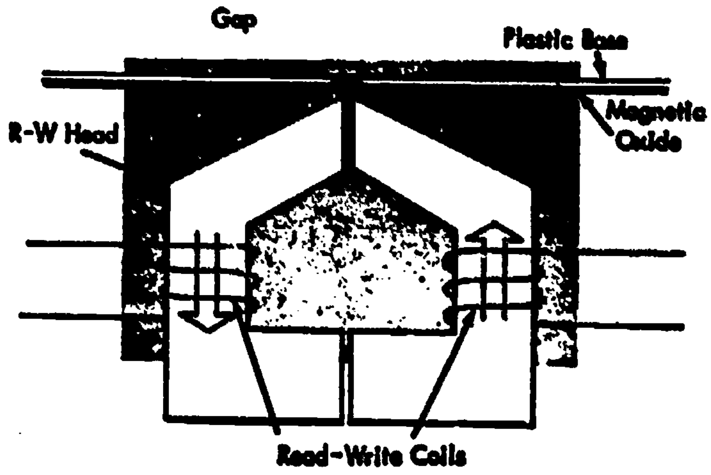
A character may, by itself, be addressed in storage. That is, each character group of bits may be located and moved, shifted, printed, punched, etc.

If each character had to be moved for output or input, it would be time consuming (as it would be if each bit of a character had to be individually moved). Therefore, characters are also grouped into what are called WORDS. A word is a character string or bit string considered as an entity. What this does is allow storage to move more than one character at one time, thus speeding up data movement.

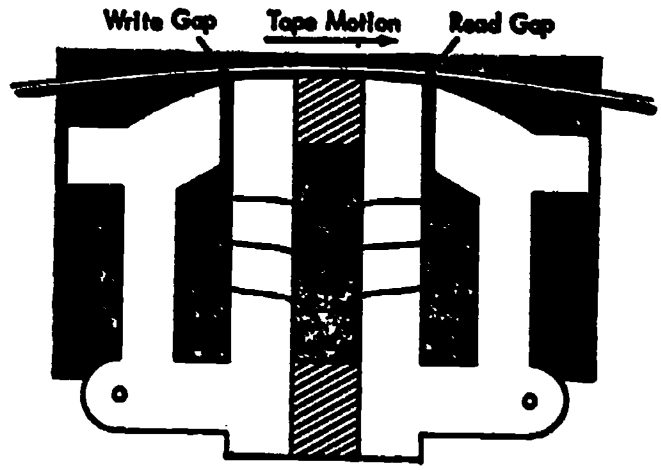
In most arithmetic operations the numeric data is changed from its coded (BCD, six-bit alphameric) format to base two and placed in a word sized register for faster operation. When the arithmetic operation is complete, the answer is changed from base two back to its original code and delivered to an area of storage.

In the CPU storage (memory) characters and/or words may be moved about for individual processing of one RECORD. A record is a collection of related items of data treated as a unit, for example, a set of one or more consecutive fields on an individual's payroll record. If the payroll record were read from a card into storage, the 80 columns would occupy 80 characters of storage. If three characters make up a word, the record will occupy 27 words of storage.

Once all the data for one record has been processed, it is then available for output. As the records are written onto magnetic tape, magnetic disk or magnetic drum, they collectively comprise a file. A file is a collection of related records treated as one unit.



ONE-GAP READ-WRITE HEAD



TWO-GAP READ-WRITE HEAD

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Figure 12-12.—Read/write heads.

MAGNETIC TAPE

Reading from and Writing on Magnetic Tape

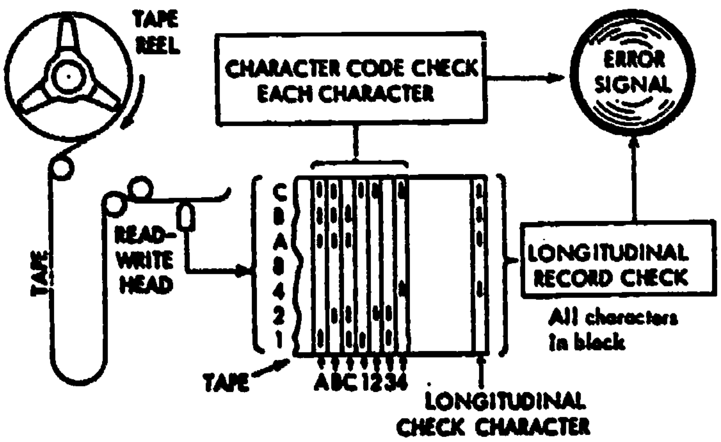
The magnetic tape unit reads or writes data in parallel channels or tracks along the length of the tape. Each channel or track can be read by a read/write head, one for each channel, as the tape moves across the magnetic gap of the head. Read/write heads may be either one-gap or two-gap as shown in figure 12-12. The one-gap head has only one magnetic gap at which both reading and writing occurs. The two-gap head has one gap for reading and another for writing.

There is one write coil in the write head for each recording track. Electrical current flowing through these coils magnetizes the iron oxide coating of the tape, thus erasing previously recorded information.

Checking Tape Recorded Data

Tape validity may be checked by tape units using either a one-gap or two-gap read-write head. When using the one-gap head, the tape must be backspaced over the record, or the tape must be read as it is used in another operation before validity checking can occur. Although the one-gap method is satisfactory, the two-gap head gives increased speed by checking while writing. For example, a tape being written passes over the write gap (where data is recorded) and then over the read gap where errors in writing are detected almost instantly.

In checking BCD tape, each binary coded character is checked for validity as it is written on magnetic tape. An automatic odd or even count is made of all bits (1 bits) in each vertical tape column. If even parity checking is used, a bit is placed in the C track during tape writing for each vertical column in which the count is odd, making the total number of bits even (fig. 12-13). For each subsequent reading operation, the total count of bits in each character must be even in order to pass the parity check. If odd



R49.301X

Figure 12-13.–Seven-track tape validity checks, BCD mode, even parity.

parity checking is used, the C bit is written when the bit count is even, making the total number of bits odd. During subsequent reading operations, each character must have an odd total bit count to be considered valid.

In addition to vertical parity check, a horizontal parity check is made on each record. A record is a unit of information, such as the information recorded in a punched card. The bits in each horizontal row are counted as each record is written, and a check bit is recorded at the end of the record for each track in which the bit count is odd, if even parity is used, or for each track in which the bit count is even, if odd parity is used. Thus, each time a record is read, it is checked for parity not only by characters, but by track as well (fig. 12-13).

Checking Binary Code

In electronic data processing systems using the binary code for data representation, the basic unit of information is the word, consisting of a fixed number of consecutive bit positions. These words usually are recorded on magnetic tape in six vertical columns, with six bits recorded in each horizontal track. The seventh track, or C position, is used for parity checking only. Parity checking is performed in a manner similar to that used for checking BCD tapes. That is, a parity check is vertically by column and horizontally by track.

The difference in checking binary tape and BCD tape is that the vertical parity check including the check character must have an odd parity for binary coded data; whereas the horizontal parity check, including check character, for binary tape must be even. If these conditions are not met, an error condition is indicated.

Tape Records, Density, and Interrecord Gap

Records on magnetic tape can be of any practicable size, being restricted only by the length of the tape or the capacity of internal storage devices. For example, a record can be 80 characters long, corresponding to the 80 columns in a punched card; it can be shorter, or it can be longer. Records can be placed on tape ungrouped, or they can be grouped. Ungrouped records consist of individual records separated on tape by an interrecord gap. The length of the gap varies, depending upon the particular system and method of recording, but is in the neighborhood of from 2/5 to 3/4 inches. Grouped records consist of a number of records called a RECORD BLOCK. Records within a block are separated by a control symbol or RECORD MARKS, and blocks are separated by an interrecord gap. During writing, the interrecord or interblock gap is produced automatically at the end of each ungrouped record or at the end of each record block (as it is the area generated when decreasing from and increasing to writing speed). During reading, the record begins with the first character sensed following an interrecord or interblock gap, and continues until the next gap is reached. All input records are internally stored in accordance with the storage positions assigned by the stored program. Output records are written from the storage positions designated by the stored program. Examples of various ways in which records are placed on magnetic tape are shown in figure 12-14, and are discussed in the following paragraphs.

Ungrouped records fall into two general classes: fixed length and variable length. All fixed length records have the same number of set positions for each record, and each item of data is recorded in the same positions for each record. Thus, if any item is missing from any

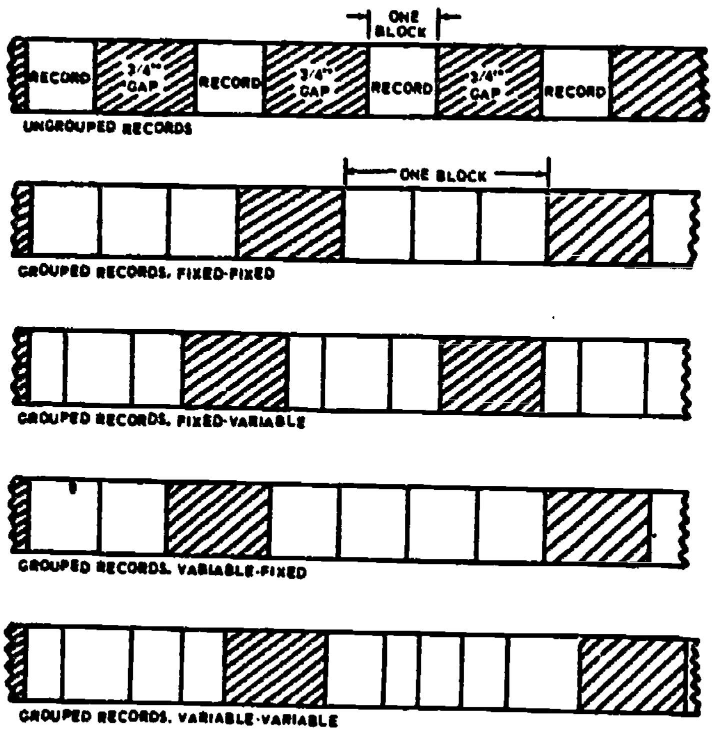


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Figure 12-14.—Placing data records on magnetic tape.

record, its position or positions must be filled in with zeros or blanks or any designated fill characters. Variable length records may vary in length from one record to another, depending upon the number of positions required to record the necessary data. All items of data which are common to all records must be recorded in the same positions of each record. If any of these items are missing, their positions must be filled with zeros or blanks. Items common to all records usually are placed at the beginning of each record, and extended for the required length. Additional items required in some records but not in others normally are placed at the end of the record. This provides for maximum speed in reading records, since less tape space is required for the shorter records.

As a general rule, fixed length records are easier to program than variable length records. When there are few differences in the length of records, the additional tape space and read time required by partially empty, fixed length records may be justified by the shortened programming time required. In applications where there are many record length differences, the saving in tape space and machine read time may very well justify the use of variable length records.

In ungrouped records an individual tape record rarely exceeds 3/4 inch in length. In fact, the average approximates 1/4 inch. Since an interrecord gap may be 3/4 inch long, you can readily see that in reading ungrouped records, more time is spent spacing between records than is spent actually reading records. To cut down on this wasted time, records are often grouped in blocks, with the interrecord gap placed between each block, and only a record mark separating the records within a block. The number of records placed in a record block is called the BLOCKING FACTOR.

When record blocks contain a fixed number of records, with each record containing a fixed number of positions, they are called FIXED-FIXED. This form of grouping records is best suited to files having little variation in record size.

The term FIXED-VARIABLE applies to grouped records that have a fixed number of records of variable length in each record block. The maximum length of the records must be known in order to assign sufficient internal storage space for the incoming record blocks. The length of each record usually is indicated by a special character or control field which is part of—and is found at the beginning of—each record. Programming is more difficult for this type than for fixed-fixed.

The VARIABLE-FIXED form of record grouping has a variable number of fixed length records in each record block. Records may be grouped this way when a relatively small number of records in a file exceeds the fixed length. Records exceeding the fixed length are made up into two or more grouped records, thus increasing the number of records that can be placed in a block. Programming is more difficult than for fixed-fixed.

VARIABLE-VARIABLE is the case where each record block has a variable number of variable length records. This arrangement may be worthy of consideration when a file has many variations in the length of its records. However, this arrangement is more difficult to program than any other arrangement and should be used only if the end justifies the means.

The major differences in magnetic tape units are the speed at which the tape is moved past the read/write head and the density of the recorded information. Density describes the rate at which characters are recorded on tape. Among the most common are 200 and 556 columns per inch. Tape speed varies to a great extent, from less than 50 inches per second to more than 100 inches per second. Character transfer rate is determined by multiplying speed and density.

MAGNETIC CORE STORAGE

The magnetic core storage device is composed of tiny rings, or CORES, of ferromagnetic material. The ferrite used in this application is a ceramic iron oxide possessing magnetic properties. The ferrite particles are pressed on each core and then baked in an oven.

Magnetic cores normally have four wires passing through them (fig. 12-15). The X and Y drive (MAGNETIZING) wires are used for read selection. (These same two wires are used for write by reversing the direction of the current flow.) The SENSE wire is to sense the magnetic state of the core, and the INHIBIT wire ensures that the core remains in its original state after its contents have been read.

Since a single core stores only one bit of a word, a large number of cores are required to handle all the bits in every word to be stored. These cores are mounted on PLANES and the planes are stacked one upon the other. Each core is capable of containing one bit of information. A vertical column of cores consisting of one core in each plane is used to store one character, and is called a STORAGE POSITION. Figure 12-16 illustrates how magnetic cores are arranged to form a storage position, using the binary coded decimal system. Any number of adjacent storage positions can be grouped together to form words.

Every magnetic field has polarity. This can be demonstrated by the common horseshoe shaped magnets, which attract each other when turned one way, and repel each other when turned the other way.

In computer memory applications the ferrite core is magnetized by a flux field produced

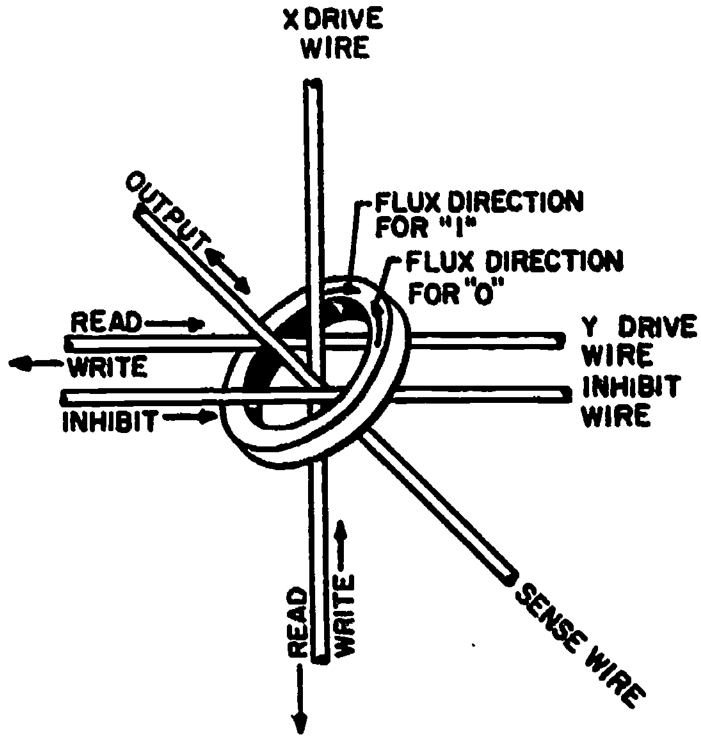

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Figure 12-15.—Magnetic core.

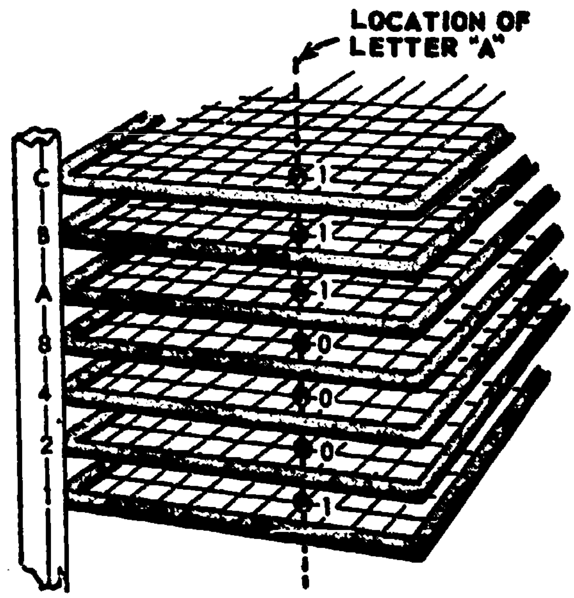

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Figure 12-16.—Representing a character in core storage.

when a current flows in drive wires that are threaded through the core. It retains a large amount of this flux when the current is removed. Flux lines can be established clockwise or counterclockwise around the core depending upon the direction of the magnetizing current. A current in one direction establishes magnetization in a core in a given direction. Reversing the direction of the current flow reverses the direction of the flux field and the core magnetization. These two unique magnetic states represent the binary digits 0 and 1, or NO BIT (0) and BIT (1).

Once information is placed in core storage, a means must be provided for obtaining that information when needed. This is accomplished by a sense wire, which passes horizontally through all cores in a plane. The presence of a bit or no bit in each core is transmitted through the sense wire to the location called for by the stored program.

An inhibit wire prevents writing a "1" when a "0" is to be written. Like the sense wire, the inhibit wire also runs through every core in a plane.

It is beyond the scope of this text to fully explain core storage, but a basic knowledge of how core storage works is useful in understanding the operation of all data processing systems using core memory. More detailed coverage can be found in DIGITAL COMPUTER BASICS, NAVTRA 10088.

MAGNETIC DRUM STORAGE

The magnetic drum storage device consists of either a hollow cylinder (thus the name "drum") or a solid cylinder that rotates at a constant velocity. The outer surface is coated with a material capable of being magnetized. Magnetized spots can be placed on the surface of the drum to represent data. These bits are placed in a series of tracks running around the drum, as shown in figure 12-17.

Each data track has its own read-write head which is used for recording and reading. The drum is rotated so that the heads are near but not touching the drum surface at all times. As the drum rotates, the tracks are continuously passing under their respective read-write head.

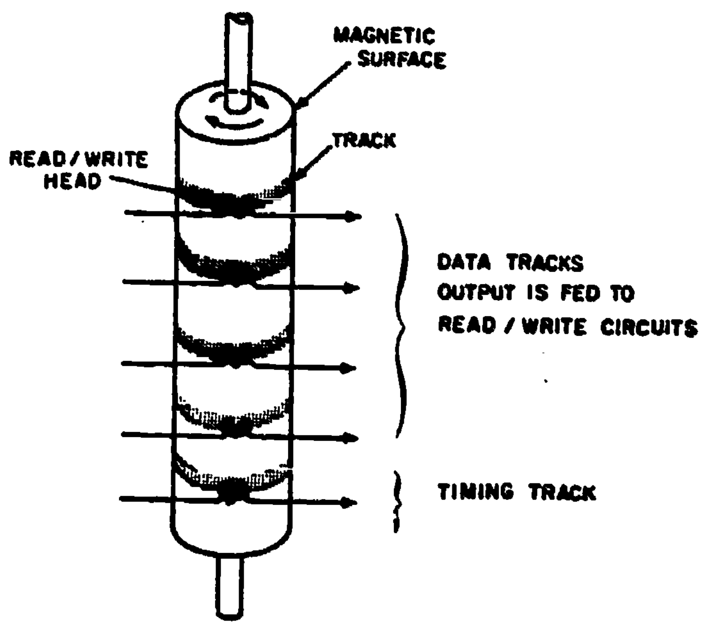

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Figure 12-17.—Magnetic drum.

The read-write heads read information from a magnetic drum by sensing the magnetized spots on the drum surface, converting them to an electrical signal, and transmitting it to the computer. Information is written on the drum by converting electrical signals from the computer into magnetized spots on the drum surface.

Data recorded on the surface of drums remains indefinitely and may be used repetitively. The old data is automatically erased each time new data is recorded.

Each drum has a specific number of storage locations which are addressable by the computer. The capacity of each storage location depends upon the design of the drum and the data representation code used. Because neither reading nor writing can occur until the particular location to be read or written is directly under the read-write heads, the speed of access is dependent upon the location of the desired storage position on the drum in relation to the read-write heads.

MAGNETIC DISK STORAGE

Magnetic disks resemble phonograph records which have been coated with ironoxide. The

disks (or records) are arranged in stacks in much the same way as a record stack in a modern "juke box." All of the disks are continuously revolving and spaced apart so that a read/write head, driven by an access mechanism, can be positioned between the disks.

The data are recorded at certain addresses on a specific disk. When readout of a particular section of storage is desired, the recording head is automatically positioned and the data are read from the surface of the selected disk.

Disk storage makes it possible for records to be accessible without having to read from the beginning of a file to find them. This is called either DIRECT ACCESS or RANDOM ACCESS processing as contrasted to SEQUENTIAL or BATCH processing where reels of magnetic tape or files of punched cards must be read from the beginning in order to read or write a desired record.

Assume that ten magnetic disks are used for storing all material inventory records by stock number. All stock numbers starting with zero are placed on one disk, those starting with 1 on another disk, 2 on a third disk, and so on through stock numbers starting with 9, which are placed on the tenth disk. If an issue card with a stock number starting with a 4 is fed into the system the disk which has all stock numbers starting with 4 is selected and spun around until the particular stock number which the computer is looking for is reached.

Direct access processing has a decided advantage over sequential processing if master files have to be updated on a continuous basis. Continuous processing usually results in a small percentage of the master records being affected. In sequential processing, each master record must be read and written for each processing cycle, even though only a few records may have to be updated. In direct access processing, only those master records affected by transactions need be read and written, thus saving considerable reading and writing time.

One disk arrangement (fig. 12-18) has the disks mounted on a vertical shaft, with each disk separated from the adjacent one. As the shaft revolves, spinning the disk, magnetized spots can be placed in tracks on both sides of the disk to represent data. One or more access arms are located at the side of the disk stack, and move under control of the stored program to any desired track on any disk. Magnetic recording heads mounted on these access arms are used to write data on the disks and to read data from them. Each access arm is forked, with a recording head on each fork, making it possible to read or write on either side of the disk.

Another disk arrangement (fig. 12-19) uses interchangeable disk packs. Six disks are mounted in a disk pack which can be replaced or removed from the disk drive and stored in a library in much the same manner as magnetic tape reels may be stowed. The packs weight less than ten pounds each, and up to 7.25 million characters of information can be stored on each disk pack.

The inside ten disk surfaces are used for recording data, while the outermost two surfaces are protective plates. When installed in a disk drive, information is written or read from the surfaces by read-write heads mounted in pairs between each two disks on a movable access mechanism.

The magnetic disk data surface remains recorded until written over. Each time new information is recorded and stored, the old information is automatically erased. Data recorded on magnetic disks may be read as often as desired.

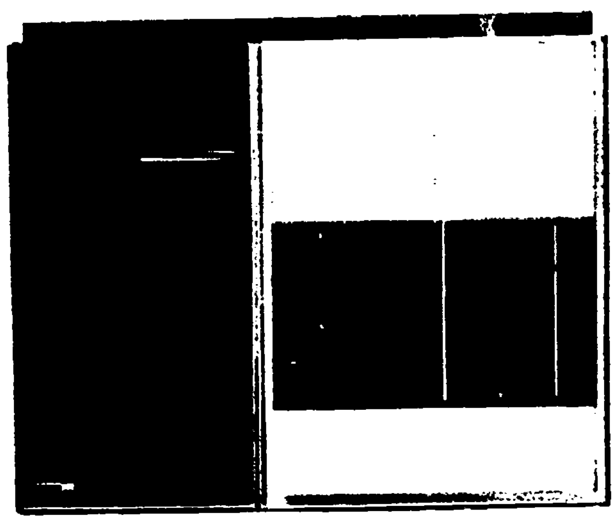

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Figure 12-18.—Permanent disk storage.

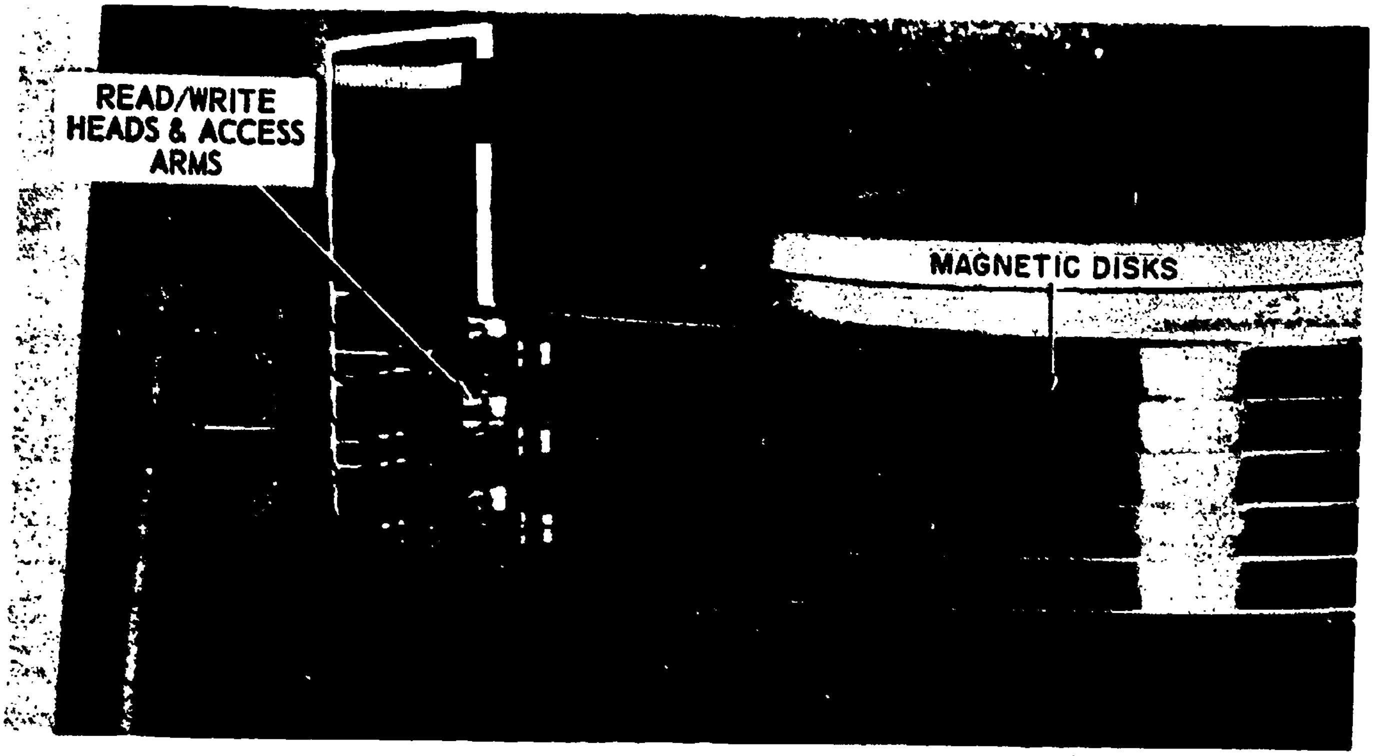

Figure 12-19.—Mounted disk pack and access arms.

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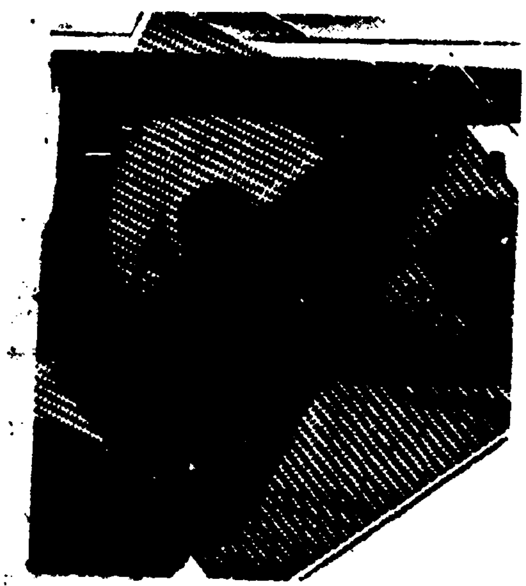

Figure 12-20.—Thin film memory.

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THIN FILM STORAGE

Thin film storage consists of small spots of magnetic material less than one-sixteenth of an inch in diameter, deposited on an insulating base, such as a glass (fig. 12-20). The spots are made only a few millionths of an inch thick and are made by the deposition of magnetic alloys under a high vacuum in layers so thin that magnetization can be switched by rotation within time intervals of several nanoseconds. Access time of the Univac 1107 thin film memory is 300 nanoseconds (.3 microseconds).

Magnetic drums, disks, and tape use spots of magnetization, whereas the magnetic material is continuous. In thin film the spots of magnetization and the spot of magnetic material have the same boundaries. The spots are made by evaporating the magnetic material in the presence of a magnetic field. Therefore, magnetization in the preferred direction or opposite direction can be easily made.

CHAPTER 13

PROGRAMMING AND LANGUAGES

INTRODUCTION

In the normal process of advancement in the data processing rating a person usually is first an operator, next a programmer and finally a systems analyst. At the E-4 level, studying for E-5, he must be introduced to programming. The E-5 is looked upon as being the prospective programmer.

It is the intent of this chapter to provide an introduction for the prospective programmer. Programming terminology will be defined and examples given of languages used throughout the Navy.

Programming is the designing, writing and testing of a program. To write a program one must use a language. A language is a set of representations, conventions and rules used to convey information. Information is the meaning that a person assigns to data by means of the known conventions used in their representation (e.g., 121872 is data until it is titled date; it is then month 12, day 18, year 72). The completed writing is known as a program. A program is a series of actions proposed in order to achieve a certain result.

DESIGN

To get to the program writing stage much preparatory (design) work must be done. The amount of design work depends on the type of installation to which a person is attached. In large organizations there may be system analysts, program flowcharters, coders, program maintenance people, etc. Each of these people has a specific function in the stages of developing a system.

As this is an introductory chapter on programming it will present material related to programs that are to be developed by a trainee receiving on-the-job training at a medium sized command. At such a command part of the design work will be accomplished before the program package is turned over to the trainee. The trainee is then required to complete the programmer's function.

The design materials that should be provided are:

1. Input requirements—This would include all source documents (card layouts, tape record layouts, disk record layouts). If the input is from other than cards, the file names will be provided.
2. Output requirements—This would include the layouts for whatever type of output is required. It could be card, tape, disk, printed reports or combinations of these.
3. List of library routines—This would contain the call name(s) of libraried routines. Library routines are programs that have already been written and are in object decks, on tape or disk. These are programs that can be called in by your program to provide certain functions such as merging two or more files, sorting, calculating square root, etc. This saves each programmer from duplicating other's efforts.
4. A problem description—This is a narrative statement of the problem. It may include a description of the method of solution, the solution itself, the transformations of data and the relationship of procedures, data, constraints, and environment. In simpler terms this means a longhand definition of the problem which provides all necessary formulas for any calculations involved.

In a small installation the preceding list of design material would have to be gathered by

the programmer. Only a written or oral general problem description and a rough idea of the required output would be provided. Design development is described in more detail in the *Data Processing Technician 1 & C* rate training manual.

Continuing on the assumption that the four pieces of design are provided, the trainee is now left to complete two steps—flowcharting and program coding.

FLOWCHARTING

Flowcharting is a graphical means of representing the definition, analysis, or solution of a problem, in which symbols are used to represent operations, data, flow, equipment, etc.

There are two types of flowcharts—data flowcharts and programming flowcharts. A data flowchart represents the path of data through a problem solution. It defines the major phases of the processing as well as the various data media used. This type of flowchart is most generally constructed by the system analyst. In the past it has been referred to as a systems flowchart and is still referred to as such by "old timers." An example of a data flowchart will be given later in this chapter.

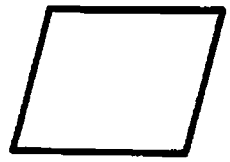
The second type of flowchart, programming flowchart, is the one that will have to be constructed by the programmer. It represents the sequence of operations in a program. Some people erroneously refer to this type as a detail flowchart.

FLOWCHART SYMBOLS

To construct a flowchart it is first necessary to know the symbols and their related meanings. The following symbols and their meaning are standard for the military, as directed by SECNAVINST 5233.1 of 30 June 1972.

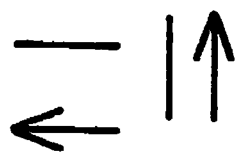
Basic Symbols

Symbols represent functions. These functions are input/output, processing, flow direction, and annotation. All flowcharts may be initially constructed using only the basic symbols as a rough outline to work from.

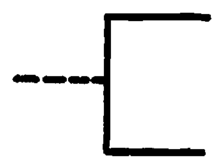


INPUT/OUTPUT SYMBOL represents any type of medium or data available for processing (input), or the processed information (output).

PROCESS SYMBOL. A major data processing function, the process of operations resulting in a change of value, form, or location of information.



FLOWLINE SYMBOL. Normal direction of flow is from left to right and top to bottom. If the direction of flow is other than normal, arrowheads are required at the point of entry.

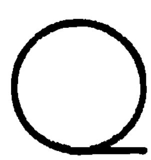


ANNOTATION SYMBOL is used for the addition of descriptive comments or clarification notes. The broken line may be extended in whatever fashion to any symbol where applicable.

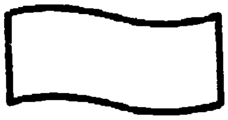
Specialized Input/Output Symbols

Specialized I/O symbols are used to construct all final programming flowcharts. They more specifically denote the medium on which the information is recorded or the manner of handling the information.

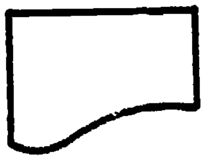
PUNCHED CARD SYMBOL is for an I/O function in which the medium is punched CARDS.



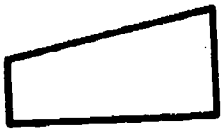
MAGNETIC TAPE SYMBOL represents an I/O function in which the medium is magnetic tape.



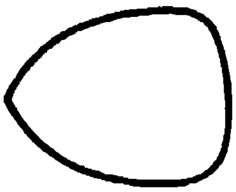
PUNCHED TAPE SYMBOL is for an I/O function in which the medium is punched tape.



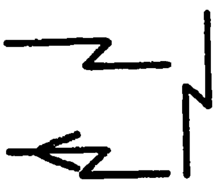
DOCUMENT SYMBOL represents source documents and all varieties of reports and documents.



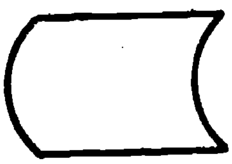
MANUAL INPUT SYMBOL is used when information is entered manually at the time of processing, by means of online keyboards, switch settings, pushbuttons, card readers, etc.



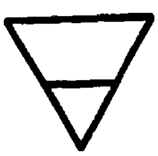
DISPLAY SYMBOL is used when information is displayed by plotters or video devices.



COMMUNICATION LINK SYMBOL denotes automatic transmission from one location to another. The direction of flow is left to right and top to bottom. Arrowheads are used when increased clarity is desired.



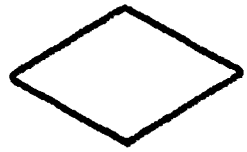
ONLINE STORAGE SYMBOL indicates the use of a mass storage unit such as magnetic disks and drums.



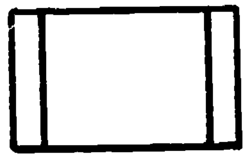
OFFLINE STORAGE SYMBOL represents any offline storage of cards, paper, and all other media.

Specialized Process Symbols

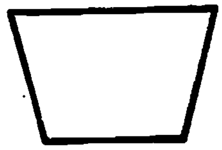
Specialized process symbols are also used for the final programming flowchart as they represent more meaningful processing functions, and identify the specific type of operation to be performed on the information.



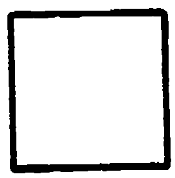
DECISION SYMBOL is used to depict a point at which a branch or switching type operation to one of two or more alternate paths is possible.



PREDEFINED PROCESS SYMBOL indicates a named process consisting of one or more operations or program steps that are specified elsewhere, e.g., subroutine or logical unit.

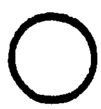


MANUAL OPERATION represents all manual offline operations which do not require mechanical aid. These are clerical processes geared to the speed of a human being.

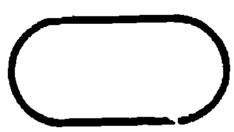


AUXILIARY OPERATION SYMBOL represents an offline operation performed on equipment not under direct control of the central processing unit.

Additional Symbols



CONNECTOR SYMBOL represents a junction in a line of flow to another part of the flowchart. The entries and exits are represented by a set of two connector symbols. When flowcharts are broken due to page limitations, this symbol is used to indicate the break, and identifications should be placed within the symbol.



TERMINAL SYMBOL represents a terminal point in a system at which data can enter or leave; (start, stop, halt, delay, or interrupt).

Graphic Symbols

The following graphic symbols are used when appropriate on flowcharts and other documentation.

+	plus, add
-	minus, subtract
*	multiply
/	divide
±	plus or minus
=	equal to
>	greater than
<	less than
≥	greater than or equal to
≤	less than or equal to
≠	not equal to
≯	not greater than
≮	not less than
YES or Y	Yes
NO or N	No
TRUE or T	True
FALSE or F	False

Flowcharting Template

An aid for drawing the symbols is called a flowcharting template. Figure 13-1 shows a template containing the standard symbol cutouts. A template is usually made of plastic with the symbols cut out to allow tracing the outline.

FLOWCHART CONSTRUCTION

There is no "best way" to construct a flowchart. There is no way to standardize problem solution. Flowcharting and programming techniques are always unique and conform to the individual's own methods or direction of problem solution.

This manual will show an example of developing a programming flowchart. It is not the intent to say this is the best way, rather, it is one way to do it.

By following this text example the trainee should grasp the idea of problem solution through flowchart construction. As experience is

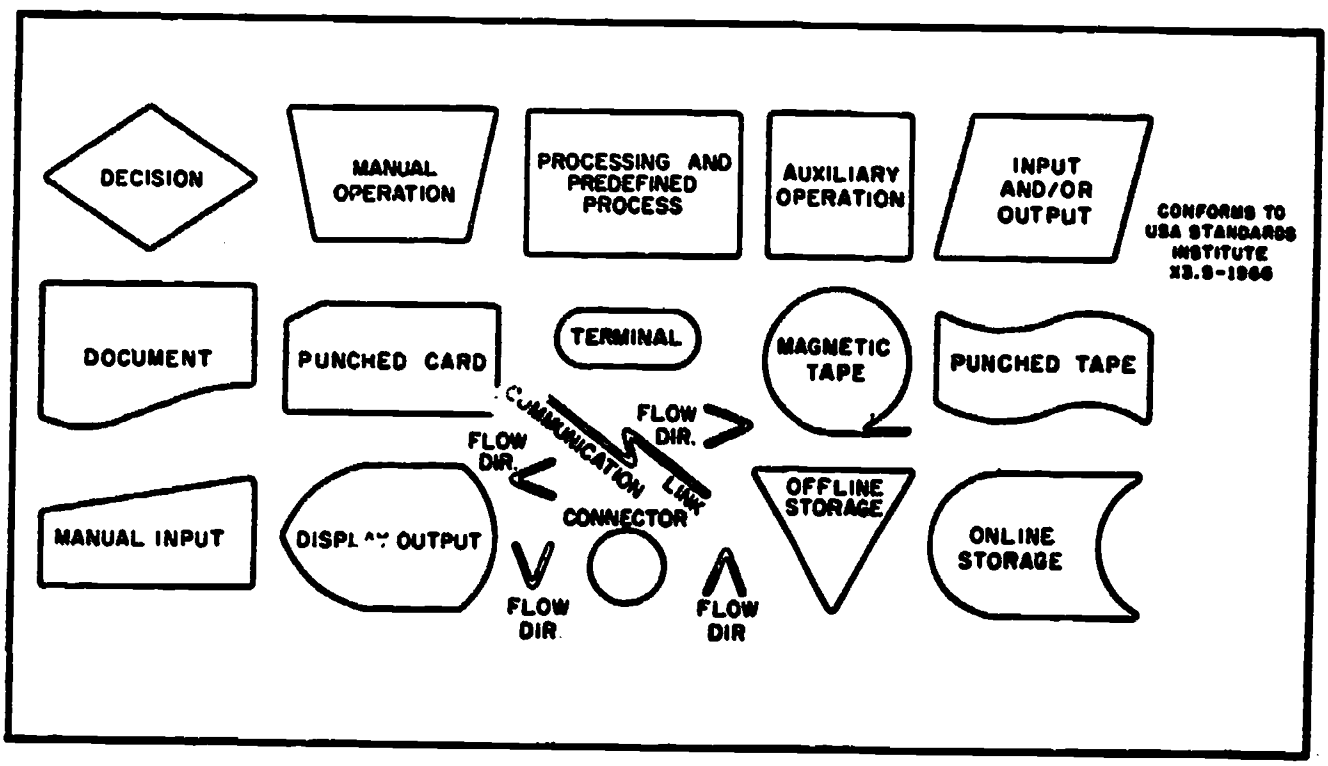


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Figure 13-1.—Flowchart template.

gained and familiarity with a computer system is acquired, these basic ideas will serve only as a foundation.

In order to develop a flowchart a person must first know what problem he is to solve. As was stated earlier, some design material will be provided. Two of these items are a problem definition and data flowchart. These two items are provided as follows for this example.

PROBLEM DEFINITION

DIVISION BUDGET. This program will be to determine a division's remaining balance of quarterly budget funds. The current balance will be contained on a master tape. The tape label will be "SUPPLY" with each record 110 characters in length.

The tape will be in sequence by a four digit numeric division code. The division code will be the first four characters of each record, and the current balance will be located in positions 20-28.

The detail file for the update of current balance will consist of cards. The card layout will be as follows: Division code, cc 1-4; Expenditures, cc 5-12; Credits, cc 13-22; Blank for cc 23-80. These cards will be accumulated for a month's period and sorted into ascending division code sequence.

The end result will be to produce a listing of monthly expenses, credits and the current balance together with an updated current balance on the master tape file. A master record with no transactions need not be listed.

DATA FLOWCHART

The data flowchart for an entire ship's supply system is depicted in figure 13-2. This is the type of flowchart constructed by a system analyst to show the relationship of numerous jobs that make an entire system.

That portion that would be presented to the programmer for this problem is from entry point (connector) A through the writing of NEW SUPPLY at entry connector B. All steps involved in this problem are numbered in the upper right corner of each symbol. These numbers would not normally appear but are to be used for reference later in this chapter.

PROGRAMMING FLOWCHART

Many things must be considered when developing the programming flowchart. The experienced programmer can foresee many of these things and usually has a plan of attack. This plan is put down in the form of a rough programming flowchart. This rough will be used to trace through each of his logical solutions for each of the situations that may occur for correctly processing the data.

After the initial rough (with possibly many changes) is drafted, it is put into a smooth. From this smooth programming flowchart it should be possible for any programmer to write the program. This is why flowchart symbols and data processing terminology must be standardized.

The "plan of attack" and logic for flowcharting this problem will be explained as it was developed. Reference will be made to the problem definition (PD) and data flowchart (D F/C) as support for the logic.

The first step will be to transform a low speed input to a high speed input. D F/C symbol 2 indicates an input of current division expenditure/credit file. This will be the punched cards for update (PD). As the update records must be compared to the master records, it is to our advantage to first get both inputs on the same storage medium. This provides equal speed factors for better use of computer time.

Figure 13-3 is the flowchart required to indicate the transfer of data from cards to magnetic tape. The predefined process symbol is an indication to the operator that a utility program (library routine) is to be called in. This particular flowchart will not generate programming. It will go in the finished documentation package as part of the operator's manual.

Both inputs for this problem are now going to be on magnetic tape. To start the programming flowchart for this problem the first logical steps will be to read a record from each file. Figure 13-4 depicts the symbols and notations required for initial file reading.

Checking for end of file (EOF) is standard procedure after reading. At this point it seems ridiculous to check for EOF, as it is evident that only the first record is being read from each file. Further development of this flowchart will

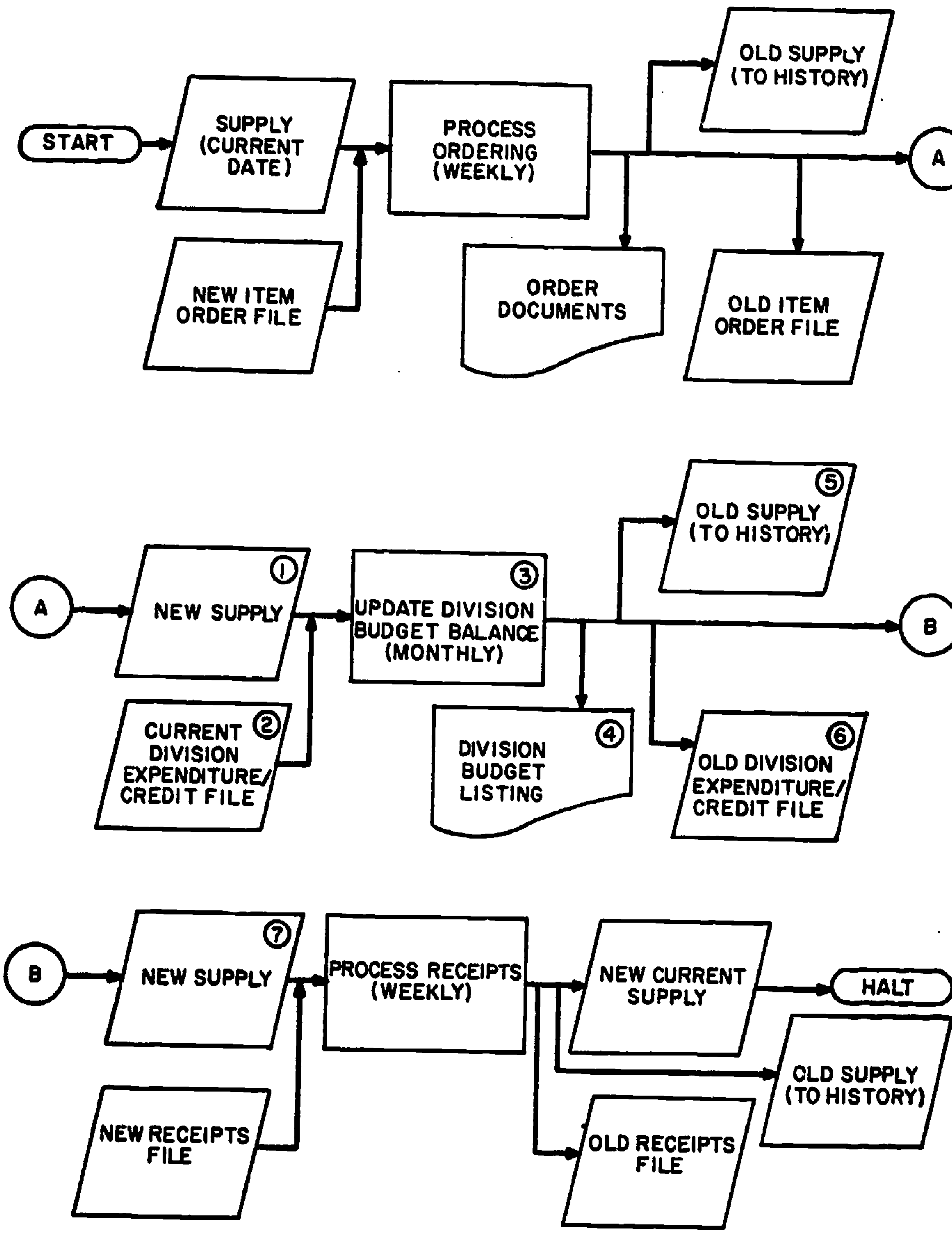

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Figure 13-2.—Data flowchart for ship supply system.

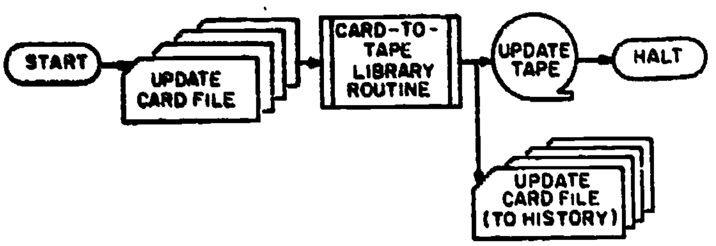

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Figure 13-3.–Step 1.

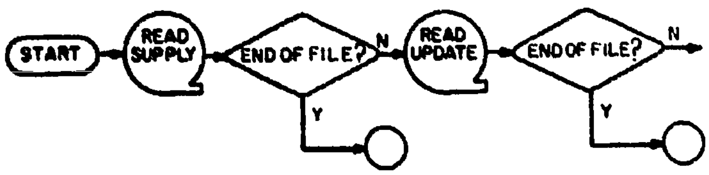

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Figure 13-4.–Step 2.

clarify this necessity for EOF. For now, the plan of attack assumes that EOF has not been detected for either file, indicated by the N's. The EOF detection routes (Y's) are left with blank connector symbols. These connector symbols will be filled in when the logic for those situations is flowcharted.

Once a record from each file is available, it is then necessary to determine if the records match on division code (PD). The N route of EOF, therefore, will lead to the decision symbol in figure 13-5. The result of this decision is again twofold, and the plan of attack is to solve for the Y first. The N route is, therefore, left with a blank connector symbol.

The processing symbols for the Y route (DIV CODEs are equal) indicate the individual steps required to calculate the current balance, produce an updated record on a new tape and print a report as required by the PD.

The flowcharting of figure 13-5 indicates the extent of processing required for an equal condition and could end with a connector indicating a required looping back (return) to read both files. This is not indicated at this point but will be left in abeyance until further flowchart development. For now this line of logic is completed.

The next logic in the plan of attack to be developed is the N route of the DIV CODE comparison. Figure 13-6 shows the flowcharting required for the N route connector symbol of DIV CODE comparison in figure 13-5. Once the decision is made that DIV CODE are not equal, it still remains that one is higher than the other. The first thing to be accomplished in figure 13-6 is determination of which code is higher. The processing flowcharted in figure 13-6 follows the decision that the update file has the greater division code number. The connector for the N route is left blank until further logic development.

When the update DIV CODE is greater than the supply DIV CODE, it means that a master

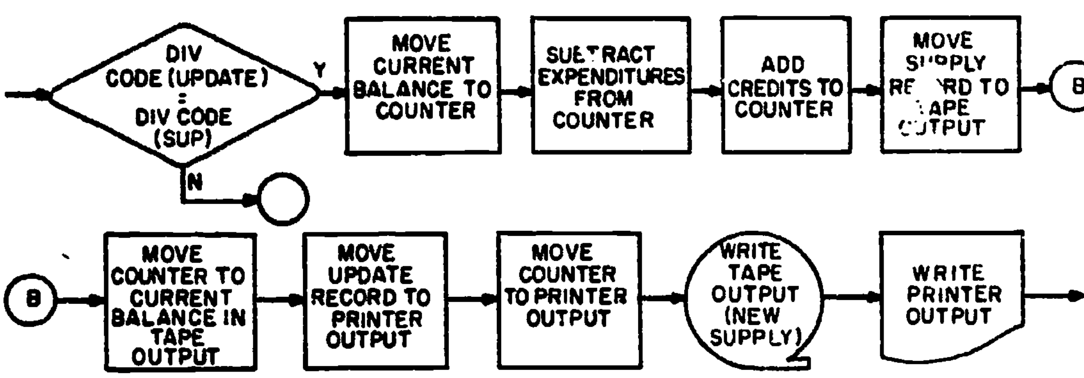

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Figure 13-5.–Step 3.

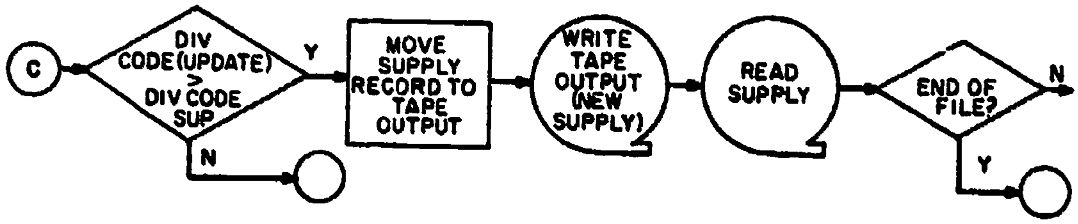

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Figure 13-6.—Step 4.

record (a particular division) had no transactions for the month. For this situation all that is required is to transfer the old supply record to the new supply tape (PD).

After the write operation, the supply record has been processed and the next old supply record must be brought in (read). The READ SUPPLY is done at this point rather than looping to the READ SUPPLY at the program start. The reason is that if a loop had been indicated, both files would have been read. This would be erroneous as the update record that was originally compared is still unprocessed. This unprocessed update record must be compared against the next supply record.

After determination that EOF does not exist on this read, it is then logical to loop back to the initial compare of DIV CODEs in figure 13-5. This is not indicated, however, as further development will prove it would be erroneous to directly loop. For now this line of logic is completed.

The next logic to be flowcharted is for the N route of the decision on DIV CODE in figure 13-6. This route will denote the processing required when the supply record is greater than the update record. This means that there is no master record for a particular division (most likely a newly established division). Figure 13-7 depicts the flowcharting required for this processing.

As there is no master record for this division, one must be constructed. The first step is to build a record of appropriate length (PD). Once the record area is established, the DIV CODE can be written into the supply record from the update record. As there is no current balance,

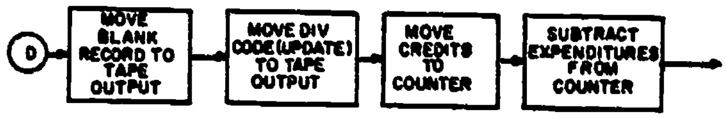

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Figure 13-7.—Step 5.

the update records credits are moved to a counter area and the expenditures subtracted.

The next five steps would be identical to the routine of figure 13-5 after connector B. Rather than duplicate efforts, a loop could be initiated back to connector B. Again, a connector is not provided to indicate this action.

All lines of logic have now been flowcharted except for the EOF routines. The conditions that are flowcharted include:

1. DIV CODE of both files being equal (figure 13-5).
2. DIV CODE of update being greater than DIV CODE of supply (figure 13-6).
3. DIV CODE of supply being greater than DIV CODE of update (figure 13-7).

For completion of this programming flowchart the following must be considered:

1. What must be done when EOF has been detected for the supply file but not the update file?
2. What must be done when EOF has been detected for the update file but not the supply file?

3. As it is planned to utilize a portion of the flowchart in a looping action (from figure 13-7 to figure 13-5, entry B), how is indication and detection of this loop performed? Of what significance is it to detect that a loop has been performed?

Figure 13-8 is the completed programming flowchart for this problem. One EOF routine cannot be completed without involvement of the status of the other file. The entire picture is, therefore, shown, and the logic is as follows:

Basically, when a file is ended, the procedure is to set a condition (move 1 to EOFCK, at connector E; move 2 to EOFCK, at connector G) and loop to a routine which will process the other file until EOF (entry 3 and entry 4).

By tracing through each routine the programmer can determine if the logic is correct. The routines that are in this flowchart are for:

1. an equal compare condition
2. an unequal compare condition with supply containing the greater DIV CODE
3. an unequal compare condition with update containing the greater DIV CODE

Any of the preceding routines may end with an attempted read of one of the files and detection of EOF.

The first routine is traced through as follows: On an equal compare both file records have been processed and two new records must be read. This is performed by a loop to entry point 5.

The first EOF that may then be encountered by this routine is for the supply tape. If EOF is detected (Y), a branch to connnector G is indicated. At G a 2 is moved to an area of storage called EOFCK. As it is evident that supply is terminated, the update file is read, EOF checked, and (if not also EOF) a loop is performed to process the update record (entry 7). The processing at entry 7 is performed and a check is made to see if supply EOF is present. If this is the case, the Y routine is performed, and a loop to entry point 2 occurs.

The processing is completed for the update record, and EOFCK is checked for supply EOF indication. (The COUNTB = 1 will be explained later.) As the contents of EOFCK are equal to two, a branch occurs to entry point 4, and another update read is attempted.

This looping and branching will continue until such time as EOF for update is detected. When this occurs, the program is terminated.

If on a loop (from an equal compare processing) to entry 5, supply is not at EOF, but update is, a branch is indicated to connector E. At connector E a 1 (instead of a 2) is moved to EOFCK. It is now evident that all that remains is to process the supply file until EOF. A loop is, therefore, indicated to entry point 3. This routine processes the supply record, reads supply and checks for EOF. If EOF does not exist (N), EOFCK is checked for indication of update EOF (contents of a 1). If a 1 is present, a loop to entry point 3 is performed.

This loop will continue to occur until EOF of supply is detected. Once this condition exists, a branch to connector F is directed. The routine at F checks to see if the update file is ended. If so, both files are now ended and the processing is terminated. If EOFCK does not contain a 1 (update not EOF), normal processing has caused this entry and the first EOF detection has been encountered. In this case a 2 is moved to EOFCK and a loop is indicated to entry 7 for processing of the update record. The looping as previously described is then performed until EOF at entry point 4 is detected and the processing is terminated.

All conditions involving EOF have not been logically solved and flowcharted. The remaining element is the involvement of COUNTERB. During normal processing when the DIV CODE of supply is greater than that of update, a branch to connector D occurs. For this routine the update record only is processed. If EOF of supply is detected, a direct loop to entry 2 is indicated (EOFCK = 2). This routine will again check the EOFCK contents and direct the process through the route to finish the update file (to entry 4).

If the EOFCK is not equal to 2 but the loop to entry 2 is still performed (without setting COUNTERB), an erroneous loop from that routine to entry 5 will be performed. It will be erroneous because it will read supply (as out of equal processing) with a supply record still unprocessed. Therefore, by moving a 1 to COUNTERB (another memory area), correct

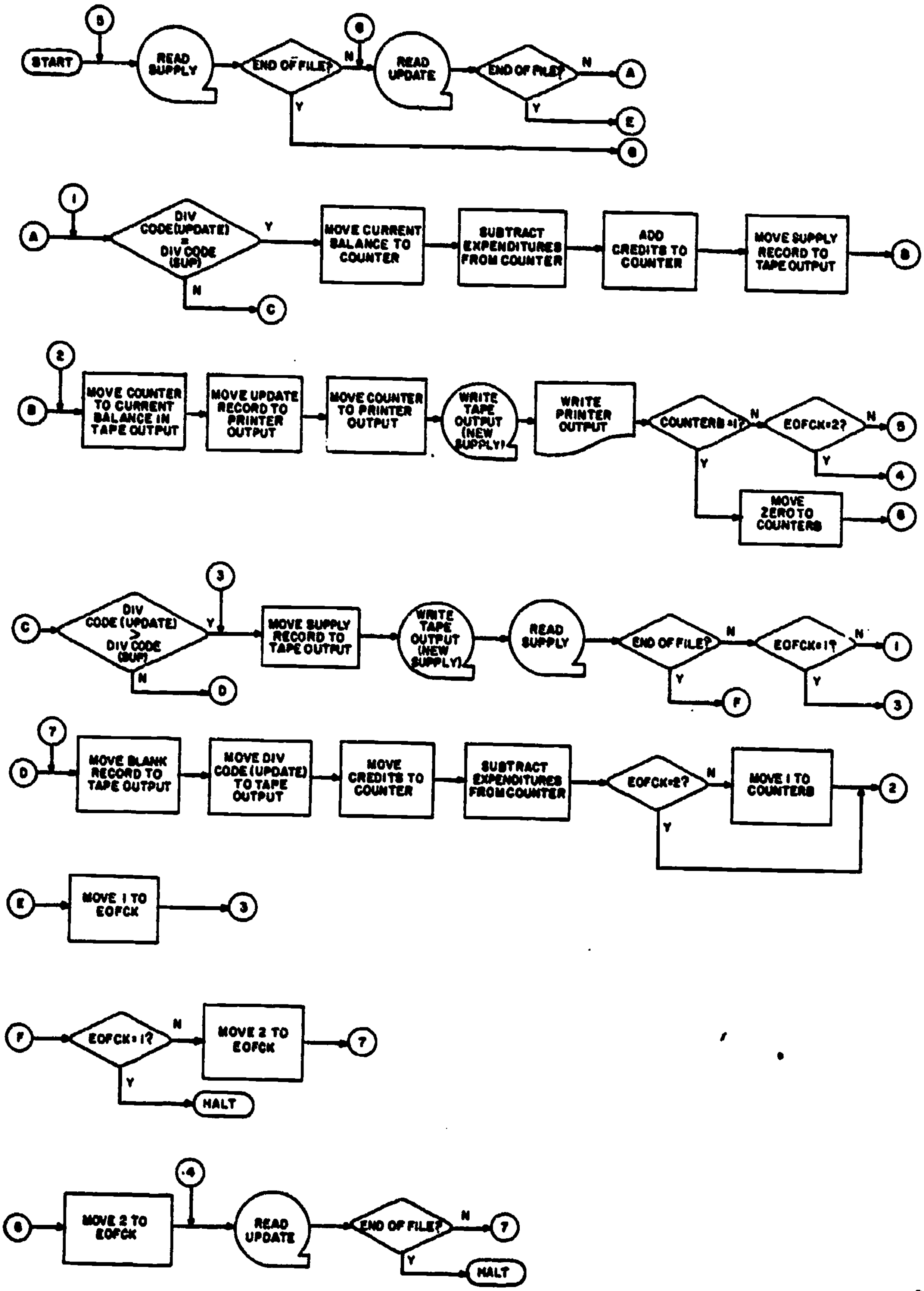

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Figure 13-8.—Completed programming flowchart.

control can occur (COUNTERB = 1) to direct looping to entry 6. This provides a read of a new update record and comparing against the unprocessed supply record.

Whenever COUNTERB is determined to have a 1 present, it is reset to zero so as not to provide misrouting if tested under different circumstances.

Flowcharting Summary

The preceding programming flowchart depicted is relatively basic. The complexity of any flowchart is determined only by the complexity of the problem. For any problem involving two inputs the read ins and EOF's will be depicted in much the same manner as in figure 13-8. The big difference between this flowchart and one any other programmer will develop is the processing (problem solving) steps involved.

The logical sequence of problem solving steps may be influenced by a number of factors including:

1. the programmer's personal method of problem solution
2. the programmer's degree of knowledge of the system
3. the programmer's degree of knowledge of the instruction set (repertoire) of the language used by the system

Once the flowchart has been constructed and the program written, a test run may expose errors. These errors may be due to misuse of an instruction, keypunching of the program, or a combination of these or one of many other factors. Errors, of course, require that changes be made.

When changes are made to the program coding which change the flowcharted sequence, these changes must be reflected in the flowchart.

LANGUAGES

Once a programming flowchart has been completed, the next step is to produce a written set of instructions. These instructions will eventually permit the computer to input, process and output the data in a sequence similar to that depicted in the programming flowchart.

To communicate with the computer (as in any communications) there must be a language. A language is a set of representations, conventions and rules used to convey information.

There are many types of languages in the computer world. Among these are programming language, source language, object (or target) language and machine language.

PROGRAMMING LANGUAGE

The programmer's objective is to produce a computer program by using a programming language. A computer program is defined as a series of instructions or statements, in a form acceptable to a computer, prepared in order to achieve a certain result. This program is developed by use of a programming language.

Programming language is a general term relating to any and all languages used to prepare computer programs. The type of programming language of most concern to a trainee is a source language.

SOURCE LANGUAGE

A source language is the language which is input to a computer. When the programmer writes (symbolically codes) a program, that program becomes input to a processor. The source language eventually is translated into object (target) language which can be loaded into memory and executed.

The source language is not always in symbolic coding (programmer written). It may be the object language of one computer system that requires translation into the object language for another computer system.

In some computers the object language is machine language. In this case all addresses are absolute (fixed) in the object language. Other computers do not provide absolute addresses until a loading routine has taken place. Therefore, a distinction is made between object and machine language.

OBJECT LANGUAGE

Object language is the language into which a statement is translated. This translation is accomplished by a processor.

A processor, in software, is a computer program. This program includes the compiling, assembling, translating, and related functions for a specific programming language. In other words, everything that is needed to go from one programming language to another is included.

The source language is translated (by compilation or assembly) into object language. Object language is also called target language.

MACHINE LANGUAGE

When the object language has been generated for the entire source language program, it is ready to be loaded into main storage for execution. Once this loading (read in) is accomplished, it is said that the program is in machine language. Machine language is that language that is used directly by the machine.

PROGRAMS

The use of these languages will result in programs being developed. There are two major terms used when referring to programs—source and object.

SOURCE PROGRAM

A source program is a computer program appearing in a source language. For most programmers this means a symbolic coded program. Some of the symbolic coding structures available to Navy programmers are:

Common Business Oriented Language (COBOL), Formula Translator (FORTRAN), Assembler Language Coding (ALC, also called Basic Assembler Language or BAL), Jules Own Version of International Algebraic Language (JOVIAL), Programming Language/1 (PL/1), a language simply called LASS, and Compiler Monitor System-2 (CMS-2).

A programmer will code a series of instructions or statements in one of these symbolic coding structures. The symbolic coding will then be keypunched into a deck of cards. This deck is usually called the source deck.

The source deck is input to a processor, and if output is requested in card form, the punched output is referred to as the object deck. The output may be on any other storage medium (tape, drum, disk, etc). Regardless of what output storage medium is used, the program that results is known as an object program.

OBJECT PROGRAM

The object program is a fully compiled or assembled program that is ready to be loaded into the computer for execution.

SYMBOLIC CODING

The programmer will normally write a program in one of the symbolic coding structures. To accomplish this coding a programmer must be familiar with the coding rules, formats of instructions, actions directed by the operation codes, and method of indicating the address part for the particular coding used.

This manual will not attempt to provide more than a few brief examples of instructions from various coding structures. These examples will familiarize you with some general terminology relating to coding.

FORMAT

The format for coding instructions is similar for each low level code. A low level code is a code that will, in most cases, produce one machine instruction for each symbolic coded instruction during translation.

For low level coding each instruction contains an operation code and normally one or more operands. As there are many low level codes available, the following examples will utilize ALC.

The operation code in symbolic code is usually an alphabetic character abbreviation of the operation that is requested such as: A (Add), S (Subtract), L (Load), C (Compare), etc. The operation code in symbolic code may also be referred to as a mnemonic.

The operand of an instruction is that part of an instruction that indicates a storage address. In symbolic code it is usually, but not restricted to, a group of alphabetic characters (called label) which the programmer has assigned to a field. That is, a field may contain the years of service for a Navy man, and the programmer may label

it YSER or YEARS or whatever unique combination of letters he chooses. That particular combination may not be used again for that program. If the programmer labels one field AMT (amount) he may label another field AMTA or BAMT but never any two exactly the same.

Each of the operands (labels) will be equated to a specific storage address during assembly. This means that if one label were used for two different fields, the same storage address would be sought out for each, and the program would not execute properly.

An example of instructions coded in ALC to add two fields together is as follows:

```
L    3,FIELDA
A    3,FIELDB
ST   3,FIELDC
```

The L operation code means that a loading operation (moving data from one storage area to another) is to take place. The first operand (address) is a decimal number that indicates a reserved area of storage used as an arithmetic register. Register 3 is, therefore, going to receive the data moved from the storage address specified by the label FIELDA.

The mnemonic A indicates that adding is to take place. The data found at address FIELDB will be added to the contents (FIELDA) of register 3.

Finally, the result of the add (in register 3) will be stored (moved) from the register to a storage address equated to the label FIELDC.

If the symbolic coded instructions from the given add are put through an assembler, one machine language instruction will be generated for each. For the computer this is the fastest method. For the programmer, however, it is more painstaking to code (and remember) three separate instructions.

In a high level code such as COBOL the translation takes longer (compilation time), but the programmer takes less time to write the statement.

In COBOL the same add action could be generated by writing:

```
ADD FIELDB TO FIELDA GIVING FIELDC.
```

This type of coding does not lend itself to a one for one generation of instructions. This program must also be translated to object language. The object language for COBOL is generated by a compiler.

The main difference between a compiler and an assembler, therefore, is the level of the source language that requires translation. Each (for its respective level) will produce the same final result of an object program, which is the goal of a programmer.

SUMMARY

The symbolic coding is the key step for a trainee to understand. If a trainee can code a series of instructions or statements to execute the logic and produce the output depicted in his programming flowchart, he is as useful as any programmer in his command.

Once the trainee is advanced to Petty Officer Second Class, formal schooling, local command schooling, programmed instruction courses or on-the-job training with an experienced programmer should be provided. This education will build on his basic knowledge.

In the meantime, while still a seaman or Petty Officer Third Class the trainee may acquire through study the knowledge of the skilled data processor required by the Navy.

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