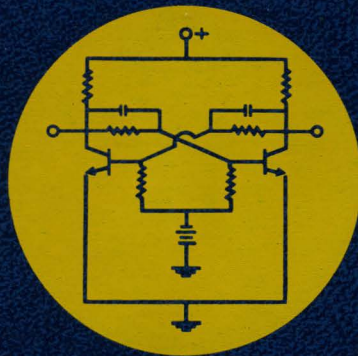


TELEPHONE COMMUNICATION SYSTEMS

VOLUME IV
DIRECT DISTANCE DIALING AND TOLL SYSTEMS



GRADUATE ENGINEERING
AND
INFORMATION SYSTEMS EDUCATION

TELEPHONE COMMUNICATION SYSTEMS

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PREFACE

Connecting any two phones among the millions of subscribers is accomplished by telephone switching systems. The process, although not simple, is normally taken for granted in our everyday use of telephone services. This is indeed a compliment to the Bell System people who have developed, engineered, and maintained the many types of telephone systems. The switching equipment in the Central office is considered by many to be the heart of the telephone highway, for without it the telephone never would have progressed to the highly developed and integrated entity it is today.

Although the switching equipments may be considered the "heart," the other parts of the telephone network are equally important. For without the connecting wires and cables, the subscribers' equipment and the power plant, there could be no universal telephone network and no Direct Distance Dialing.

Switching is a highly dynamic field. From the first crude switching arrangements developed by the Holmes Electric Company in Boston in 1877 to the highly sophisticated No. 1 ESS system developed by the Bell System Laboratories in the early 1960's, the telephone switching system has indeed come a long way. What the future holds can only be speculated upon: on the horizon, we now see new developments, such as the use of satellites, lasers, and holography in communications.

Each subject covered in this text could be developed much more extensively; however, our objective is not to print a comprehensive treatise on telephony, but rather to treat each subject briefly presenting a general technical explanation of its operation and function.

This text has been prepared for Graduate Engineering Education courses presented at the Western Electric Corporate Education Center. Its contents are the result of over 12 years of development, starting from a group of handouts given to students and leading to the book we have today. Although much of the material and ideas were taken from various Bell System sources, a great deal of the book can be attributed to the members of the Graduate Engineering Education staff. Acting as writers, instructors, and editors, each diligently worked in assembling a well organized telephone communications text. Their collective efforts are sincerely appreciated, and are hereby gratefully acknowledged.

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TELEPHONE COMMUNICATION SYSTEMS

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TELEPHONE COMMUNICATION SYSTEMS

VOLUME IV

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CHAPTER 11

DIRECT DISTANCE DIALING

11.1 INTRODUCTION

Direct Distance Dialing (DDD) is a term used to designate calls dialed by customers to points outside their local or extended service area. When such calls are dialed by operators, the phrase "Operator Distance Dialing" is used. Distance Dialing (nationwide dialing) has been accepted as an ultimate objective of the telephone industry, since it will usually provide the fastest, most accurate, and most dependable telephone service and at the same time give over-all operating economies. The direct distance dialing plan might more appropriately be referred to as "continentwide" rather than "Nationwide" since it provides for the handling of long distance traffic both within and between the United States and Canada and to Alaska and Hawaii.

Successful operation of the DDD program depends primarily on three factors:

1. A standard nationwide numbering plan.
2. A fundamental plan for automatic toll switching.
3. A method of charging the customer.

The first two requirements will be considered further in this chapter. The third requirement is met by automatic message accounting systems which are covered in Chapter 14.

11.2 THE NATIONAL NUMBERING PLAN

A primary requisite for distance dialing is that each customer be assigned a distinctive telephone number that does not conflict with the number of any other customer in the United States and Canada. It is essential that these numbers be similar in form, convenient to use, and compatible with local and extended area dialing arrangements. This is accomplished by giving each local central office a unique designation which is, nevertheless, similar in form to that of all other offices connected to the nationwide network. With such an arrangement, operators or customers,

wherever located, can use that designation as a "destination code" to reach the required office through the dial switching network. All offices, in effect, become a part of one huge multioffice city with each office having its own distinctive identity for routing purposes. The designations selected, readily understandable and convenient to use, have reduced the number of misdialed calls to a minimum. The result has been a savings in circuits and switching equipment, as well as improved customer relations. On each misdialed call the subscriber must call an operator to avoid being charged for the call.

The numbering plan adopted in 1947 required a maximum of 10 digits and was expected to last beyond the year 2000. The first 3 digits are the "area code" and the next 3 are the "office code." Together, they comprise the required unique designation for each central office. The remaining 4 digits constitute the "station number" of the telephone served from the particular office. The 3-digit office code plus the 4-digit station number make up the 2-letter 5-numeral (2-5) customer's number listed in the telephone directory.

TABLE 11-1 INITIAL NUMBERING PLAN

Listed Directory Number		
Area Code	Office Code	Station Number
X X' X''	L L N	N N N N

Notes:

- Where L = Any letter except Q or Z
- N = Any numeral from 0 to 9
- X = Any numeral from 2 to 9
- X' = 0 (zero) or 1
- X'' = Any numeral from 0 to 9 when X' = 0
Any numeral from 0 to 9 except 1 when X' = 1

The United States and Canada have been divided geographically into numbering plan areas, each of which is assigned a distinctive 3-digit designation called the area code. Calls between numbering plan areas (foreign area

calls) in general, require dialing the code of the area in which the called station is located as well as the called customer's listed telephone number. Home area calls, which originate and terminate within the same area, require dialing only the called customer's listed number, which consists of the office code and the station number. In this geographical division of numbering plan areas, borderlines between states and between Canadian Provinces have generally been used as area boundaries. Since, as will be shown later, only about 540 central offices can be served in a numbering plan area, it was necessary to divide the more populous states and provinces into two or more areas.

In fixing the intrastate numbering plan boundaries of subdivided states, effort was made to avoid cutting across heavy toll traffic routes to have as much of the toll traffic as possible terminate in the originating area. Also, wherever possible, the boundaries have been set to avoid having central offices in one area be tributary to toll offices in an adjacent area. With the numbering plan areas arranged this way, much intrastate dialing can be kept on a 7-digit basis.

As shown in Table 11-1, the numbering plan "Area Code" consists of three digits. If the middle digit is either a "1" or a "0", the switching equipment will be able to distinguish the area codes from the central office codes, for the latter will always have a letter (corresponding to a numerical digit from 2 through 9) in the middle position. Accordingly, the area codes consist of three digits with either a "1" or "0" in the middle position; e.g., 516, 201, 607, etc.

There are 80 possible combinations with "0" in the middle (called X0X codes), digits "2" to "9" in the first position, and all digits "0" to "9" in the third position. It is not practical to use either "1" or "0" for the initial digit of the area code since many customers dial "0" to reach the operator, and an initial "1" is either used for service or toll codes, or the local dial equipment is arranged to ignore it since it may be a preliminary pulse. Only 72 usable "X1X" combinations are available for area codes since "1" may not be used in the third position because such codes as 211, 411, etc., are used in many places for service codes. There are, then, 152 possible area code combinations of which more than 132 have been assigned. Because of the limited supply, assignment of

area codes must be made on the basis of actual needs. Tables 11-2 and 11-3 show the present and proposed numbering plan areas. Assignments are made from the X0X or X1X series without regard to whether the areas are entire states or subdivisions of states, although at one time it was thought that such a distinction might be made.

Any one Numbering Plan Area is limited to about 540 central office codes. The 2-5 Numbering System will theoretically furnish 640 office code combinations. (Eight dial pulls for the first digit times eight dial pulls for the second digit times ten for the third digit; only eight holes on the dial have letters.) In practice, however, there are only about 60 usable letter combinations for the first two digits instead of 64. This is because of the difficulty in finding names to fit the dial pulls 5-5, 5-7, 9-5, 9-7 (5 corresponds to JKL, 7 to PRS, and 9 to WXY). Also, since there is considerable confusion between the letter "O" and the numeral zero, the latter is usually avoided in the central office designation. This leaves us with 60 usable letter combinations multiplied by nine numerals for a total of 540 codes.

The use of all-numerical central office codes, when preceded by "1" prefix dialing arrangements, increases the number of codes from a theoretical maximum of 640 of the 2L-5N type (about 540 generally usable) to 792. ($8 \times 10 \times 10$ minus 8 (N11 service codes) = 792.) The 55, 57, 95 and 97 series, for which no suitable names are available, can be assigned on an all-numeral basis. However, ten of these codes (950-954 and 975-979) are reserved for possible future use for new services. It is planned to change to another series of codes in the future. The 55 office code is reserved for use as the code for a universal distant information number. Also, 844 is reserved for time service, and 936 for weather service.

With the above Name-Numeral Plan (2L, 5N), a shortage of numbers arose. Eighty-six of the 152 area codes were assigned when operator nationwide dialing was started in 1947. The remaining 66 area codes were expected to care for many years of growth. However, there has been a telephone explosion in the United States. In the decade 1950 to 1960, while the United States population grew from about 150 million to 180 million people, telephones grew from about 41 million to over 75 million. The rise in population of 30 million people required the addition of 34 million telephones.

TABLE 11-2

NUMBERING PLAN AREAS AND CODES-BY AREA CODE NUMBER

<u>Area Code</u>	<u>Location</u>	<u>Area Code</u>	<u>Location</u>	<u>Area Code</u>	<u>Location</u>
201	New Jersey	417	Missouri	709	Newfoundland
202	District of Columbia	418	Quebec	710	4-Row TWX (U.S.)
203	Connecticut	419	Ohio	712	Iowa
204	Manitoba			713	Texas
205	Alabama	501	Arkansas	714	California
206	Washington	502	Kentucky	715	Wisconsin
207	Maine	503	Oregon	716	New York
208	Idaho	504	Louisiana	717	Pennsylvania
209	California	505	New Mexico	718	Unassigned
212	New York	506	New Brunswick	719	Unassigned
213	California	507	Minnesota		
214	Texas	508	Unassigned	800	Inward WATS
215	Pennsylvania	509	Washington	801	Utah
216	Ohio	510	4-Row TWX (U.S.)	802	Vermont
217	Illinois	512	Texas	803	South Carolina
218	Minnesota	513	Ohio	804	Unassigned
219	Indiana	514	Quebec	805	California
		515	Iowa	806	Texas
301	Maryland	516	New York	807	Ontario
302	Delaware	517	Michigan	*808	Hawaii
303	Colorado	518	New York	*809	Bermuda and
304	West Virginia	519	Ontario		Caribbean Islands
305	Florida			810	4-Row TWX (U.S.)
306	Saskatchewan	601	Mississippi	812	Indiana
307	Wyoming	602	Arizona	813	Florida
308	Nebraska	603	New Hampshire	814	Pennsylvania
309	Illinois	604	British Columbia	815	Illinois
312	Illinois	605	South Dakota	816	Missouri
313	Michigan	606	Kentucky	817	Texas
314	Missouri	607	New York	819	Quebec
315	New York	608	Wisconsin		
316	Kansas	609	New Jersey	901	Tennessee
317	Indiana	610	4-Row TWX (Canada)	902	Nova Scotia and
318	Louisiana	612	Minnesota		Prince Edward Island
319	Iowa	613	Ontario	903	Northwest Mexico
		614	Ohio	904	Florida
401	Rhode Island	615	Tennessee	905	Unassigned
402	Nebraska	616	Michigan	906	Michigan
403	Alberta	617	Massachusetts	*907	Alaska
404	Georgia	618	Illinois	908	Unassigned
405	Oklahoma	619	Unassigned	909	Unassigned
406	Montana			910	4-Row TWX (U.S.)
407	Unassigned	701	North Dakota	912	Georgia
408	California	702	Nevada	913	Kansas
409	Unassigned	703	Virginia	914	New York
412	Pennsylvania	704	North Carolina	915	Texas
413	Massachusetts	705	Ontario	916	California
414	Wisconsin	706	Unassigned	917	Unassigned
415	California	707	California	918	Oklahoma
416	Ontario	708	Unassigned	919	North Carolina

*Not reachable by customers - operator dialing only.

TABLE 11-3

NUMBERING PLAN AREAS AND CODES-BY GEOGRAPHICAL LOCATION

<u>Numbering Plan Area</u>	<u>Area Code</u>	<u>Numbering Plan Area</u>	<u>Area Code</u>	<u>Numbering Plan Area</u>	<u>Area Code</u>
Alabama	205	Massachusetts	617	Tennessee	615
Alaska	907	Michigan	313	Tennessee	901
Arizona	602	Michigan	517	Texas	214
Arkansas	501	Michigan	616	Texas	512
California	209	Michigan	906	Texas	713
California	213	Minnesota	218	Texas	806
California	408	Minnesota	507	Texas	817
California	415	Minnesota	612	Texas	915
California	707	Mississippi	601	Utah	801
California	714	Missouri	314	Vermont	802
California	805	Missouri	417	Virginia	703
California	916	Missouri	816	Washington	206
Colorado	303	Montana	406	Washington	509
Connecticut	203	Nebraska	308	West Virginia	304
Delaware	302	Nebraska	402	Wisconsin	414
District of Columbia	202	Nevada	702	Wisconsin	608
Florida	305	New Hampshire	603	Wisconsin	715
Florida	813	New Jersey	201	Wyoming	307
Florida	904	New Jersey	609		
Georgia	404	New Mexico	505	Canada	
Georgia	912	New York	212		
Hawaii	808	New York	315	Ontario	416
Idaho	208	New York	516	Ontario	519
Illinois	217	New York	518	Ontario	613
Illinois	309	New York	607	Ontario	705
Illinois	312	New York	716	Ontario	807
Illinois	618	New York	914	Quebec	418
Illinois	815	North Carolina	704	Quebec	514
Indiana	219	North Carolina	919	Quebec	819
Indiana	317	North Dakota	701	British Columbia	604
Indiana	812	Ohio	216	Alberta	403
Inward WATS	800	Ohio	419	Saskatchewan	306
Iowa	319	Ohio	513	Manitoba	204
Iowa	515	Ohio	614	Nova Scotia	902
Iowa	712	Oklahoma	405	New Brunswick	506
Kansas	316	Oklahoma	918	Newfoundland	709
Kansas	913	Oregon	503		
Kentucky	502	Pennsylvania	215	Bermuda and	
Kentucky	606	Pennsylvania	412	Caribbean	809
Louisiana	318	Pennsylvania	717		
Louisiana	504	Pennsylvania	814	Mexico	
Maine	207	Rhode Island	401	Northwest Mexico	903
Maryland	301	South Carolina	803		
Massachusetts	413	South Dakota	605		

Forecasts for 1985 to 1990 predict an equal number of people and phones - 280 million; and by the year 2000, approximately 340 million people may require 600 million phones.

This problem is brought about by new services that require telephone numbers: BELLBOY^R signaling service, air-ground service, mobile telephone service, military systems and many others.

Centrex, which requires every PBX extension to have a 7-digit number per extension rather than one per PBX trunk, has added many new numbers.

Another new service that requires telephone numbers is data switching over the telephone network. Each data station will require one or two numbers, so additional numbers, office codes and area codes will be needed because of this service.

Overseas Gateway Operator Dialing, which began in March, 1963 with the United Kingdom and the Federal Republic of Germany, is now in operation with twelve points as follows:

<u>New York Gateway</u>	<u>Oakland Gateway</u>	<u>White Plains Gateway</u>
Belgium	Australia	United Kingdom
Denmark	Japan	
France		
Germany		
Italy		
New Zealand		
Netherlands		
Sweden		
Switzerland		

The initial nationwide numbering plan was expected to last beyond the year 2000, but now it appears that will be outgrown by about 1975. The telephone industry in the

United States and Canada has, therefore, adopted a new plan with several times the code capacity of the present one which should last well into the next century.

11.3 THE NEW NUMBERING PLAN

Under the initial plan, procedures varied with different types of offices, however, the new plan, shown in Table 11-4 provides uniform dialing procedures for all types of central offices. The following are also provided:

1. A prefix for customer dialed person to person collect, credit card, and other calls requiring operator assistance. The assigned prefix is "0" (zero).
2. A simplified toll office access code for DDD (Direct Distance Dialed) calls in Step-by-Step central offices. With the present plan, a Step-by-Step central office customer making a DDD call uses a 3-digit access code such as "112" to reach the toll office. The access code may be followed by as many as ten digits giving a maximum of thirteen digits. With the new plan, the recommended DDD access code is the single digit "1" and the maximum number of digits is therefore eleven.
3. A prefix to prevent local intended calls from reaching toll points in error in cities using common control type switching systems which store and process the dialed digits like No. 1 and No. 5 Crossbar. The new plan uses a prefix, "0" or "1" on all toll calls. Hence, a wrong office code digit on a 7-digit local call (no prefix being dialed) cannot convert a local intended call into a toll call.

TABLE 11-4 NEW NUMBERING PLAN

	INITIAL STAGE	ULTIMATE STAGE
HOME AREA DDD	(1) + NNX + XXXX	1 + NXX + XXXX
HOME AREA SPECIAL TOLL	0 + NNX + XXXX	0 + NXX + XXXX
FOREIGN AREA DDD	(1) + NO/1X + NNX + XXXX	1 + NXX + NXX + XXXX
FOREIGN AREA SPECIAL TOLL	0 + NO/1X + NNX + XXXX	0 + NXX + NXX + XXXX

TABLE 11-5 CAPACITY OF NEW NUMBERING PLAN

INITIAL:

AREA CODES	N 0/1X.....	152
OFFICE CODES	NNX (NAMES AND NUMBERS).....	540
	NNX (ALL NUMBER CALLING).....	640

ULTIMATE:

AREA CODES	NXX.....	800
OFFICE CODES	NNX (Less Service Codes).....	792

Notes:

N = ANY NUMERAL 2 to 9
 X = ANY NUMERAL 0 to 9

(1) INDICATES THAT THE PREFIX MAY BE USED IN COMMON CONTROL AREAS BUT MUST BE USED IN SXS AREAS.

A. Requirements

The new plan was designed to meet the following requirements:

1. Capacity. Additional capacity is a basic requirement. It could be extended for a few years beyond the expected exhaust date with modest changes in the present plan but underestimations have led to

difficulties in the past. It is more sensible to set up a large capacity plan that will last well into the next century. The 800 area codes provided by the new plan are considered adequate for North America. It leaves the door open for arrangements such as doubled prefix digits which will allow the plan to grow into the ultimate desirability, a world wide plan.

2. Programmable. A plan that would require a simultaneous nationwide switch from the existing to the new would be completely impractical. Apart from the large costs of such a cutover, the co-ordination of work in thousands of central offices could not conceivably be handled without major difficulties and service interruptions. The plan adopted can be implemented in easy stages.
3. No Modification of Customers' Equipment. The chief objection to modifying equipment, such as telephones on customers' premises, is cost. One which has been discussed is the use of specially designated buttons on dials and on keysets proposed to replace dials, which customers would push instead of dialing prefix digits such as "0" or "1". Other changes have also been suggested, but costs have prevented adoption of any of these ideas as a requirement of the new plan.
4. Customer Acceptance. It was felt that a plan that was essentially an extension of the present plan would be more readily accepted by users than a radically new plan. Such a plan would also be more desirable from a customer education standpoint.

All existing telephone switching systems, both local and toll, with the possible exception of step-by-step inter-toll equipment, will need to be modified.

B. Modifications

All common control local systems must be modified to enable them to do the following:

1. To register the prefix "1" or "0" and to signal the translating equipment which prefix has been received. The prefix will not be sent to the toll office.

2. To check after an initial "0" to see whether more digits are forthcoming. If only "0" is received, the call will be routed to an operator.
3. To route calls selectively on the basis of the prefix and the code which follows.
4. To provide translation capacity for up to 800 area codes and 792 office codes.
5. To determine whether a code is an area code or an office code (according to the number of digits dialed).
6. To block toll calls which are received without a prefix.

The step-by-step local system will require special trunks from the "1" and "0" levels. The "1" level trunk will immediately seize a trunk to the toll office and a sender or register at that office. If the second digit is 2 to 9, it and succeeding digits will be repeated to the toll office equipment and stored there. However, if the second digit is a "1," it will be absorbed, the toll office trunk will be immediately released and the auxiliary selector will accept the third digit and route to a service trunk. This problem will be eliminated when 11X service codes are replaced.

The "0" level trunk will be arranged to distinguish between prefix "0" toll calls such as person to person and collect, and "zero" operator calls by waiting three or four seconds to see if any more digits are to be dialed.

11.4 SWITCHING PLAN

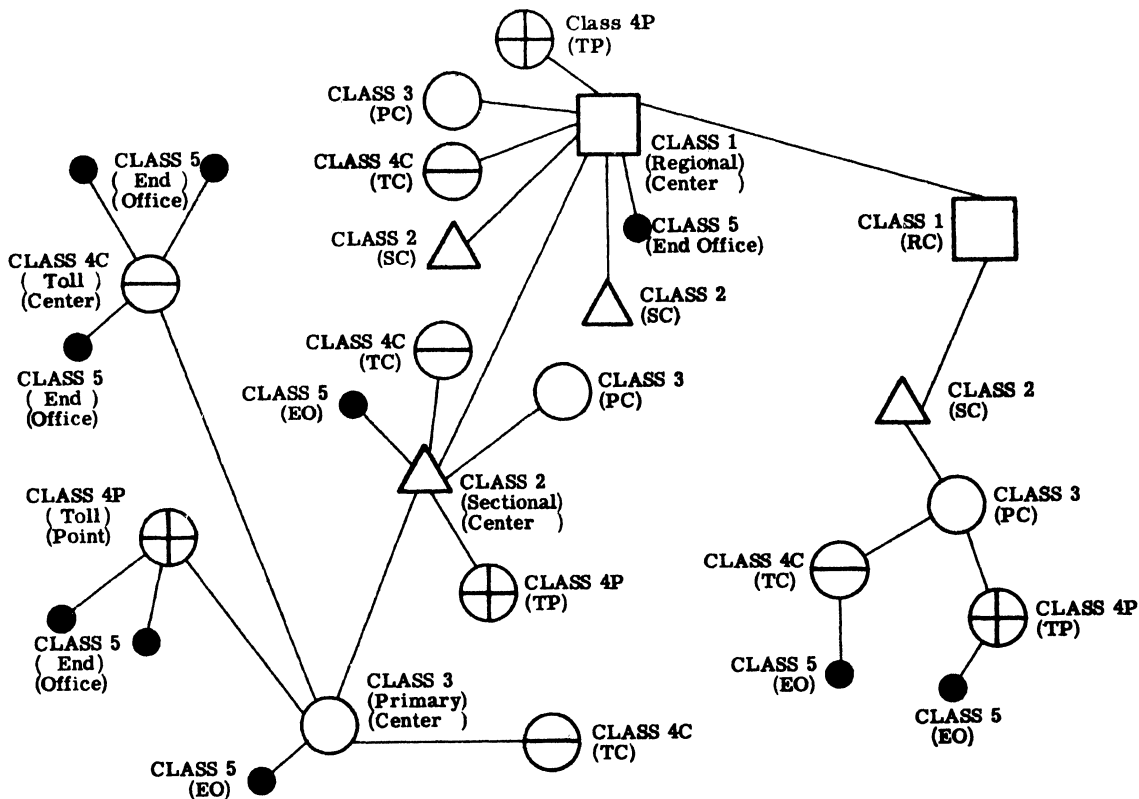
Large volumes of traffic between any two points are generally routed most economically over direct trunks. When the volume of traffic between two offices is small, however, the use of direct trunks is usually not economical. In these cases the traffic is handled by connecting together, by means of switching equipment at intermediate offices, two or more trunks to build up the required connection. The places where interconnections are made are generally known as "switching centers" and the process is referred to as a "switch." "Built-up" connections may involve several switching centers if the originating and terminating locations are a great distance apart. It is important that telephone plant be designed to provide adequate transmission

and service for this multiswitch traffic as well as the large volumes of traffic handled by the less complex direct and single switch connections.

The conditions under which toll traffic will be automatically switched on a nationwide scale are quite similar to those found in large cities with large volumes of traffic between many separate switching centers. Therefore, experience gained in these places was applied to the nationwide dialing job.

The needs of multioffice exchange areas are met by switching and trunking plans that employ a new principle, "automatic alternate routing," to provide rapid and accurate connections with few occasions for repeated attempts. With this principle, a call which encounters an "all trunks busy signal" on the first route tested is automatically and rapidly "route advanced" and offered to one or more alternate routes, in sequence.

In the general toll switching plan, the central office, where customers' telephone lines are terminated, is called an End Office. For reference, it has been assigned the classification "5". Thus, the End Office is a Class 5 office. A Class 5 office may be physically located in the same building that houses an office of higher classification and in some cases the End Office and the toll office functions are performed by one machine. However, the offices are considered as separate entities, and customers' lines are terminated at the Class 5 office only. Figure 11-1 shows how a number of Class 5 offices is grouped on or homed at, a Toll Center or a Toll Point. A Toll Center, Class 4C, is defined as a toll switching location where operators are present to handle inward toll traffic in addition to other normal traffic operating functions. A Toll Point, Class 4P, is defined as a toll switching location where operators, if present, will not handle inward traffic. A Class 4P office may or may not have operators handling other traffic items such as outward, delayed outward, assistance, information, etc. Both the Class 4C and 4P offices have the same importance and rank in the toll switching plan as regards transmission considerations. Class 4 offices are grouped upon, and serve over final routes from, a higher rank toll switching location designated as a Primary Center or Class 3 office. Class 3 offices "home" at Sectional Centers, Class 2, and the latter have final routes to Class 1 offices known as Regional



Symbol	Class	Name	Abbreviation
□	1	Regional Center	RC
△	2	Sectional Center	SC
○	3	Primary Center	PC
◐	4C	Toll Center	TC
⊕	4P	Toll Point	TP
●	5	End Office	EO
—	Final	Trunk Group	

Figure 11-1 General Toll Switching Plan (Basic Principle)

Centers. There are ten Regional Centers in the United States and two in Canada. Each of the Regional Centers (RC) serves a very large area known as a Region. The Regional Areas are listed in Tables 11-2 and 11-3. The Region is subdivided into small areas known as Sections, whose principal switching facility is the Sectional Center (SC). The Section is still a rather large area, and it, too, is further divided into smaller parts known as Primary Areas, each of which is served by a Primary Center (PC). The remaining toll offices that do not fall into the above categories are the Toll Centers (TC) and Toll Points (TP).

The general toll switching plan, as originally conceived, called for one of the regional centers to be designated "National Center" with final trunk groups to and from all regional centers. However, this "National Center" concept has now been abandoned. Instead, final trunk groups are provided between all regional centers in the United States. This does not affect the overall flexibility of the plan since it is possible to route inter-regional traffic via a third regional center on an emergency basis.

It is not necessary that Class 5, 4, or 3 offices home on the next higher ranking office; the complete intermediate final route chain is not necessary. For example, Class 5 offices may be served directly from any of the higher ranking through switching centers. One final circuit group will always be provided from each office to an office of a higher rank. That one higher ranking switching point to which an office is connected over a final group is called its "home" office; the dependent office is spoken of as "homing" on it. The network of final trunk groups will be engineered on a low delay basis so that, on the average, not more than three calls in each hundred that are offered to such a trunk group in the busy hour will find all circuits busy.

Since the general toll switching plan with DDD makes extensive use of alternate routing, the flow of traffic, in many ways, is different from what it was with

ring down operation. Figure 11-2 shows a comparison of intertoll trunk networks theoretically required with:

1. The limited switching under ring down operation, where engineering was on the basis of many inefficient direct groups, and
2. Operator and direct distance dialing utilizing common control equipment and full automatic alternate routing at the principal switching centers.

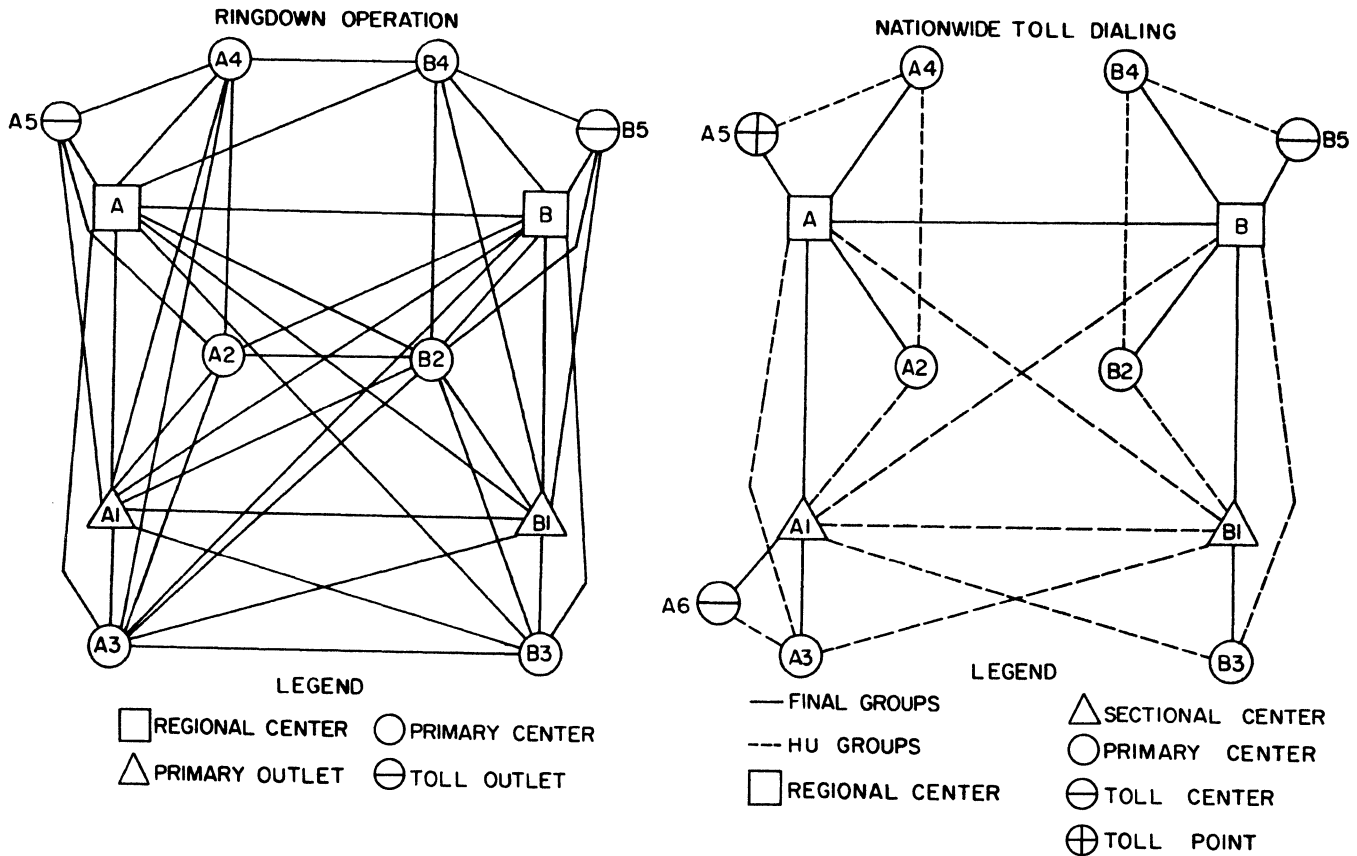


Figure 11-2 Theoretical Intertoll Trunk Network

Intertoll trunk groups, both high usage and final, are usually two-way because with the usual volumes of toll traffic, they are more economical than two groups of one-way trunks.

11.5 CONTROL SWITCHING POINTS

Collectively, the Class 1, 2, and 3 offices (Regional Centers, Sectional Centers, and Primary Centers) constitute the control switching points (CSP's) for nationwide dialing. A control switching point is a key switching location in the nationwide automatic switching network which will have some or all of the following features:

1. Storying of digits received.
2. Variable spilling - deletion of certain digits which are not required for outpulsing and sending forward the required digits.
3. Prefixing of digits when required.
4. Code conversion.
5. Translation of 3 or 6 digits. (Also translation of 4 or 5 digits for TX codes.)
6. Automatic alternate routing.

In addition to these six items, which will be covered in more detail in this chapter, there are certain transmission characteristics which will be covered in a later chapter.

11.6 SWITCHING EQUIPMENT

Nationwide distance dialing places no restriction on the type of dial switching system provided at Class 5 offices. Class 4 offices may use any type of system except panel or No. 1 crossbar. Common control equipment such as registers, or senders, is not essential at these offices although it may be used in many instances to effect economies in switching traffic and to provide uniform dialing procedures. Outward direct distance dialing requires that the Class 5 (End) office be able to send the complete 7 or 10 digit called number to the toll switching system at which it homes. Common control switching equipment can be arranged to do this. If direct control equipment such as step-by-step without senders is used at the Class 5 office, it will be necessary to prefix a toll access code, such as 1 or 112, to direct the call to the toll office.

Class 1, 2, and most Class 3 offices employ common control switching facilities, and have the control point switching features outlined in the previous section. Some Class 3 offices which do not require all the CSP features, employ step-by-step intertoll equipment. The type of switching equipment used at each center is shown in Table 11-6.

TABLE 11-6 TYPE OF SWITCHING EQUIPMENT AT CENTERS

Center	Class	Type
Regional Center	1	4A or 4M toll crossbar, crossbar tandem.
Sectional Center	2	4A or 4M toll crossbar, crossbar tandem, or No. 5 crossbar.
Primary Center	3	4A or 4M toll crossbar, crossbar tandem, No. 5 crossbar, or intertoll step-by-step.
Toll Center or Toll Point	4	Crossbar tandem, No. 5 crossbar, or step-by-step.
End Office	5	Panel, No. 1 or No. 5 crossbar, or step-by-step.

11.7 STORING AND FORWARDING (VARIABLE SPILLING) OF DIGITS AS REQUIRED

One of the main functions performed by common control equipment at control switching points is to store all digits received and send forward as many as required to complete the call.

The called number recorded at a switching point is in the form of NNX-XXXX if the call is to be completed in the same numbering plan area. If the called destination is in another area, the present area code NOX or N1X precedes the 7 digit number. The area codes NOX or N1X and local office code NNX are the digits used for routing purposes and are sufficient to complete the call towards its destination when these codes are received. If the next switching point is not in the numbering area of the called telephone, the complete ten digit number is needed to advance the call toward its destination. If the next switching point is in the numbering plan area of the called telephone, the area code is not needed and seven digits will suffice for completing the call.

For example, suppose a call is originated by a customer in South Bend, Indiana, destined for customer National 4-1234 in Washington, D.C. If it is assumed in Figure 11-3 that the route to Washington is via a switching

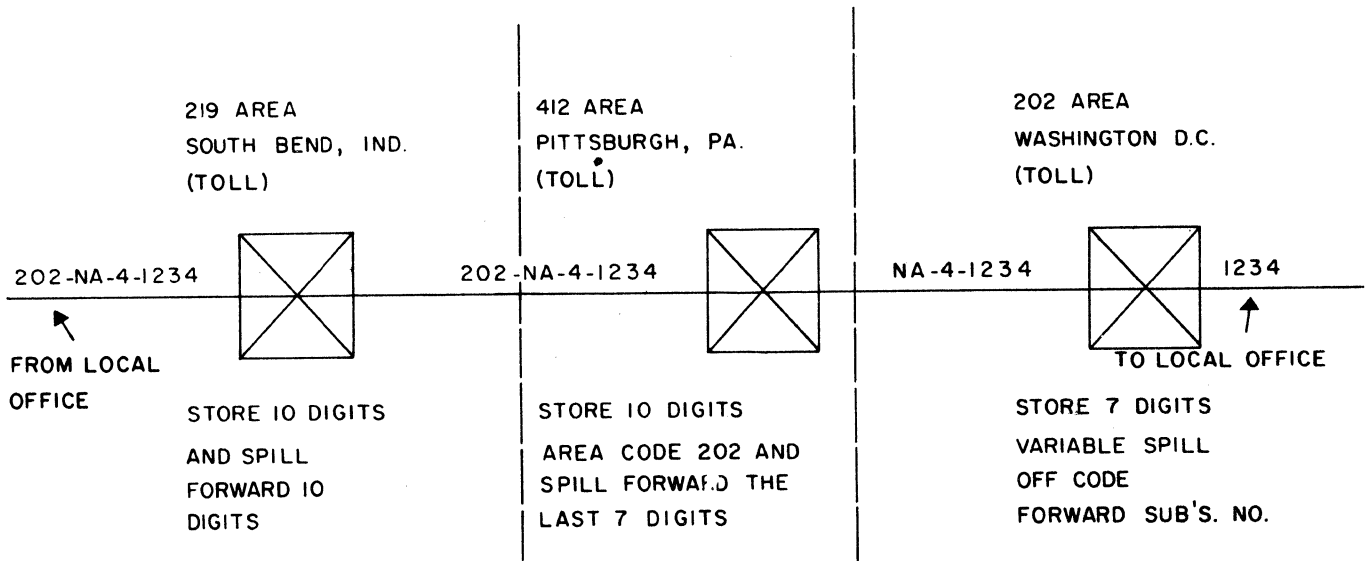


Figure 11-3 Storing and Variable Spilling (3 Digits)

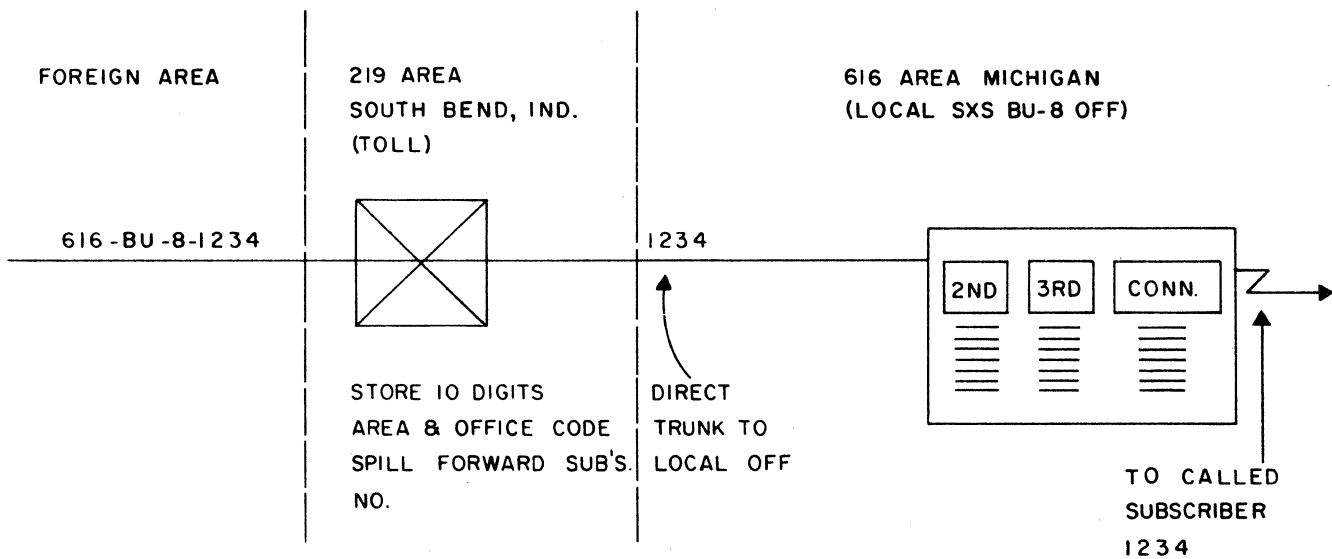


Figure 11-4 Storing and Variable Spilling (6 digits)

center in Pittsburgh, then the crossbar equipment at South Bend pulses forward to Pittsburgh 202-NA 4-1234, 202 being the area code for the District of Columbia. Pittsburgh in turn will delete the area code and send NA-4-1234 to the District of Columbia terminating area.

As another example, suppose the crossbar office at South Bend receives a call from some foreign area destined to a nearby step-by-step end office in Michigan. The crossbar equipment receives and stores a ten digit number comprising the area code and the seven digits for the office code and station number. Assuming that direct trunks to the step-by-step end office in Michigan are available, as shown in Figure 11-4, the area code and office code are deleted and the line number only is pulsed forward. To meet all conditions, the equipment is arranged to permit deletion of either the first three, four, five or six digits of a ten digit number.

11.8 PREFIXING OF DIGITS

In establishing calls, it may be necessary to route a call from one area to another and back to the original area for completion. Such a situation arises on a call from Amarillo to Lubbock, Texas, both in area 915, when the switching equipment finds all of the direct trunks from Amarillo to Lubbock busy, as illustrated in Figure 11-5. The call could be routed to Lubbock via Oklahoma City which is in area 405. A seven-digit number for example MA 2-1234, is received in the crossbar tandem office at Amarillo. Assuming that the call is to be switched out of the 915 area through the 405 area and back to the 915 area for completion, it is necessary for the crossbar tandem office in Amarillo to prefix 915 to the MA 2-1234 number so that the switching equipment in Oklahoma City will know that the call is for the 915 area and not for the 405 area.

Prefixing of digits, Figure 11-6, may also be required when calls are routed through step-by-step primary centers. For example, assume that the common control equipment at sectional center received the seven digit number MA 2-1234, for a call to a customer in the Madison office in the same area. The routing required to complete the call is through a step-by-step primary center to a No. 5 crossbar toll center and then to the Madison office. However, the step-by-step

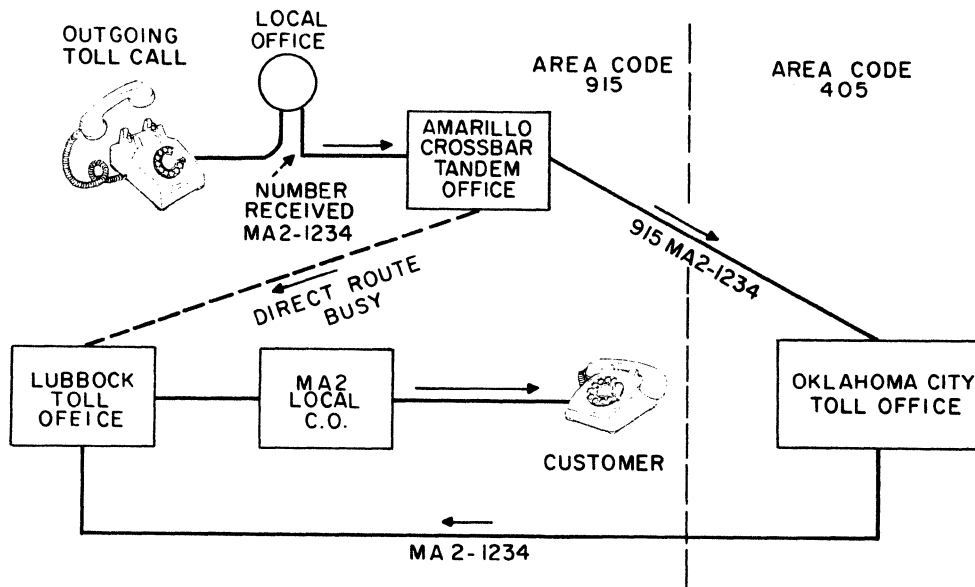


Figure 11-5 Prefixing of Digits

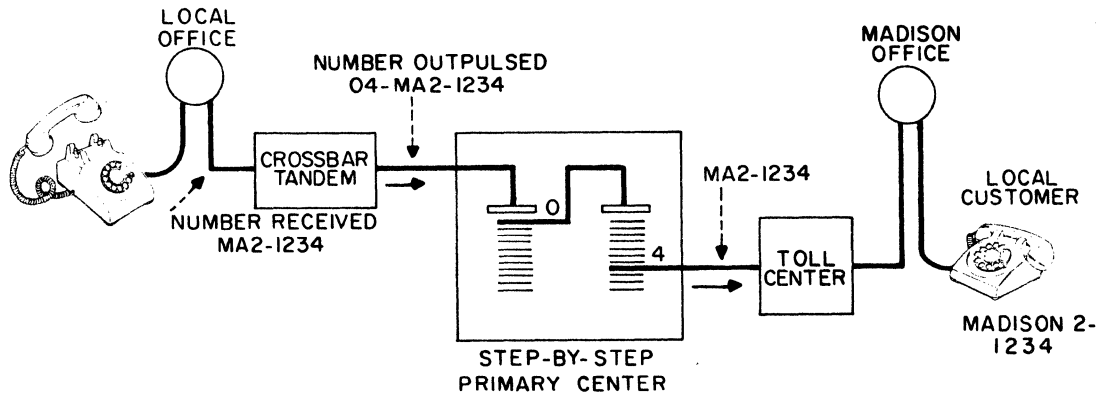


Figure 11-6 Prefixing

switches at the primary center "use up" digits for its switching of the call to the toll center. The common control equipment at the sectional center must therefore prefix digits to accomplish this switching in order to provide the full seven digit number to the toll center for completing the call.

11.9 AUTOMATIC ALTERNATE ROUTING

The nationwide trunking network is so designed that direct trunks, called "high usage" groups, are provided between individual switching offices of all classes where such trunks are warranted by the traffic load. These high usage groups are not engineered to handle all the traffic offered to them during the busy hour, since it is not practical or economical to provide facilities for the busiest five or ten minutes. Traffic offered to a high usage group, which finds all trunks busy, is automatically rerouted to alternate routes consisting of other high usage groups, and finally to a final trunk group for which no alternate route is provided. In intertoll operation there are calls for which no direct trunk groups exist. Such calls are handled over a preferred trunk group, but are automatically rerouted to other trunk groups if the preferred trunks are busy. The characteristic of the common control equipment at a control switching point to select one of several alternate routes automatically, when all choices in the first route are busy, contributes to the economy of the plant and provides additional protection against complete interruption of service when all circuits on a particular route are out of service.

Figure 11-7 and the following discussion illustrate a particular routing pattern that might be involved in completing a call that appears at an end office served from toll center TC_1 destined for an end office served from toll center TC_2 . In this example, TC_1 has trunks to PC_1 only, hence the call is routed to that primary center.

At PC_1 the call would be offered first to the high usage group to PC_2 . At PC_2 the switching equipment would select an idle trunk in the final group to TC_2 and the call would be routed to the called customer in EO_2 . If, however, all the trunks in the first high usage group (between PC_1 and PC_2) had been busy, the call would next be offered to the high usage group between PC_1 and SC_2 (if PC_1 - SC_2 - PC_2 is the most economical alternate route). At SC_2 the call would have a choice of two routings:

1. Via direct high usage trunks to TC_2 , or if they were all busy,
2. Over the two final trunk groups SC_2 - PC_2 and PC_2 - TC_2 .

In the event all the trunks in the group between PC₁ and SC₂ are busy, the call should next be offered to the final group to SC₁. There are available at PC₁ other high usage groups to RC₂ and RC₁. These are intended for terminal and certain other traffic items that must be so routed. Traffic routed via PC₁ should not be offered directly to Regional Centers if there are other lower ranking switching centers in the final route path which have not yet been selected. It is desirable to restrict the switched lead to centers of lower rank even though the service advantages of other alternate route possibilities are not realized. At SC₁ the call would have a choice of four routings in the following sequence:

1. Via the SC₁-PC₂ high usage group,
2. Via the SC₁-SC₂ high usage group,
3. Via the SC₁-RC₂ high usage group, and lastly
4. Via the final group from SC₁ to RC₁.

The routing described above is for one set of assumed conditions and could vary in actual practice to the extent that economics and plant layout would offer different high usage trunk groups.

11.10 CODE CONVERSION

At the present time, some step-by-step primary centers reach other offices by using routing codes that differ from those assigned under the national numbering plan. This arrangement is used to obtain economies in switching equipment of the step-by-step plant and is acceptable with operator originated calls. However, with the introduction of customer direct distance dialing, it is essential that the codes used by customers be in accordance with the national numbering plan. The common control equipment at the control switching point must then automatically provide the routing codes needed by the intermediate step-by-step primary centers. This is accomplished by the code conversion feature of this equipment which substitutes the arbitrary digits required to reach the called office through the step-by-step systems. Figure 11-8 illustrates an application of this feature. It shows a

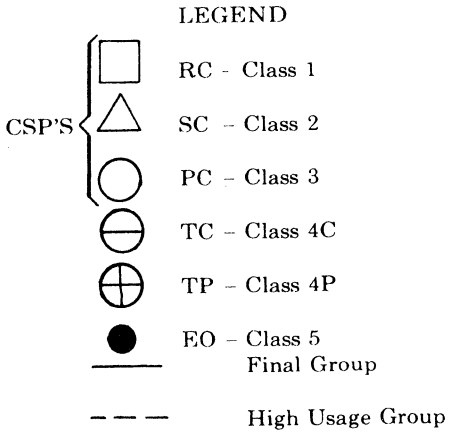
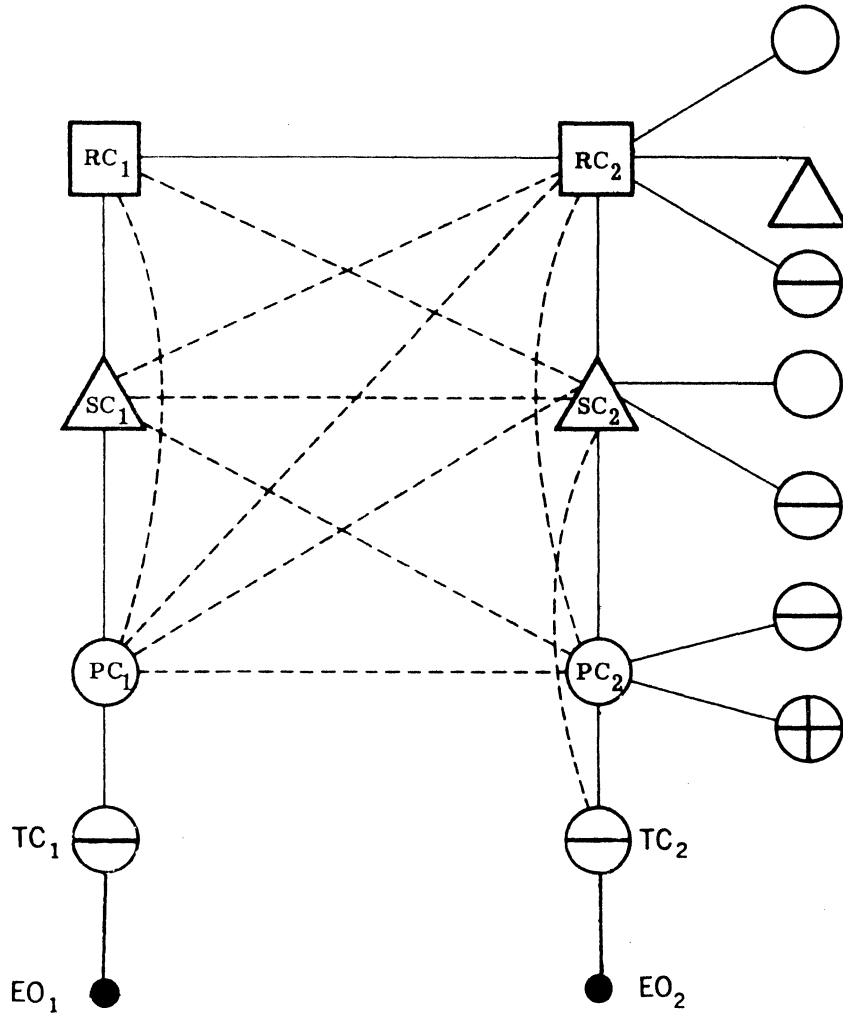


Figure 11-7 Routing Pattern

crossbar tandem office arranged for completing calls through a step-by-step toll center to a local central office, GARDEN 8, in an adjacent area. A call reaching the crossbar tandem office for a customer in this office arrives with the national number, 218-GA8-1234. To complete this call, the crossbar tandem equipment deletes the area code 218 and pulses forward the local office code and number. If the call is switched to an alternate route, via the step-by-step primary center, it will be necessary for the crossbar tandem equipment to delete the area code 218 and substitute the arbitrary digits 062 to direct the call through the switches at the primary center, since the toll center requires the full seven digit number for completing the call.

11.11 3 AND 6 DIGIT TRANSLATION

3 and 6 digit translation is mainly used when a foreign area can be reached directly or indirectly by more than one route.

Figure 11-9 shows both 3 and 6 digit translation on calls between subscriber "A" in the Oakland, California Area and subscribers "B" and "C" in the Ohio Area.

Upon receiving the details of the toll call from subscriber "A", the Oakland operator keys the area code, 216, followed by the appropriate national office code and numerals, to reach either subscriber "B" or "C".

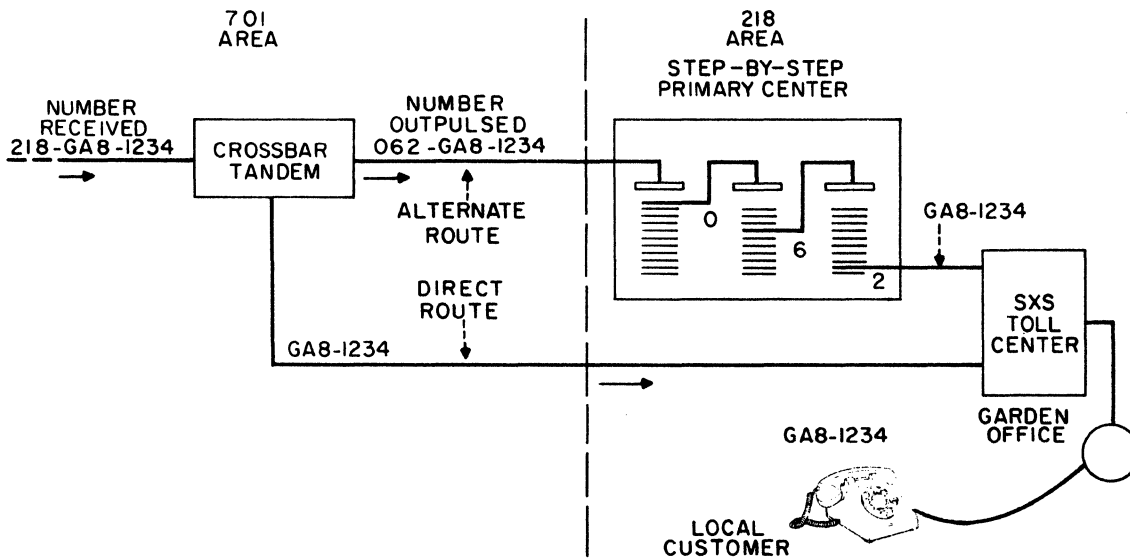


Figure 11-8 Code Conversion

On the call to subscriber "B" in Cleveland, Ohio, the Oakland operator keys 216-MA 2-1234. The Oakland toll office translates the first three digits to select a trunk to Chicago and spills forward 216-622-1234. The Chicago toll office has two trunk groups to the 216 Area (one to Cleveland and one to Canton), and must determine which one shall be used on this call. The Chicago toll center must translate the first six digits. The Area Code, 216, indicates that one of the trunk groups to the 216 Area must be selected. The national office code MA 2 (622) determines that this is the trunk group to Cleveland, since the MAIn 2 office "homes" on Cleveland. In this way the Chicago toll center translates the combination of the area code and the NAational office code to select the trunk group to the Cleveland Toll Center.

The Chicago toll center spills forward 622-1234, skipping the Area Code. This illustrates the variable spill feature. The Cleveland toll center receives 622-1234, selects a trunk to the MAIn 2 office, and variable spills forward the digits -1234. The MAIn 2 office receives the digits -1234 and connects subscriber "A" to subscriber "B".

On the call to subscriber "C" in an office that "homes" on the Canton toll office, the Oakland toll operator keys 216-623-1234. When the call arrives in Chicago the common control again translates the first six digits and this time selects a trunk to Canton, because the office with national office code MAIn 3 (623) is served directly by Canton. The call is then terminated in the same manner as above.

CH. 11 - DIRECT DISTANCE DIALING

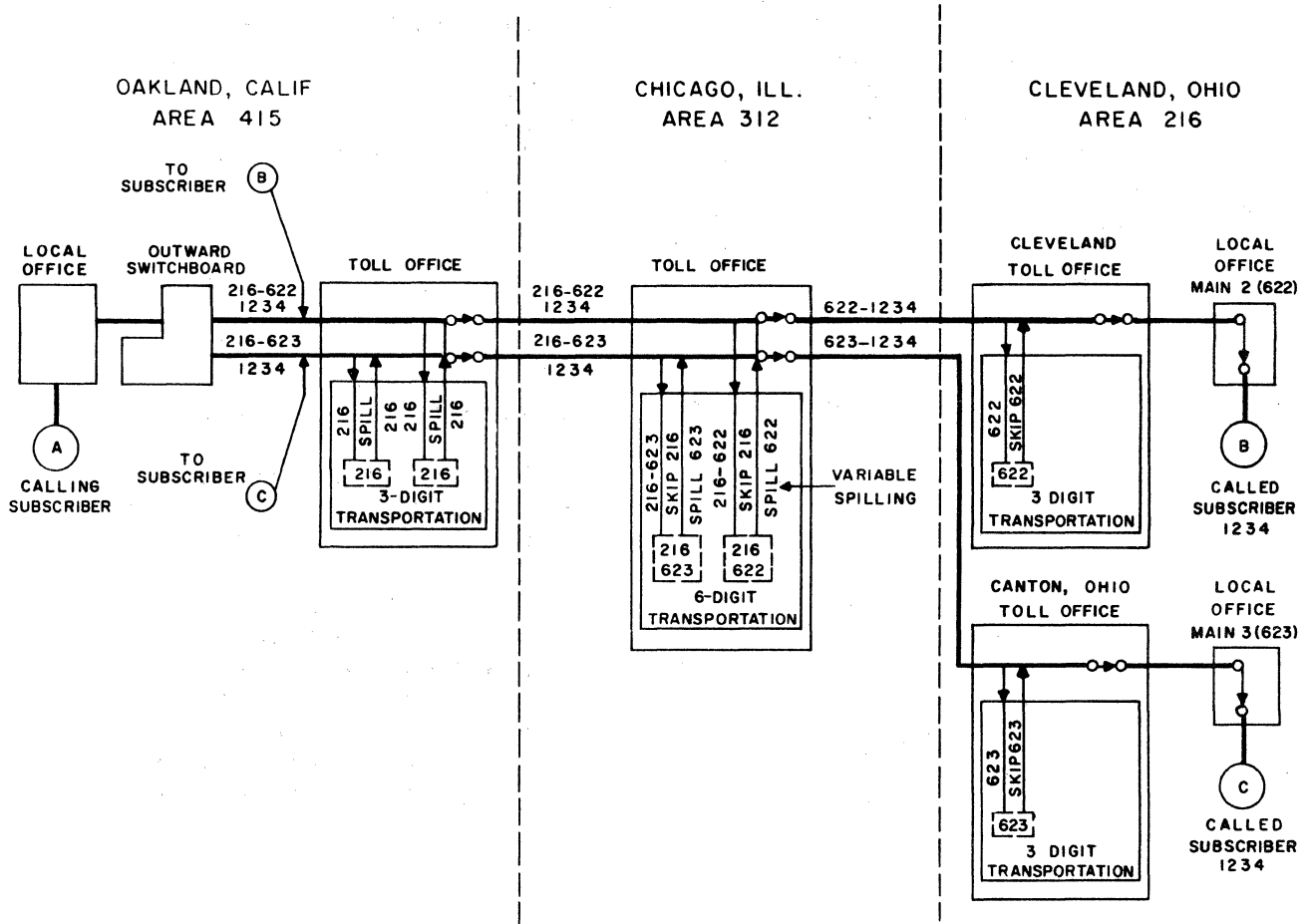


Figure 11-9 3 & 6 Digit Translation

CHAPTER 12

TOLL SWITCHBOARDS

12.1 INTRODUCTION

The complexity of toll switching probably can be attributed to exceptions and varieties rather than to its general nature. Stripped to its extreme simplicity toll switching involves suitable means for subscribers to reach toll operators, for toll operators to reach subscribers, and for toll operators to reach toll operators. The trunking arrangements for these basic problems of access become involved in detail, but not in principle. They become involved because of different types of switchboards and of central offices, because of the varying interplay of economic factors, and because improvements cannot attain immediate universal application. Toll switchboards, simple in their functions, become involved in detail because of the varieties of arrangements that various circumstances make desirable and often imperative in the rendering of good service at a reasonable cost. It is not within the scope of this chapter to penetrate very deeply into the many details of trunking and switchboard arrangements, but it is rather the intention to present a broad picture of the basic concepts.

The No. 3CL Toll Switchboard is the present standard in a long line of switchboards used for manual toll switching. This switchboard offers improved circuitry and wiring in comparison to preceding boards.

For purposes of this test, we shall consider the board as being representative of all toll switchboards and proceed to discuss its various features.

12.2 THE NO. 3CL SWITCHBOARD

The No. 3CL may be arranged for use as a Dial Systems "A" (DSA) switchboard, combined outward toll and DSA, and as an outward, through, inward or delayed call toll switchboard. Provisions are made to handle DSB traffic at a combined toll and DSA position; however, with the continued increase in the numbers of calls dialed directly by the subscriber or operator the need for DSB positions is rapidly disappearing.

A. TOLL SWITCHBOARD ONLY (WITHOUT DSA FEATURES)

When a subscriber wishes to place a toll call he dials a code or is connected manually to a toll operator known as an outward operator who takes the details of the call and attempts to complete it. This call may be completed without the aid of another toll operator, by the use of intertoll dialing facilities, or it may be necessary to enlist other toll operators to assist in completing this call. When the assisting toll operator is located at the toll center where this call terminates, she is known as an inward operator. If in completing this toll call it is necessary to connect two intertoll trunks together, it may be necessary to enlist the aid of an intermediate toll operator, known as a through operator to perform the switching function of connecting the two intertoll trunks together.

1. Outward Positions - The traffic at outward positions will originate over the recording trunks, recording completing trunks, community dial office trunks, manual lines, etc., and be completed over the intertoll trunks. These intertoll trunks may be selected directly in the multiple of the outward position or through a manual, step-by-step or crossbar toll tandem or via concentrating switches.

Assuming that the intertoll trunk selected terminates at the distant toll center serving the called subscriber and also that this intertoll trunk is of the ringdown type, the ringing signal following the seizure of the intertoll trunk brings in the answering lamp at an inward position at the terminating toll center and when the inward operator answers the outward operator passes the called subscriber's number orally. The inward operator then completes the call.

Since the outward operator is responsible for timing the call she must remain in on connections completed over ringdown intertoll trunks until conversation starts regardless of whether it is a station-to-station or person-to-person call. On calls completed over dial or key pulsing intertoll trunks, since called party switchhook supervision

is received by the outward operator, the timing can be started by observing the cord supervisory lamp on station-to-station calls. However, on person-to-person calls the outward operator must remain in on the connection to determine that the desired party is obtained.

If the intertoll trunk to the terminating toll center is of the dial or key pulsing type the outward operator dials or keys the necessary digits to select the called subscriber's line. Should the outward operator need to go to the terminating toll center for information work she will dial or key the information operator's code. After obtaining the called subscriber's number from the information operator, the outward operator releases the intertoll trunk and sets up the call again including the called subscriber's number. Switchhook supervision is received from the called subscriber by the outward operator and line or all trunks busy conditions are indicated by flashing supervisory lamps or by tone signals.

If in the process of completing a call it is necessary to switch together two intertoll trunks at some intermediate toll center, the outward operator can accomplish this without the aid of an operator at the intermediate point, provided the necessary dial equipment is available at the intermediate toll center and the intertoll trunk selected by the outward operator is of the dial or key pulsing type. The outward operator in this case dials or keys the additional directing digits where necessary, to accomplish the switching function. Also, if the intertoll trunk from the intermediate toll center to the terminating toll center is of the intertoll dialing type the two circuits in tandem will function as described for the direct circuit dial or key pulsing trunk. However, if the second link of the connection is a ringdown intertoll trunk the two circuits in tandem will function practically as described for a direct ringdown trunk. Also, if it is necessary to dial in an operator at the intermediate point to perform the switching function, the circuits in tandem will function practically as a direct ringdown trunk regardless of whether the second link of the connection is an intertoll dial or ringdown trunk.

2. Inward Positions - At the inward positions the traffic originates from the incoming intertoll trunks and is normally completed to subscribers over toll switching trunks. However in some cases toll subscriber's lines may appear in the multiple of the inward position and calls to these lines are completed directly to this multiple. The toll switching trunks may be of the straightforward type to "B" operators in the local manual or dial units or they may be of the dialing or key pulsing type to SXS, panel or crossbar dial units. In the case of the straightforward trunks the inward operator passes the called subscriber's number orally to the "B" operator. For the dialing or key pulsing toll switching trunks, the inward operator dials or keys the necessary digits to select the called subscriber's line. In either case the inward operator receives switchhook supervision from the called line and flashing or tone busy signals to indicate all trunks busy or line busy conditions. These toll switching trunks can be of the immediate ringing variety in so far as handling traffic from inward positions is concerned as there is no reason for the inward operator to delay ringing the called subscriber once the subscriber's line is seized. However, if the toll switching trunks at the inward positions are multiples of the toll switching trunks used by the delayed call positions, these toll switching trunks will be of the delayed ringing variety and in this case it will be necessary to have the inward position arranged to start the ringing automatically when the inward operator has finished dialing or keying or have the inward operator actually operate the ringing key on each call. It should be noted that where multifrequency key pulsing trunks are used the inward operator must always operate the ringing key.
3. Through Positions - For through positions the traffic originates over intertoll trunks and is completed to other intertoll trunks either directly in the multiple or through a toll tandem or No. 4 toll crossbar system. The incoming traffic may be from ringdown intertoll trunks or from dialing intertoll trunks over

which the through operator's code has been dialed. The through operator completes to ringdown and dial or key pulsing intertoll trunks in the same manner as described for the outward operator. Called party switchhook supervision and flashing busy signals are received by the through operator if the intertoll trunks to the called party are of the dial or key pulsing type. However, this supervision is not transmitted beyond the through operator's cord. If the incoming intertoll trunk from the originating operator is of the intertoll dialing type, the through operator receives answer and disconnect supervision from the originating operator and these two operators can recall each other by operating their ringing keys. Where the outgoing intertoll trunk is of the ringdown type no called party supervision is received. Likewise, no plug supervision is received by the through operator if the incoming intertoll trunk is of the ringdown type. Under this condition it is the responsibility of the outward operator to ring at the finish of conversation so that the through operator will know when to disconnect such a connection.

4. Delayed Call Positions - When an outward operator encounters a delay in completing a call, the calling subscriber is dismissed (if waiting at the telephone) and the ticket forwarded for final handling to a team of operators whose function is to complete such calls. These operators have access to the same outgoing intertoll trunks and toll switching trunks as the regular outward operators and complete over these outgoing paths in the same manner. The switching trunks are arranged for controlled or delayed ringing to enable the operator to seize the subscriber's line but delay ringing his bell until the call has been completed to the called subscriber. Also some of these controlled ringing switching trunks are arranged for coin control to handle the delayed traffic to coin box lines.

The delayed call positions are also used for completion of incoming reverse charge calls to coin box lines. When the distant operator determines that the called line to which the call is to be charged is a coin box line (such information is obtained from the information operator at the terminating toll center) she reaches a delayed call operator at the terminating toll center and passes the details of the call. The delayed call operator then reaches the called line over a toll switching trunk arranged for coin control. The timing and collecting for such calls are the responsibilities of the delayed call operator.

On person-to-person calls, if the called party's line is available but the particular person cannot be reached, the calling party may request the outward operator to have the particular person call the calling party as soon as available. Under such conditions the outward operator leaves word for the wanted person to call a particular operator who is identified by a number preceded by the toll center name, such as "N.Y. Operator 11438." The number is the identity of the team of delayed operators to which the ticket has been forwarded. When the particular called party is ready to talk he places his call with his outward operator in the regular manner asking to be connected to the designated operator (N.Y. Operator 11438). The distant outward operator completes this call forward in the normal manner and requests connection to or dials or keys the code for the particular team of operators identified by the number. If the inward operator at the terminating toll center is involved she will complete the connection to the delayed call positions over an interposition or interoffice trunk. If the terminating toll center is served by SXS intertoll dialing system, a dial tandem or No. 4 toll system, the code dialed or keyed by the distant operator will automatically select a trunk to the particular team of delayed call operators. (These trunks are commonly known as "WH" or "TX" trunks.) The delayed call operator then reaches the calling party over a switching trunk and times the call in the usual manner.

An effort is now being made to reduce the work of the ticket operators by requesting the calling party to place the call again later rather than by having the originating operator offer to try again later as has been the practice in the past. This way the original ticket can be canceled and forgotten. On "leave word" calls, the person answering the called number is requested to have the called party call the originating toll center (OTC) operator and is also given the name of the calling party so that he can give complete details to the OTC operator who writes a new ticket without having to look for the original ticket. Eventually the new ticket with the complete call details is matched with the original ticket and the original ticket scratched. It is very desirable to reduce the amount of tickets required to a minimum since the new mark sending method of ticket writing involves the use of data cards which cannot be sent through present pneumatic ticket distributing systems, but must be distributed by messengers instead.

Mark sensing is a method of recording toll calls by means of marks on specially designed card-type tickets. Operators mark the tickets in designated locations which indicate route and dialing codes, called place, the central office, type of calling number, etc. Cards are then processed in a machine that punches a hole represented by each mark. Machines then compute, sort and print customer's toll statements.

Marking is done with a pencil, and the marks have the ability to conduct electricity. When mark sense cards are processed, electrical brushes move down over the bubbles in each column on the card, one in the center, and one near each end of the bubble. When the brushes reach a properly made mark, an electrical impulse passes through the mark between the center brush and either or both of the outer brushes. The machine then senses the mark and translates it into an appropriate punch which can be read by other machines.

B. COMBINED TOLL AND DSA SWITCHBOARD

At a combined toll and DSA switchboard there is a certain amount of DSA traffic which originates over the recording-completing trunks in addition to the normal toll traffic originated by these trunks. This assistance traffic can be completed over the direct toll switching trunks which are available for handling the toll traffic. However, since direct toll switching trunks to all the local dial or manual units may not be available, facilities are usually made available to the combined toll and DSA operator which will permit the operator to use the normal completing paths used by the dial subscribers for completing this assistance traffic. These completing trunks, known as toll switching trunks, to local SXS selectors for SXS areas, operator's district junctors for No. 1 crossbar areas, operator's completing trunks for No. 5 crossbar areas or operator's districts for panel areas, are of the noncoin immediate ringing type.

In addition to the foregoing, facilities are usually provided at a combined toll and DSA switchboard for handling some or all of the following items of DSA traffic: intercept, verification, sender supervisory (sender monitor and permanent signal), trouble observation and test, coin supervisory, coin overtime, coin zone dialing, official PBX, business office lines, emergency completion to fire and police lines, emergency manual service for selected dial lines, route transfer arrangements and load control lamps. Since most of the above items require specialized handling, they are usually confined to one or two positions at the head end of the switchboard.

Facilities may also be provided for handling call distributing "B" traffic at the combined toll and DSA switchboard. If a separate DSB switchboard is provided, arrangements can be provided whereby the separate DSB switchboard can be closed down during the periods of light load and the light load DSB traffic handled at one or more combined toll and DSB positions along with the normal toll and DSA traffic. Also, if the DSB traffic requirements are too small to warrant a separate DSB switchboard, one or more positions equipped with DSB position equipment can be placed in line with the combined toll and DSA switchboard to provide exclusive DSB positions.

C. DSA ONLY SWITCHBOARD (WITHOUT TOLL FEATURES)

With a DSA only switchboard the toll traffic will be directed to the toll switchboard over the "110" or "211" channel and the assistance traffic to the DSA switchboard over the "0" channel. However, there will be a certain amount of station-to-station or A-B toll traffic which will originate over the "0" channel. This traffic is handled in the same manner as described for an outward operator. The completion of this traffic requires delayed or controlled ringing completing trunks (toll switching) and the method of operation is similar to that at a delayed call position. Assistance traffic and other DSA types of traffic are handled in the same manner as covered for the combined toll and DSA switchboard.

A certain number of calls on which the subscriber should have dialed the Long Distance code but dialed "0" instead, will reach the DSA operator over the "0" channel. These calls can either be turned back and the subscriber told to dial the Long Distance code or operator recording-completing cords and trunks can be provided at the DSA switchboard to extend these calls to the toll switchboard for final handling. The use of these operator recording-completing cords and trunks permits the switchhook supervision of the calling subscriber to be extended to the toll switchboard operator and also permits the toll switchboard operator to recall the calling subscriber without the aid of the DSA operator. Disconnect supervision is given the DSA operator when both the calling subscriber and the toll switchboard operator have disconnected.

12.3 NO. 3CL SWITCHBOARD CIRCUITS

With the exception of the DC key set and MF key set circuits the existing No. 3C switchboard circuits have been retained for use with the No. 3CL switchboard.

A. CORD CIRCUIT

The cord circuit which functions with a common position circuit is a two relay switchboard cord circuit. One relay operating under control of the Talk key controls the switching of the tip, ring, sleeve and lamp leads to the position circuit. (If a dial or key set circuit is used the tip and ring

leads are carried through the dial or key set circuit to the position circuit.) The other relay, which operates under control of the Ringing key switches a separate set of tip and ring leads to the position circuit which are used for ringing and coin control purposes.

With the cord circuit keys normal, the tip and ring leads are connected straight through the circuit without intervening apparatus, and the sleeve circuit consists of 24 volt battery fed in parallel through 1/2 of a 1000 ohm resistor and the respective cord supervisory lamp to the sleeve of the cord. When the cord is connected to a trunk circuit, the sleeve of the cord is connected (in the trunk) through an 1800 ohm winding (or resistor) to ground. The 1800 ohm winding may or may not be shorted to ground through an 85 ohm winding (or resistor). When the 85 ohm winding is connected, there is sufficient current flowing in the cord sleeve circuit to light the supervisory lamp to give "on hook" (lighted lamp) supervision. When only the 1800 ohm winding is connected there is insufficient current in the sleeve circuit to light the lamp and we have "off hook" (dark lamp) supervision. Both the 1800 and 85 ohm windings are usually found on one double wound sleeve relay, although occasionally separate relays are used and also sometimes either may be replaced by a resistor.

B. POSITION CIRCUIT

The position circuit functions with the cord, dial or keyset and grouping circuits. This circuit provides for connecting the cords to the telephone circuits and for performing certain functions with respect to supervision, ringing, splitting, dialing, key pulsing, coin control, transfer, tone removal and number checking. The various individual functions are associated with a particular cord by the operation of the listening key of that cord to the talking position in conjunction, where necessary, with the proper common key.

C. GROUPING CIRCUIT

The grouping circuit for the 3CL switchboard is connected between the position circuit and the operator's telephone circuit. This circuit is arranged for successive grouping of positions within the same line of switchboard from left to right regardless of direction of growth of the

switchboard. By means of a key located in the miscellaneous key and lamp mounting space at the top of the multiple, any position may be grouped with the adjacent position on the right. Any number of positions may be grouped and the telephone set jacks of any one position in the group are effective. This enables an operator to handle more than one position during periods of light load.

D. OPERATORS TELEPHONE CIRCUIT

The operators telephone circuit provides means whereby the toll operator may communicate with subscribers or other operators or monitor on established connections. It is also arranged to permit the toll operator in panel areas to communicate on a number checking trunk and monitor on the regular connections at the same time.

E. KEY SET CIRCUIT

Three key set circuits are available for use with the 3CL switchboard. These are for use where DC key pulsing, MF key pulsing or combined MF-DC key pulsing are required. The 3CL switchboard positions are universally wired such that they may be equipped for any of the above types as required. Thus, it is possible to initially equip a position for DC key pulsing and later convert it to combined MF-DC key pulsing with a minimum of effort and expense.

The DC key set is used where pulsing into DC key pulsing senders is required while the MF key pulsing set is used when pulsing into multifrequency key pulsing senders or when pulsing over outgoing MF key pulsing trunks. Where it is necessary to pulse into both DC key pulsing senders and MF pulsing senders or over outgoing trunks arranged for MF pulsing, the combined DC-MF key set is used. With the combined MF-DC key set, the key set is normally in a DC key pulsing position. When connection is made to a trunk requiring pulsing into MF key pulsing senders or over outgoing trunks arranged for MF pulsing, a mark on the trunk automatically switches the keyset to the MF condition. This trunk mark is 1000 ohms or less to ground on the ring of the trunk.

MF key pulsing trunks that are arranged for operation with MF-DP senders cannot be used with combined MF-DC keysets since these trunks lack the mark necessary to condition the combined keyset to the MF condition.

The tip and ring leads of both front and rear cords which normally connect to the position circuit are looped through closed contacts of relays in the keyset (or dial) circuits to the position circuit. When either the front KP or rear KP key is operated the corresponding relay operates to transfer the tip and ring leads of the associated cord to the keyset circuit as well as a number of control leads to the position circuit. This prepares the circuit for use as soon as a sender attached signal is received on the appropriate lamp.

F. DIAL CIRCUIT

Dialing is provided in small offices only and is arranged for repeated dialing. The No. 3CL switchboard dial circuit is suitable for both local and intertoll dialing. A start dialing lamp is provided in each position when dialing is furnished. This lamp functions as a dial pilot in simple dial operations and as a start dialing signal in connection with intertoll dialing and certain community dial arrangements. A dial key is used to connect the dial circuit with either the front or rear cord on which the operator is working.

G. OPERATOR RECORDING-COMPLETING CORD

Provision has been made for equipping each outward position of the 3CL switchboard with either one or two operator recording-completing cords. These cords are used in conjunction with operator recording-completing trunks for extending mobile radio or other special traffic originating at one operating unit to the mobile service or other operator at another operator unit for final handling.

The operator recording-completing cord circuit is equipped with a single supervisory lamp and a talking key. The two lamps and two talking keys for the two cords per position are mounted on a single "G" type key base located at the left of the position. No provision is made to omit one lamp and one key in those cases where only one cord is provided. The talking key is integrated with the other talking keys on the same 3CL switchboard position so that only one talking key will be effective regardless of how many talking keys are operated.

The operator recording-completing cord is arranged to provide the following supervisory features:

- (a) Supervision from the calling subscriber prior to the answer of the mobile service operator.
- (b) Through supervision from the calling subscriber to the mobile service operator after the mobile service operator answers.
- (c) Flashing and disconnect supervision from the mobile service operator.

H. TEST CORDS (TEST LINES)

Provision has been made for mounting test cords in the head end position, foot end position and in the space assigned to cords Nos. 1 and 2 in the regular outward positions when these cords are not equipped. The test cords, except those located in the blank end position, can be equipped with supervisory lamps if desired. Test trunks are used to connect toll switchboard circuits to the testing equipment at the local test desk or at the toll test board used in locating trouble. The test trunks can also be used to connect toll switchboard circuits to transmission measuring equipment in order to provide facilities for making transmission measurements.

12.4 MONITORING ARRANGEMENTS

The foot end position of a 3CL switchboard lineup can be arranged as a monitoring position. The monitoring circuit provides means whereby an observer may monitor on the telephone circuit of any supervisor or operator. It also provides means for checking the keying accuracy of toll operators completing calls by key pulsing or the dialing accuracy of toll operators completing calls by dialing. This circuit may also be used to check the accuracy of the toll operators in counting incoming calls, more familiarly known as peg count.

The tip and ring leads of the observed telephone circuits are connected in position monitoring jacks at the monitoring position. One jack is provided for each telephone circuit on which monitoring is required.

To observe on a position the observer at the monitoring position inserts the monitoring cord plug into the position monitoring jack desired. This connects her telephone set across the T & R leads of the operator's telephone set.

A. PEG COUNT CHECKING

Peg count checking facilities are available if desired. The arrangement consists of a lever type key, a lamp and a message register mounted in the lower part of the last panel of the switchboard. The other position of the lever type key is used for keyset observing when required. When the observer connects to a line as described above, she hears the verbal operating at the position under observation. When the operator's positional peg count key is operated the observer's peg count lamp lights for the duration of this operation. If the operator's peg count key is properly operated, the observer's register will score along with the regular position peg count register.

B. POSITION KEY MONITORING

Key set observing facilities are generally provided for all 3CL switchboards so that operator keying performance can readily be obtained. With keyset observing, the keyed digits are displayed in front of the observer on a group of indicators located in the last panel of the board. When the lever type key mentioned in the previous paragraph is in the KM position and the monitoring cord inserted in the position monitoring jack, the digits keyed by the operator are displayed on the indicators. All displayed digits remain locked in until the observer restores the key to its normal position or removes the cord from the position monitoring jack.

Each indicator plate has a capacity of four digits. Thus if a maximum of 11 digits were to be keyed, three indicators would be necessary.

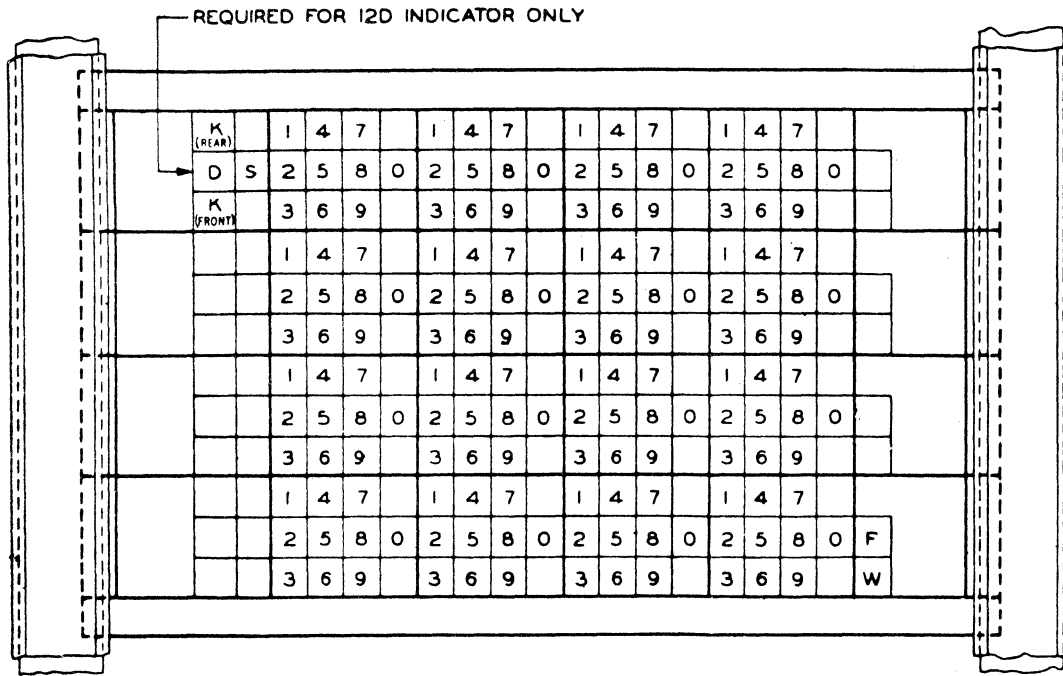
A four indicator arrangement for toll use and a two indicator arrangement for combined DSA and DSB use is shown in Figure 12-1. In the four indicator arrangement, the lamps designated with letters at the left of the top indicator function as follows. The "K" lamps indicate the operation of front or rear KP key as designated, "S" is the sender lamp and D is a number checking lamp. The digits keyed by the

operator start at the left of the top indicator and proceed from left to right across the indicator and then from left to right across the next indicator below and so on until all digits keyed have been displayed. At the right of the bottom indicator are two lamps designated by letters "F" which indicates the operation of the start key and "W" which shows registration complete.

In the two indicator arrangement shown when used for DSA keyset observing, the indicators function exactly as described above except the maximum digit capacity is eight digits. For DSB keyset observing, the lamps designated with letters at the left of the bottom indicator have the following functions. "K" shows a call has been connected, "S" is the sender lamp, D indicates operation of the position disconnect key and "R" indicates operation of the reset key. The four digit lamps in the bottom indicator from left to right shows the thousands, hundreds, tens and units digits of the called number and the "W" lamp indicates registration complete. If a "B" office code is required, the extreme right digit of the top indicator is used for this purpose.

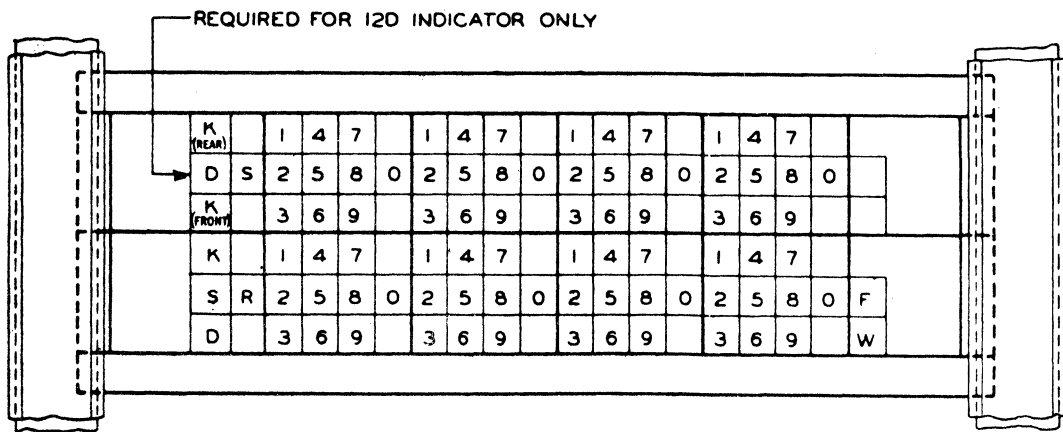
C. DIAL MONITORING

Observing is accomplished for positions having dialing features by recording the digits dialed by the operator on a pen register rather than the indicator used for observing key pulsing. When the observed plugs the monitoring cord into a position monitoring jack and operates a dial monitoring key, the digits dialed by the operator under observation are registered on the tape of the pen register which can be read by the monitoring operator.



FRONT VIEW

FOUR INDICATOR ARRANGEMENT FOR TOLL BOARD



TWO INDICATOR ARRANGEMENT FOR COMBINED DSA & DSB BOARD

FIG. 12-1 NO. 3CL SWITCHBOARD KEYS ET OBSERVING INDICATORS

12.5 COIN CONTROL ARRANGEMENTS

The 3CL switchboard is arranged for positional coin control. The operator depresses the positional collect or return key and then connects the correct coin potential to the line or trunk by operating the ringing key associated with the cord which is plugged into the line or trunk. This permits coin potential to be applied to either cord. A typical circuit is shown in Figure 12-2.

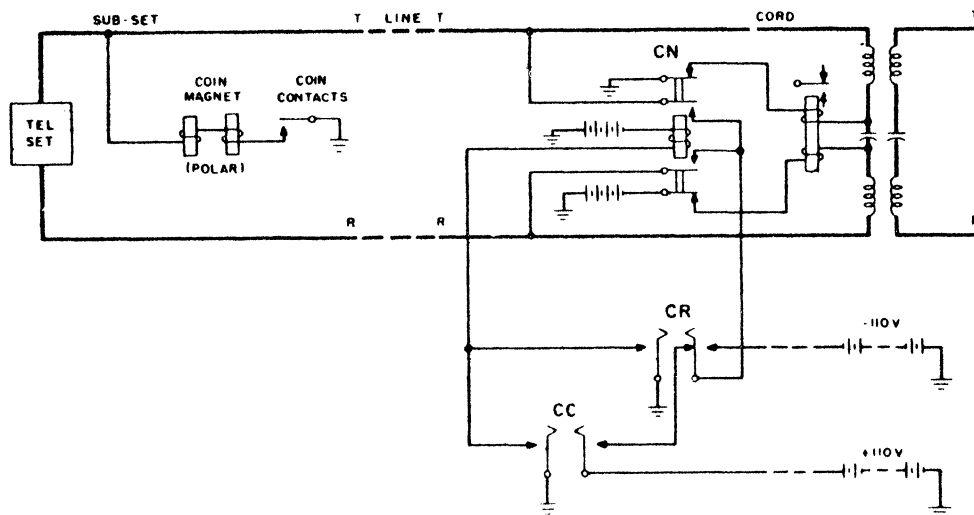


Figure 12-2 Coin Collect and Return Circuit

12.6 MISCELLANEOUS 3CL SWITCHBOARD FEATURES

A. SERVICE ASSISTANT CALL CIRCUIT

The service assistant call circuit provides a means for calling a service assistant. A key is located in the piling rail and a white beehive lamp above the multiple. Operation of the key lights the lamp as an indication to the supervisor handling that position that assistance is required.

B. ROUTE TRANSFER AND MAKE BUSY ARRANGEMENTS

In periods of light traffic it may be desirable to reroute toll traffic originating in a panel, crossbar or SXS office from positions normally handling this traffic to other positions which may be in the same or a distant building. In a panel or crossbar system this is accomplished by operating a key which operates a route relay in the decoder or marker of the panel or crossbar office. The route relay informs the decoder or marker to reroute traffic from the normal toll switchboard to the light load or night position. In a SXS office the operation of the key operates a transfer relay causing groups of trunks to be transferred when idle. The transfer keys are located in the first panel of the switchboard of the office normally handling toll traffic from the local offices involved.

Trunks which are not transferred in a SXS office can be made busy by the operation of a make busy key. Thus, these trunks test busy when they are idle.

C. LAMP TRANSFER AND MAKE BUSY

The Lamp Transfer and Make Busy circuit is used to transfer the lamp leads of one or more groups of circuits to a night or a light load position and when necessary for making busy other groups that are not transferred.

D. NIGHT ALARM CIRCUIT

The night alarm circuit provides an audible and visual signal at a switchboard position when a signal is received on an associated circuit such as an alarm circuit. It is intended for use during light load periods when the maintenance force is at a minimum. The night alarm key, located in the first panel above the multiple, when operated causes an audible and visual signal at the switchboard when any of the associated circuits receive a signal.

E. FUSE ALARM CIRCUIT

A fuse alarm circuit is furnished for the 24 volt and 48 volt battery fuses mounted in the rear of each switchboard position. A lamp is located above the multiple in each position to indicate a failure in that position. A fuse alarm pilot lamp located above the multiple in the first panel signals a failure in any position.

F. LINE AND TRUNK LAMP AND ALARM CONTROL CIRCUIT

Where it is desired to provide for call storing arrangements a line and trunk lamp and alarm control circuit is provided. The control key for this circuit and its associated pilot lamp as well as the alarm key are located in the first panel of the head end position for 7 panel multiple switchboards; in the cable turning section for 6 panel multiple switchboards or above the multiple for 6 panel multiple 6'2" height switchboards.

This circuit is intended for use during periods of heavy traffic load. It provides means for alternately permitting the lighting of all trunk and line lamps associated with waiting calls and then preventing the lighting of any more trunk or line lamps until all calls in the first group have been answered, thereby assuring that no call will be overlooked because of the heavy traffic load.

G. DOOR OPENING CIRCUIT

A door opening circuit may be provided at a position in the toll switchboard lineup by means of which the operator can open the door leading to the operating room. Operation of a key located in the piling rail releases the door latch.

H. EMERGENCY RINGBACK CIRCUIT

An arrangement is available to permit a DSA operator to ring back a calling customer over a recording completing or special service trunk in case of an emergency where the calling number has not been obtained. The circuit is primarily intended for calling back on a line which has originated an emergency call for the police, fire department or an ambulance and then abandoned the call without identifying either the calling station or person.

A nonlocking key located in the piling rail is provided at each position for this purpose. The operator operates this key in conjunction with her regular cord ringing key.

I. PERMANENT SIGNAL CORD

Those positions handling calls coming in on trouble observation and test trunks and permanent signaling holding trunks are equipped with a permanent signal cord. This cord, when plugged into the TST jack of the above trunks, permits the operator to talk, apply standard 20 cycle ringing, reversed 20 cycle ringing or nongrounded 20 cycle ringing to the line. Howler tones can also be applied to the line if so desired. If the howler feature is equipped, a busy lamp is provided with each cord to indicate when the common office howler supply is in use by another permanent signal cord. A supervisory lamp is also provided to furnish subscriber switchhook supervision.

J. NUMBER CHECKING

1. SXS - The regular 3CL cord circuit is used for number checking in SXS areas. The "dial-back" method of number checking is used in conjunction with number checking trunks. The recording completing trunk number and the subscriber's number are dialed over a number checking trunk outgoing to a number checking selector in the SXS office. The number checking selector returns a visual signal to the toll operator indicating whether or not a successful check has been made.
2. Panel - The straightforward number checking arrangement is used for calls from panel areas. It requires the use of separate number checking cord. The toll operator reaches the DSA operator at the panel office over a number checking trunk and verbally requests a check of the number. The DSA operator can then set up a "check" or "no check" condition which returns visual signals to the toll operator.
3. Crossbar Areas - A separate number checking cord is also used for calls originating in crossbar offices. Two methods of number checking tolls from crossbar areas are available.

If the subscribers number being checked is in a crossbar office being served by a call distributing "B" board, the toll operator

reaches the "B" operator over a number checking trunk via the number checking cord and verbally requests the "B" operator to key the number.

If the subscribers number can be reached by using MF pulsing, the operator operates the front key of her keyset and upon receiving a lighted "sender ready" lamp, keys the subscriber's number over the number checking trunk. A visual signal is returned to the toll operator indicating a "check" OK or "no check" condition. The MF-KP arrangement can be used either where the 3CL switchboard and the crossbar unit are in the same or distant buildings. An arrangement is also available, which enables an operator to DCKP the number checking calls in the same building only. Where combined MF-DC keysets are furnished in the switchboard, DCKP is used for number checking to crossbar units in the same building and MF-KP for crossbar units in other buildings.

Since the 3CL switchboard scheme of number checking requires that the talking key of the regular cord used to answer the recording completing trunk and the talking key of the number checking cord be operated at the same time, the operators telephone circuit is connected in the monitoring condition across the regular cord and in the talking condition across the number checking cord. This enables the 3CL operator to pass the calling subscribers number verbally on straightforward calls or to attach the key set to the number checking cord by operating either KP key and at the same time monitor the regular connections.

K. NUMBER CHECKING LAMP SIGNALS

The lamp signals for number checking as received at the toll switchboard are shown in Table 12-1.

Table 12-1 Number Checking Lamp Signals

Condition	Number Checking Cord Lamp			
	Straight Forward	Dialing	Key Pulsing DCKP	MFKP
1. Plug In	Lighted	Dark	Lighted	Dark
2. Sender Attached and Ready to receive pulses		Lighted	Lighted	Lighted
3. Keying or Dialing		Lighted	Lighted	Lighted
4. Dial Key Released - Key Set Released - (ST) Key Operated		Lighted	Lighted	Lighted
5. O.K. Check	Dark	Dark	Dark	Dark
6. Failure to Check	Flashing	Flashing	Flashing	Flashing

12.7 CENTRALIZED SUPERVISORY CONSOLE

A centralized supervisory console has been developed to permit one supervisor to handle a maximum of 70 operator positions. Two consoles can be multiplied to serve the same 70-position unit. If more than 70 positions are to be served by the centralized facilities, the incoming circuits can be multiplied to two consoles so that each console can answer 140 operator positions. However, each of the consoles can originate calls to a maximum of 70 positions. The new facilities will enable the telephone companies to use supervisor time more efficiently and at the same time provide the supervisors with more attractive and effective equipment.

A supervisor will use a console which will permit her to:

- (a) Answer calls from operators or customers.
- (b) Originate calls to any of the 70 operator positions.
- (c) Monitor on any of the 70 operator positions.
- (d) Originate dial calls over a dial central office line circuit.
- (e) Originate nondialable calls over a toll subscriber line.

Figure 12-3 shows the new supervisory console.

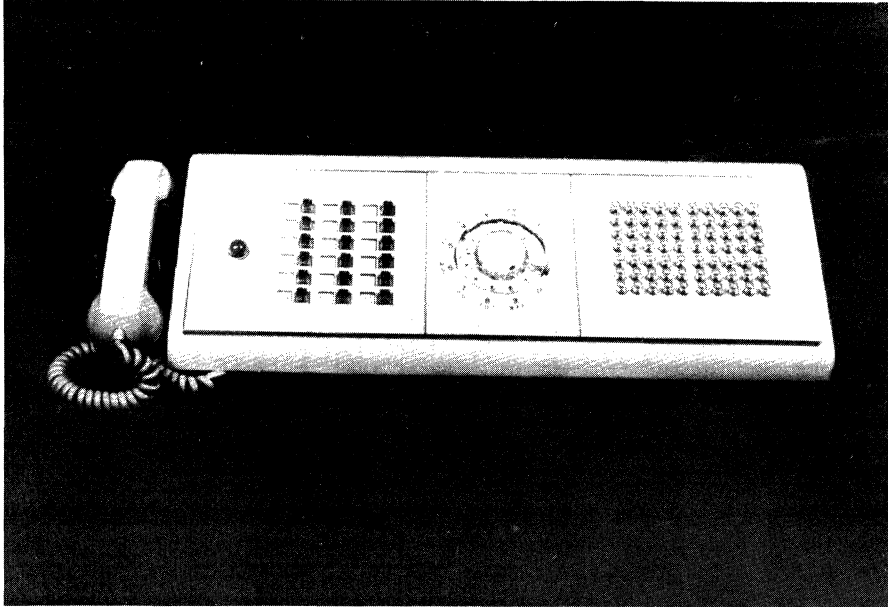


Figure 12-3 Centralized Supervisory Console

12.8 TRUNKS ASSOCIATED WITH TOLL SWITCHBOARDS

Because of the numerous listings of trunks associated with the 3CL switchboard, we shall consider these circuits in groups and give detailed attention to only a few typical circuits. There are several ways in which the trunks can be grouped, such as:

- (a) By direction of Traffic (incoming, outgoing and 2-way).
- (b) By type of traffic (toll, local).
- (c) By type of circuit (toll switching, recording-completing, intertoll, etc.).

A. INTERTOLL TRUNKS

These trunks can be divided into three subgroups consisting of ringdown, automatic, and intertoll dialing trunks. The circuits used in completing a toll call are of two general types known as intertoll trunks and toll connecting trunks. The intertoll trunks are used for that portion of the call extending between Toll Centers (TC) and the toll connecting trunks for the portion of the call between the local office line circuits and the toll switching equipment in the Toll Center which may be of either the manual (switchboard) or machine switching (dial) type.

1. Ringdown Trunks - Ringdown intertoll trunks are the type which, previous to the advent of intertoll dialing, carried practically all intertoll calls. The name "ringdown" derives from the fact that the earliest circuits actually rang down drops located in the switchboards. On present day circuits the ringing current actuates relays which in turn light line lamps to signal the called operator. Either the called or calling operator can signal the other operator during the progress of a call by ringing, in which case the recall signal appears on the cord circuit supervisory lamp and at the end of a call the originating operator again rings as a disconnect signal. Auxiliary trunks can be connected to ringdown trunks to permit intertoll dialing trunks to complete calls to points served only by manual means.
2. Automatic Trunks - Automatic trunks are those trunks which automatically signal the called operator upon seizure by the originating operator. They are mainly used in transferring calls between toll switchboards in the same area and are generally used in pairs, one of which is arranged for rering and the other to repeat the ringing signal. The use of these trunks is restricted mainly to those situations where an outlying toll office does not have access to a full complement of the intertoll trunks appearing in the main toll office. The circuit arranged for rering is used at the outlying office and the one arranged to repeat the ringing signal is used

at the main office. Either operator may recall the other operator by replugging. The use of these circuits has become greatly reduced in recent years since most toll centers, large enough to have more than one toll office, are now equipped with either toll crossbar, crossbar tandem, or #5 crossbar toll offices; and can be reached over tandem trunks from the outlying office, thus enabling the outlying office to have access to all trunks appearing in the automatic office. There are a few other applications of automatic trunks which do not warrant consideration in this text.

3. Intertoll Dialing Trunks - Intertoll Dialing Trunks are those trunks in which the routing of the call is controlled by some type of pulsing. Only those intertoll dialing trunks with an appearance in the toll switchboard itself will be considered in this chapter. The most commonly used circuits are those which have their outgoing appearance in the switchboard and the incoming appearance in the automatic switching equipment. These circuits can also be used for outgoing traffic from the automatic switching equipment where this equipment is serving as a tandem point. These circuits can be either of the dialing DC key pulsing or MF key pulsing type on the switchboard end but must be dial pulsing incoming for use with SXS type intertoll dialing equipment. Trunks which are incoming on an MF pulsing basis must terminate on crossbar toll switching equipment, crossbar tandem or #5 crossbar equipment; those calls directed to the switchboard reach it through auxiliary or incoming trunks or are routed directly to answering jacks in the case of the #5 crossbar office. These trunks are reached by means of outgoing tandem trunks to the crossbar equipment for calls outgoing from the switchboard. The outgoing tandem trunks make all outgoing or two way intertoll trunks, terminated in the crossbar office, available to the switchboard operators.

Incoming traffic is only routed to the switchboard where the called party cannot be reached on a dial basis (manual office's, some CDO's and some nonassociated areas), on TX calls and reverse charge calls or where additional information is required. The bulk of the incoming calls are completed on a dial basis; as a result, the inward traffic on toll switchboards has fallen off greatly in recent years and will decrease still further as more and more offices are made available to the intertoll dialing network.

In some cases the trunks are used on a temporary manual (automatic or straightforward) basis when they are used with manual areas not equipped with incoming automatic switching equipment. If the distant manual board is equipped for dialing, these trunks can still be used for incoming calls on a dialing basis.

Most intertoll dialing trunks use E and M lead (CX) signaling although there are a few circuits of the loop signaling type available for use on short haul circuits.

There are a few cases where trunks are used to manual offices which are not arranged for pulsing or where for other reasons the incoming calls must be on an automatic signaling rather than on a dialing basis. In these cases the incoming end of the intertoll trunk is connected to the switchboard incoming trunk through an auxiliary circuit.

B. TOLL SWITCHING TRUNKS

Toll switching trunks are a subgroup of a larger group of trunks known as "Toll Connecting Trunks." Toll connecting trunks are those trunks which are used between the toll switching equipment (manual or automatic) and the local equipment to which toll calls can be connected. The main trunks in this group are the toll switching and recording completing trunks although there are others such as toll subscribers lines, trunks to some desks, etc. These are the trunks which must have at least a 2db loss in offices operating on a VNL basis.

Toll switching trunks are used primarily in completing incoming toll calls to the local subscribers, as well as delayed outward calls and incoming TX calls. Those trunks operating on a dialing basis (or key pulsing) may connect to either toll or local trunks in the local office. Where toll trunks are used the toll switching trunks are usually arranged for controlled ringing. Where local trunks are used, the ringing is always on an automatic basis; that is, the ringing is automatically applied by the local office equipment as soon as the called line is seized.

Where toll switching trunks are used on a manual basis, the ringing is always controlled by the toll operator and is repeated by the toll switching trunk in the local office both on the initial ring and on a rering is required. The toll switching trunk also repeats the subscribers switchboard supervision to the toll operator. Once such a manual toll switching connection is established, the local toll switching operator receives no further supervision on the call until she receives a disconnect signal from the toll operator.

When the toll office is located in the same building with a SXS local office, the toll switching trunks are usually of the 4 wire type connected directly to toll incoming selectors in the local office rather than to the more expensive toll transmission selectors, which are required with 2 wire toll switching trunks. The 4 wire trunks can be arranged for either controlled or automatic ringing but if controlled ringing is used with DC key pulsing trunks they must be in a sender class arranged for 20 cycle ringing simplex. Reverse battery switchhook supervision is over the T & R leads. The S lead is used to hold the switches under control of the operator and with the C lead controls the ringing.

When the toll office is in the same building with a #5 crossbar local office, the toll switching trunk is an integral part of the #5 crossbar trunk which cross connects direct to outgoing trunk jacks in the switchboard and to idle indicating chain relays, group busy circuits or busy indicating relays as may be required. These are MF pulsing circuits from the switchboard. There is one other group of trunks which are handled on very much the same basis.

These are called "Marker Pulse Conversion Trunks" and are used when a switchboard on an MF key pulsing basis must complete some calls on a dial pulse basis to SXS or CDO offices. The marker pulse conversion trunks are furnished as a part of the local #5 crossbar office and cross connect to the switchboard jacks. The equipment in the local office converts the MF pulsing to dial pulsing and routes the call to the desired office.

With the exceptions noted in the preceding two paragraphs all toll switching trunks are provided on a 2 wire basis. Mention has been made of connection to either local or toll trains. Presently automatic ringing local trains are being predominately used with no local trains being provided in addition to existing offices or in new offices. In line with this it can be readily seen that the practice of handling delayed calls must be discouraged.

Toll switching trunks of the dialing, or key pulsing types can also be used with auxiliary trunks to complete incoming intertoll dialing calls. Also 2 wire toll switching trunks of the dialing or key pulsing types can be used as verification (SXS) or No test (X-Bar or Panel) trunks. This is a DSA service which will be covered later.

C. RECORDING AND RECORDING COMPLETING TRUNKS

In the past when most telephone switching was on a manual basis and a subscriber wished to make a toll call, the call had to be passed by the local operator to the toll operator and when the toll operator was located at a separate switchboard, recording trunks were used for this purpose. Since the local cord circuit would not pass supervision between the toll operator and the subscriber it was necessary for the toll operator to obtain the call details from the subscriber, request the subscriber to hang up and then recall the subscriber over a toll switching trunk when she was ready to proceed with the call. For this reason recording trunks were simple one way incoming trunks at the toll switchboard. In present day practice, recording trunks are used mainly for situations where a simple incoming trunk is required such as trunks to the toll switchboard from information desks.

With the development of machine switching central offices it was possible to provide trunks that would enable a subscriber to dial a special code that would connect the subscriber directly to the toll operator. Since these trunks gave the toll operator subscriber's switchhook supervision, it was possible to complete the toll call over these trunks providing the call could be completed immediately. The new trunk was therefore called subscribers recording completing trunks.

There is another recording completing trunk known as an operators recording completing trunk that is used when it is necessary to transfer a call from one toll board to another for special handling, such as to a mobile radio position. The operator at the first toll board must have a recording completing toll cord on her position which she uses to connect between the subscribers recording completing trunk on which the call originated, and the operators recording completing trunk, which in turn connects to another subscriber's recording completing trunk terminated at the desired special service position. The special service operator then has complete control of the call. These arrangements can be furnished on a coin or noncoin basis.

There is also available a recording completing switching trunk for use between a 3CL switchboard and a manual tributary office for both the loop signaling and composite or simplex signaling condition. Outgoing calls to the manual tributary office are handled on a straight-forward basis and these calls can originate from the switchboard and also from the switches of a dial tandem or an intertoll dialing system in the same building. Incoming calls from the tributary office can terminate at the 3CL switchboard or in the dial tandem or intertoll dialing system.

A 3 wire recording completing trunk is generally used when the toll office is in the same building with a SXS local office, with a fourth wire added when tone identification is required.

D. OPERATOR OFFICE TRUNKS

An operator office, for the purpose of this discussion, is an office equipped with a toll and DSA switchboard that serves the operators of one or more community dial offices (CDO). Of course, any office with operators is an operator office, but the term, as such, need be considered only in its narrower meaning. A community dial office, is a dial office in an outlying or distant town, having no switchboard of its own and which must, therefore, obtain the required operator services from some other point. Both the size of the CDO and it's distance from the operator office, vary widely. Some CDO's may exceed 5000 lines in capacity and the distance located from the operator office is limited only by the cost of line facilities to the operator office, as compared to the cost of providing operator facilities at the CDO. Occasionally, a CDO may be used as a tandem point to reach other CDO's.

Most CDO traffic is handled over two-way trunks on an automatic ringing noncoin basis. These trunks may be the dialing or the DC key pulsing type and either can be arranged for loop or CX signaling.

If the volume of traffic warrants it, separate incoming and outgoing trunk groups may be used exclusively, or in combination with 2 way trunk groups. Standard toll switching and recording completing trunks are used for the one way trunk groups. Regardless of the type of trunks used, the operator has full supervision over all calls. Facilities are available for connecting operator office trunks to any standard intertoll dialing system so that incoming intertoll dialing calls can be completed direct to the CDO subscribers.

E. TRUNKS FOR DSA SERVICE

There are many types of trunks used for DSA (dial switching assistance) traffic. While some are the same circuits used for toll traffic, others are for DSA traffic exclusively.

When a dial subscriber wants assistance and dials the operator, the dial line is connected to a trunk known as a zero level trunk, so called from early SXS days when

these trunks were connected to the zero level on a SXS switch. Standard recording completing trunks are used for this service (when toll positions are used for DSA service) and operate as previously described.

Completing trunks are used to complete assistance calls when necessary. Generally, standard toll switching trunks are used on combined toll and DSA switchboards where the volume of DSA traffic to be completed is small in relation to the toll traffic. Where the volume of DSA traffic is heavy and for DSA switchboards only there are a considerable number of completing trunks available. The selection of the proper circuit for any individual case depends on the type of local office involved and the type of pulsing required. Since completing trunks connect only to local trains, ringing and coin control features are not required, but otherwise these trunks function substantially as previously covered under toll switching trunks.

F. NO-TEST TRUNKS

No-test (verification) trunks are used to determine whether a particular line is actually busy or whether it tests busy due to trouble conditions. Standard toll switching trunks are generally used for this service, although here again, there are other circuits available for specific applications where their use is more economical. The circuits provided in the DSA (or toll) office connect to equipment in the local office which is designed to connect to the called line without making a busy test (hence no-test).

G. INTERCEPT TRUNKS

Intercept trunks are used, as their name implies, to intercept calls. Regular intercept trunks are used to intercept calls to vacant number, vacant levels, to subscribers denied service or whose number has recently been changed. Trouble intercept is used with a plugging up circuit to intercept calls to or from lines in trouble or where it is necessary to monitor the call for any reason. Until recently there were a great many different intercept trunks available but most of them have now been replaced by three standard circuits which cover regular, trouble or machine intercepting on most any combination of desks and switchboards.

The preferred present day practice is for vacant code (or level) and vacant number intercepting to be handled by the recorded announcement machine which states that a wrong number has been dialed and requests the customer to recheck the number and dial again. After a predetermined number of announcements the call is routed to an operator if the customer is still on the line. Calls to changed or denied service numbers are classed as regular intercept and routed to a desk operator. Trouble calls are always routed to switchboard position so that they can be completed where possible. In smaller offices the recorded announcement machine and even the desk may be omitted and all intercepted calls routed to the switchboard. All three types of calls are usually handled over the same trunk group and the routing is controlled by marks on the tip or ring leads. The large number of intercept trunks required in the local office end are usually concentrated on a small number of trunks to the toll or DSA office by means of concentrating switches usually called trunk finders.

Verification request trunks provide a connection to a toll switchboard operator from terminating circuits in SXS, panel, manual or crossbar offices for receiving verification request calls.

H. SENDER MONITOR TRUNKS

Sender monitor trunks are available for use with panel and #1 crossbar senders when they are located in the same building with the 3CL switchboard. If the subscribers senders in the #1 crossbar have been modified for automatic time release, sender monitor trunks are not required. All #5 crossbar senders are arranged for automatic time release. The purpose of these trunks is to give an indication when a sender stays attached to a subscribers line beyond a specified time. If the local dial unit is in a building separate from the switchboard this service must be handled at the sender make busy frame.

CHAPTER 13

THE TRAFFIC SERVICE POSITION SYSTEMS

13.1 INTRODUCTION

Before the advent of electromechanical switching offices, the switchboard operator not only connected the calling customer with the called party but also provided a number of other functions. Whenever a person wanted to make a long distance call, it was the switchboard operator's function to cause the proper connections to be made through the various subsequent switchboards until the called party answered the call and the talking path was established. In addition, the operator had to remain available so that when the call was terminated, she could properly record the charges. If any problems appeared either in the establishment of the call connections or during the talking phase, the operator was always at hand to supply information, and provide any required "assistance" necessary for the proper solution of these problems. The nature of these problems varied extensively from simple "the line is busy" cases to complex situations such as a "person-to-person" long distance call where the determination of the location of the called party required considerable effort.

When coin telephones were installed, another chore was added to the list of switchboard operator functions. This was the conversation with the calling customer to determine the initial charge, the supervision of the coins deposited and the final charging and coin deposit supervision at the end of the call.

With the advent of electromechanical switching offices, it became possible for a telephone customer to dial directly another subscriber. Later this feature was extended to the direct (automatic) establishment of long distance as well as local calls. However, on each long distance call a "toll" charge had to be manually made, and this required the inter-vention of a switchboard operator. On a toll "ticket" which the operator filled out and which was subsequently used for the tabulation of a customer's bill, the operator had to record the called number, the calling number, the length of time of the call, etc. Considerable operator activity was thus necessary for each long distance call and with the heavy

growth of telephone subscribers, a considerable number of operators were needed. The constant increase in the number of coin telephones incremented the burden still further.

Although dial telephones became quite universal, the customer still retained the prerogative to simply dial "0" (for Operator) and state the number of the telephone subscriber to which he wished to be connected, instead of dialing the number directly. In a more general sense however, the dialing of "0" enabled his connection to a human operator which provided him with any required assistance rather than being completely dependent on automatic devices. It soon became evident that the growth of telephone traffic would require an over proportional increase of "human" assistance. As a result, a special telephone switchboard specifically to alleviate the heavy influx of assistance calls was designed; this was the 100A Traffic Service Position.

A. THE 100A TRAFFIC SERVICE POSITION SYSTEM

In 1964 the 100A Traffic Service Position (TSP) System was introduced. This system (which was electromechanical in nature) was designed for operation with Crossbar Tandem offices only. The primary equipment was a number of 100A Traffic Service Sections each consisting of two identical operator positions. Each of these cordless consoles (positions) included a horizontal writing space and a slightly sloping control keyshelf which extended into a sharply sloping display panel containing ten display lamps. By obtaining information displayed by various lamps on the console, conversing with the customer, the called party or other switchboard operators, and manipulating the various "buttons" on the keyshelf, the Traffic Service Operator was able to give better and faster service. Also, this system (and the associated electromechanical equipment) provided a direct means to extend customer direct distance dialing (DDD). This included special toll calls such as person-to-person, collect, credit card and charges to a third number.

B. THE TRAFFIC SERVICE POSITION SYSTEM NO. 1

As a result of the successful development of the No. 1 Electronic Switching System, a Traffic Service Position System No. 1 (TSPS No. 1) was designed. In this system each Traffic Service Section is designated "100B," and although somewhat similar to the "100A" Section is very much different in that

an electronic switching system "computer" is now used instead of the electromechanical equipment to aid the Traffic Service Operator. The new system also differs from the 100A system in that it is a common system with a stored program control and operates with one or two toll centers. Instead of being limited to operation with Crossbar Tandem offices, the system works with offices equipped with No. 4 Crossbar, No. 5 Crossbar, Tandem, Panel, Step-by-Step Intertoll and No. 1 ESS equipment.

13.2 GENERAL DESCRIPTION OF THE TSPS SYSTEM NO. 1

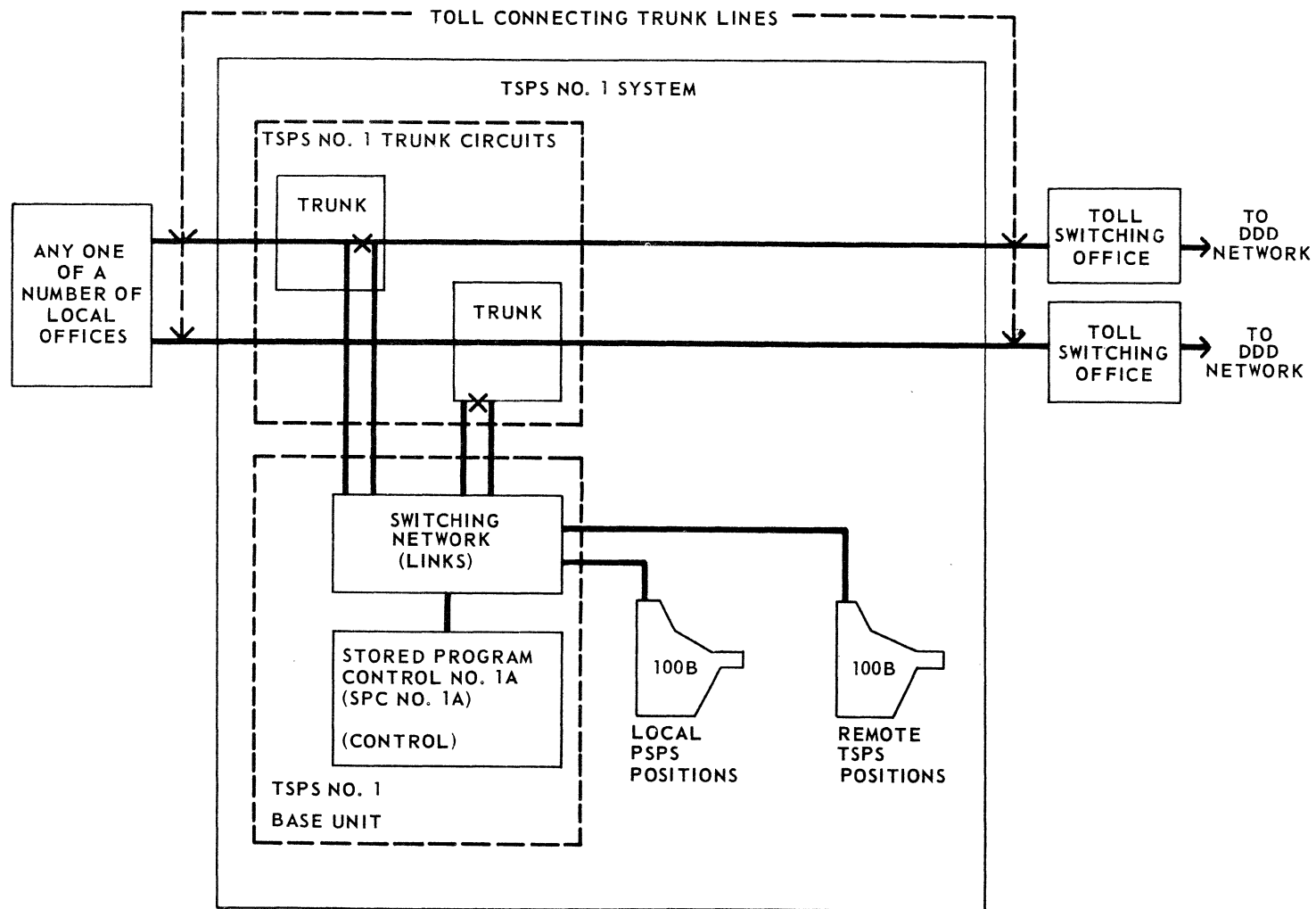
Figure 13-1 illustrates the basic Traffic Service Position System (TSPS No. 1) interconnections. As the figure indicates, the system is located (electrically) between a number of local offices, where calls requiring operator action or assistance are originated, and a maximum of two toll switching offices through which the Traffic Service Operator may route the call to the direct distance dialing (DDD) network for connection to the called number.

The system is subdivided into the Trunk circuits, the Base Unit and the 100B Positions. Each Trunk circuit is located in the transmission path (the trunk line) extending from a local office to a toll switching office. The Base Unit consists of Switching Networks (the Trunk Link (TL) and the Position Link (PL) frames) and the Stored Program Control No. 1A (SPC No. 1A) "electronic computer" equipment. The 100B positions may be located locally (in the same location as the Base Unit) or remotely up to a distance of about 50 miles using T-1 Carrier equipment. The normal location of the entire TSPS No. 1 System (except the remote positions) is at a toll switching office.

13.3 THE TRUNK CIRCUITS

There are several types of TSPS No. 1 trunk circuits, all of which can be used for either coin or noncoin traffic. Most are plug-in type trunk units (two circuits per unit) which are mounted on either 2-wire or 4-wire Universal Trunk frames similar to the Universal Trunk frames used in No. 1 ESS.

TSPS No. 1 has no trunk switching or trunk concentrating capability. In other words, it does not connect the calling number to the desired called number. Each trunk circuit is permanently connected on one side to a trunk line



13.4

Figure 13-1 The Basic TSPS No. 1 Interconnections

(the two wires) from a specific local office. On the other side it is connected to one of the associated toll switching offices. In addition, each trunk circuit is connected to terminals on a Trunk Link Network in the TSPS No. 1 Switching Network.

The trunk circuits are designed to have "transparent" transmission characteristics so that when a call has been completely processed, the trunk circuit is "cut through" and the Switching Network, Base Unit and Positions are effectively cut off. When the trunk circuit becomes connected to a 100B TSPS position, special transmission features are provided to ensure trunk stability and proper transmission between the calling customer, the TSPS operator and the called party.

Since all outpulsing (the transmission of telephone numbers to the toll switching office) originating at the TSPS position consists of multifrequency (MF) pulses, each toll switching office in which the trunk lines are terminated (on associated trunk circuits in that office) must be able to accept these multifrequency pulses.

Across each pair of wires representing the trunk line from a local office, a Ferrod is connected. The Ferrod is a current sensing device operating on electromagnetic principles. It consists of a ferrite rod around which is wound a pair of solenoidal control windings. In addition, a single-turn "interrogate" winding and a single-turn "readout" winding are threaded through two holes in the center of the ferrite rod, as further explained in the No. 1 ESS chapter. By periodically scanning the status of these Ferrods (which are assembled into a matrix of 512 scanning "points" for each Universal Trunk frame) the existence of new calls requiring TSPS operator action is detected.

The detection is actually performed by the SPC No. 1A control equipment which scans (interrogates) many times every second each of these Ferrods as guided by the appropriate Program in the SPC No. 1A memory. When a new call is detected, the control equipment routes the call (again as guided by a Program in memory) through the Switching Network to a TSPS operator at a 100B TSPS position.

13.4 THE "BASE UNIT"

The functions of the Base Unit are to detect a request for Traffic Service Positions operator action, to route the call to an operator, and to enable the operator to properly supply the required and requested services by effecting various interconnections on the basis of the "Programs" and data stored in the SPC No. 1 memory (the Store).

Figure 13-2 is a Block Diagram in which the components of the Base Unit are shown. The major sections of the Base Unit are the Switching Network (shown as TSBO, TL and PL), the SPC No. 1A equipment (outlined with dotted frames), and the associated peripheral equipment such as the Miscellaneous Trunk frame, Service Observing frame, Position Grouping Gate frame, etc. The Universal Trunk frames, although always located with the Base Unit, are not considered as part of the Base Unit.

13.5 THE SWITCHING NETWORK

The basic TSPS No. 1 Switching Network consists of a Trunk Line Network (TLN) on which up to 256 trunk circuits may be terminated and a Position Link Network (PLN) to which up to 80 100B TSPS positions and 96 Service circuits may be connected. When additional trunk capacity is required, a maximum of three Trunk Switching Buildout (TSBO) frames may be installed, each providing for an additional 256 trunk circuits. If required, additional Trunk Link Networks and Position Link Networks may be added to further increase the capacity. Thus, the TSPS No. 1 Switching Network design allows for orderly growth of TSPS office sizes. The design also allows for a number of flexible arrangements for a variety of traffic conditions.

The basic switching device in the Switching Network (in the TP, PL and TSBO frames) is the Ferreed. The Ferreed consists of two miniature glass-enclosed reed switches which are opened or closed by the magnetic action of the surrounding material. These are arranged into square arrays of 64 Ferreeds each (8 columns and 8 rows) for 8 input pairs of wires and 8 output pairs of wires. The arrays, called "crosspoint Ferreed switch assemblies," (which are the same as the ones used in the No. 1 ESS equipment) are described in the No. 1 ESS

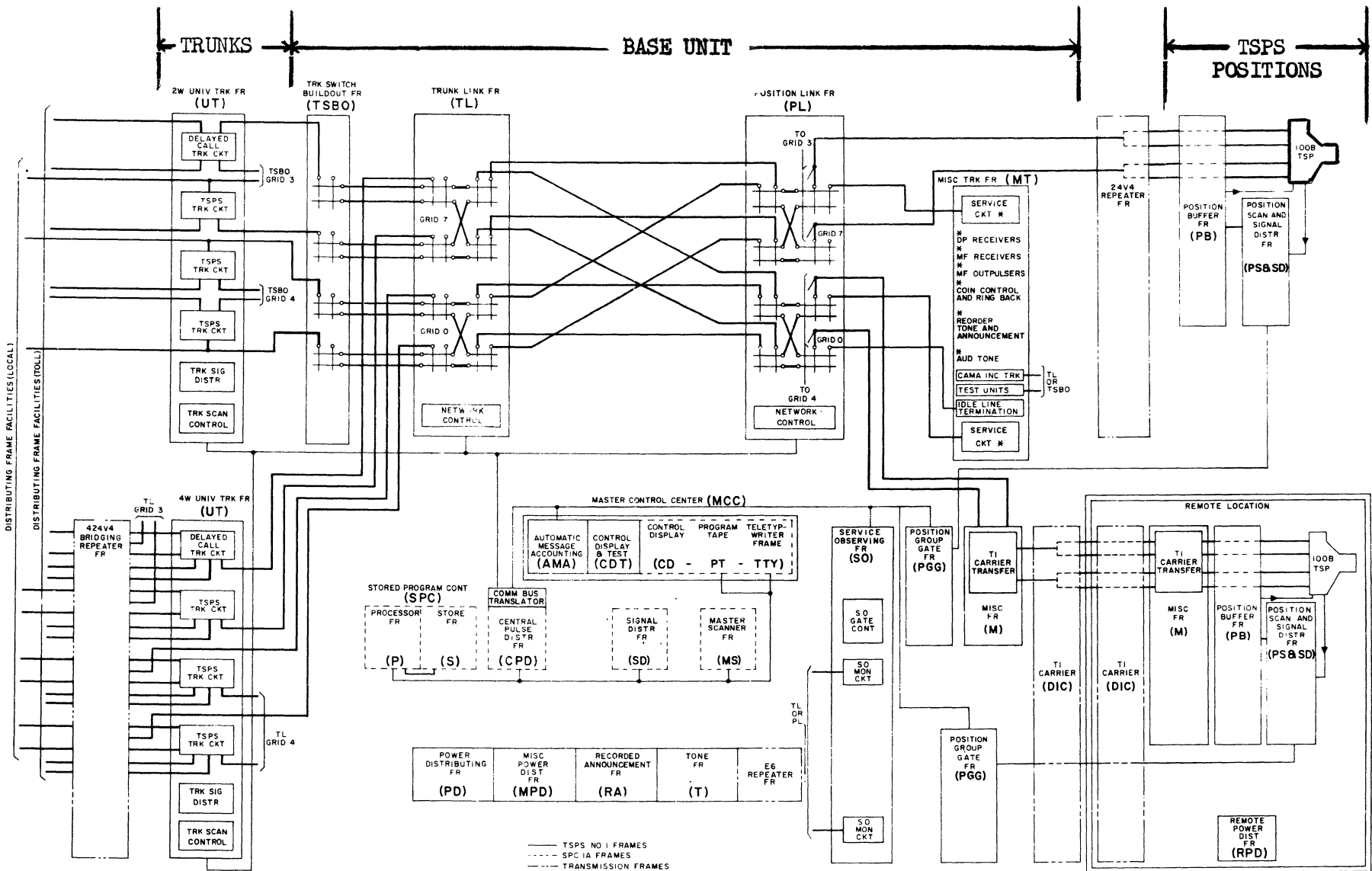


Figure 13-2 TSPS No. 1 Equipment Block Diagram

chapter. It is by means of these switches that a trunk line becomes connected to a TSPS position or to any of the Service circuits in the Miscellaneous Trunk frame. The switches are selected and controlled by the SPC No. 1A equipment.

13.6 THE SPC NO. 1A EQUIPMENT

The TSPS No. 1 system employs a store program method of control similar to the one used in the No. 1 Electronic Switching System (No. 1 ESS). This method of control, called the Stored Program Control No. 1A (SPC NO. 1A) System, was designed not only for the TSPS No. 1 system, but also as a device for improving the operation of certain other switching systems such as No. 5 Crossbar, 4A and 4M Crossbar, etc.

The SPC No. 1A equipment is basically an electronic digital computer containing a memory which in turn contains procedural, system maintenance and suitable application programs. The memory also serves as a "scratch pad" for the recording of any data either permanently or temporarily. Additions and changes in the basic service can be introduced primarily through program modifications rather than by re-wiring or by making hardware changes. Thus, the installation is able to have a large degree of flexibility.

The basic unit of the memory (referred to as the "store") is the Piggyback Twistor (PBT) which provides for the storage of information. This information can be "read" by the associated control equipment repeatedly, and can also be changed (by "writing" into the "store") by the same control equipment. The Programs (contained as information in the memory) consists of a logical sequence of instructions which when decoded one at a time by the control equipment (the Processor) will cause certain equipment action only if the conditions at that moment require the particular action to take place.

The Processor is the center of all control activities. As it executes each program instruction it monitors and controls peripheral equipment by operating on data temporarily stored in memory. It then transmits the resulting output to the peripheral equipment as orders or commands, which in turn causes the proper action to take place in the Switching Networks, the TSPS positions or anywhere else in (as directed) the system. The Processor therefore, in accordance with the instructions and data stored in the Piggyback Twistor memory, either directly or indirectly controls the operation of every circuit in the system.

Two identical Processor frames are used for continuous parallel operation from duplicated Stores (memory). Both Processors perform the same routines simultaneously but only one (either one) is always actively in control. High-speed matching of the information in each of the two Processors provides the major means for the automatic detection of any equipment troubles.

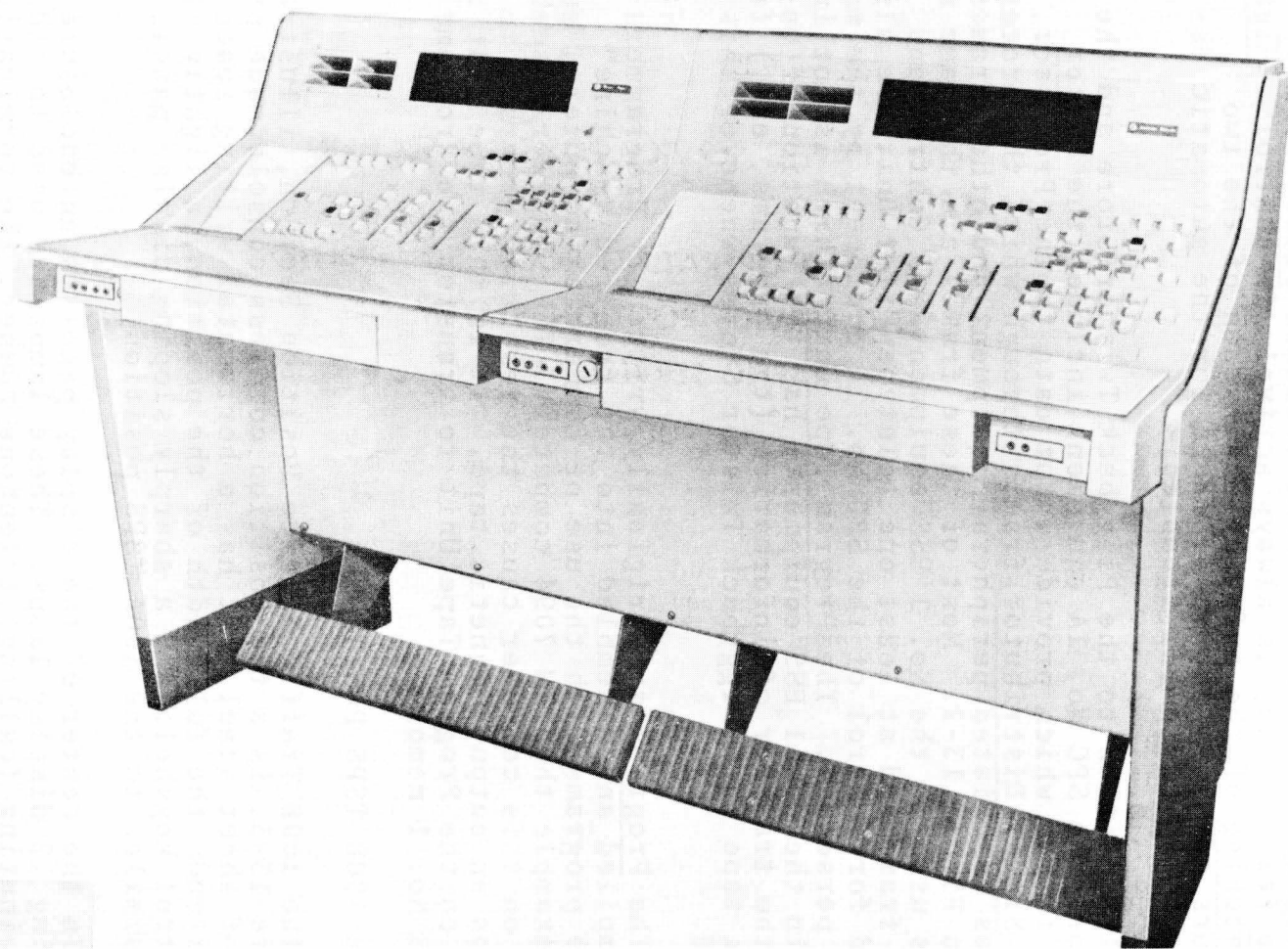
In addition to the Piggyback Twistor Store and the Processor, the SPC No. 1A equipment includes the Master Scanner frames which provide input data to the Processor, and the Signal Distributor frames through which the processor activates associated peripheral equipment and other frames shown on Figure 13-2. Most of these frames are the same as the ones used in the No. 1 ESS equipment. A Control and Display frame and at least one teletypewriter unit are also included for control of the SPC No. 1A equipment by the maintenance personnel. The Program Tape Unit (which is not included in the No. 1 ESS equipment) has the function of enabling the transfer of information (the programs, etc.) from magnetic tape into Piggyback Twistor Stores whenever this is required.

The Programs are originally written by Programmers and then compiled and assembled into the required "machine" language programs with the use of commercial computers, such as for example the IBM 7094 computer. The Compiler-Assembly process on this computer causes the resulting programs to be stored on an output magnetic tape. It is this tape that is mounted on the Program Tape Unit to transfer the Programs into the TSPS No. 1 memory.

13.7 THE 100B TSPS POSITION

The 100B Traffic Service Position Section, illustrated in Figure 13-3, is a two-position cordless console made primarily of sheet steel. It has a horizontal writing space which extends the full width of the position, a lightly sloping control keyshelf and a sharply sloping display panel, and is similar to the 100A TSPS position.

In the center of the display panel is an enclosure containing 12 display lamps. These lamps are used to indicate the originating (calling) telephone number, the termination (called party) telephone number, the charging rate for the call, the elapsed number of minutes, the time of the day, a special billing number, a hotel serial number or any other data which is obtainable from the Base Unit.



13.10

Figure 13-3 100B Traffic Service Position Station

To the left of the display lamps is a four-compartment ticket box which is used to hold "mark-sense" (data cards for processing by automatic optical scanning equipment) toll tickets. This holds new and completed tickets. Three single-compartment boxes on the keyshelf hold tickets for calls that are in progress. Thus each of these ticket boxes is associated with one of the three "loops" available to the operator. A "loop" may be considered as essentially composed of the circuits and associated equipments required for the holding and processing of calls through the TSPS. By placing one of these "loops" into a "hold" status and placing the toll ticket for this call in the associated ticket box, the operator can then process another call with one of the other "loop" circuits while waiting for the results on the first call.

Each keyshelf is usually equipped with a multileaf bulletin holder which the operator may use to readily obtain traffic information.

The various keyshelf keys (buttons) and lamps which the TSPS operator uses to perform her functions are shown on Figure 13-4.

If the positions (and associated buffer circuitry) are located up to a distance of 4 miles from the Base Unit, voice and data paths are used. However, when the remote positions are located from 4 miles and up to a distance of 50 miles away from the Base Unit, T1 Carrier facilities (which are duplicated for reliability) must be used.

A group of positions (up to a maximum of 62) at a single location, and supervised by a chief operator is called a "chief operator unit." An administrative unit at the Base Unit location is responsible for the administration of all chief operator units (local and remote) in a TSPS No. 1 system.

All calls are distributed automatically to idle positions in any chief operator unit, on a rotational basis and in accordance with a certain priority. This priority depends on the number of idle "loops" available in a position. Positions with no "loops" in a "hold" status are considered (at the time the automatic assignment of the next call is made) as having the highest priority while those positions with two "loops" in the "hold" state are considered as having the least priority.

13.12

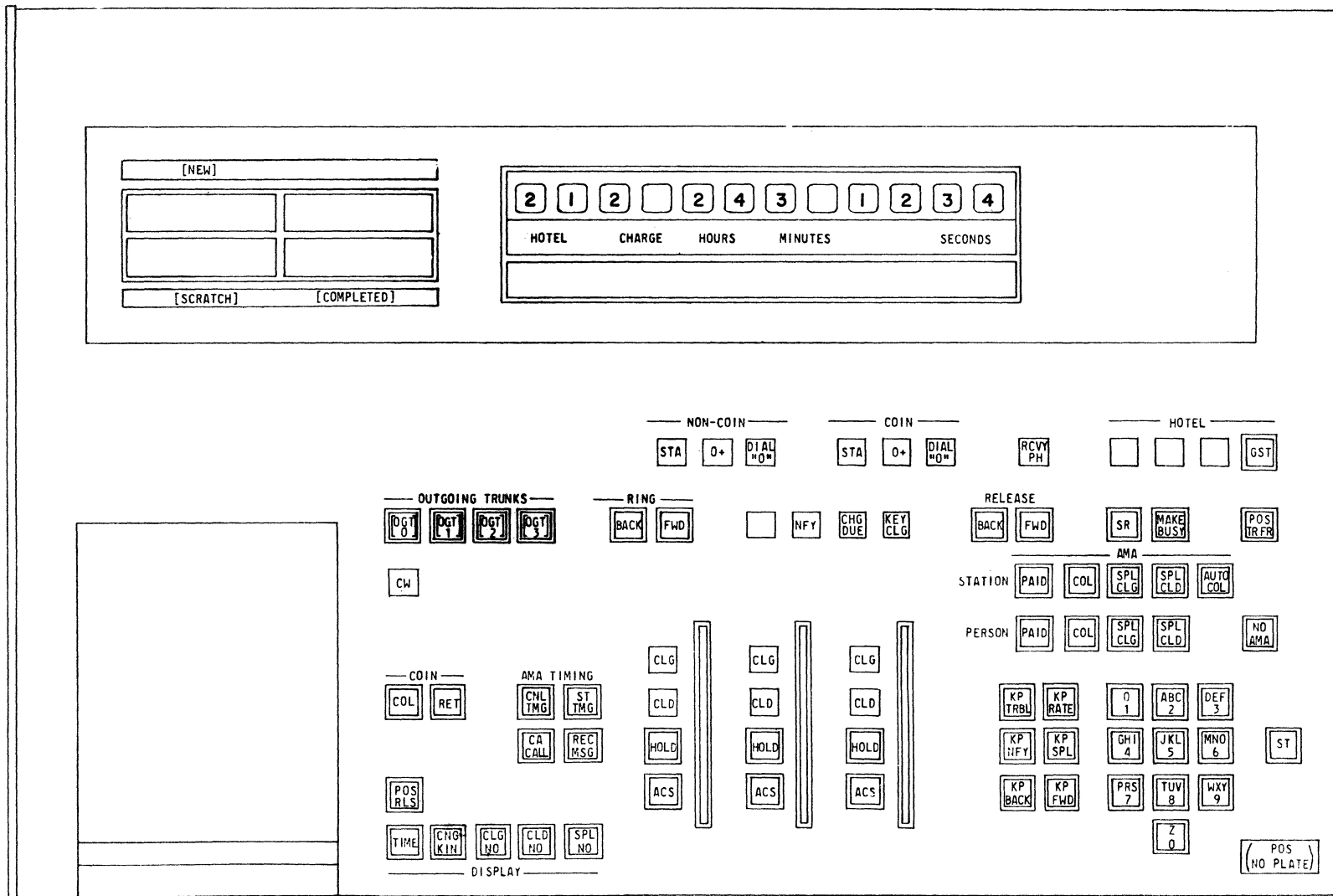


Figure 13-4 Traffic Service Position System No. 1 Keyshelf

Whenever the operator encounters a type of call which she cannot completely process, she can forward the call to a cord switchboard elsewhere by key pulsing a locally designated code. This causes the toll switching office to route the call to a cord switchboard operator which will process the call. The TSPS operator, after passing the appropriate information to the cord switchboard operator may release her position from the call by pressing the POS RLS (Position Release) key on the keyshelf.

13.8 THE CALL PROCESSING SEQUENCE

The TSPS No. 1 call processing sequence begins at the local exchange. If "0" (for Operator) is dialed (with or without the called party's telephone number dialed immediately thereafter,) or if the call (long distance) originates at a coin station, or if it is a person-to-person call, or a "collect" call, etc., it is routed via a trunk line which contains a TSPS No. 1 trunk circuit, to the toll switching office. The call is then detected by the Traffic Service Position System. The detection is accomplished by the frequent scanning of all the Ferrods in the Trunk Scanner. The SPC No. 1 control equipment, as guided by the Programs in memory, recognizes the new call by comparing the state of the Ferrod (associated with the particular TSPS trunk circuit) with its previous state as recorded in memory. This recognition causes the execution of various programs by the SPC No. 1 Processor while simultaneously executing other programs for other calls associated with other positions. If, for example, during the execution of these programs a particular call is deduced by the proper program as being a "0+" type call ("0" for Operator plus seven or ten digits dialed or pulsed immediately thereafter), and that the number will be received as dial (and not multifrequency) pulses, the control equipment quickly establishes a path through the Switching Network from the particular trunk circuit to a dial digits receiver. The function of this receiver is to recognize each dialed digit and enable the control equipment to store the entire number in memory. This, of course, must all happen rapidly so that none of the dialed digits are lost.

In a similar manner, (for a "0+" call) a path between the trunk circuit and a multifrequency pulse transmitter is established through the Switching Network. The dialed number is then automatically pulsed out to the toll switching office through this connection.

The SPC No. 1A control equipment also establishes a path through the Switching Network and automatically connects the trunk line to a TSPS 100B position which it has found idle and ready to serve the next call. The connection of the position to the new call is recognized by the Traffic Service operator by means of a tone which she hears on her telephone headset and by the lighting of various lamps on her keyshelf. By observing the pattern of lighted lamps, certain information (the type of call, etc.) is immediately indicated to her. The lighting of the lamps is caused by the SPC No. 1A equipment which analyzed the call according to the program instructions in its memory.

By conversing with the calling customer the operator is now able to render assistance as well as obtain additional information about the call. Subsequently, by pressing the proper buttons on the keyshelf, she performs the required functions which naturally vary with the type of call. Usually, this includes the entering of certain information for the recording and eventual charging of this call by the Automatic Message Accounting (AMA) equipment. If this is not applicable, she may be required to fill out a toll ticket for the same purpose. Whenever the operator is handling a call from a coin station, she may request from the SPC No. 1A equipment, automatic charging rate information. By reading the rate as revealed on the display lamps and by stating the charge to the calling customer, she then supervises the depositing of the correct amount of coins.

After all the necessary functions have been completed, the operator releases the position from the call, and is free to be automatically assigned to another call.

Each active trunk circuit has a certain area in memory devoted to the storage of all information pertinent to the particular call in progress. When the SPC No. 1A equipment, in its scanning process, detects the termination of a call, proper disconnection takes place, the original TSPS operator is reassociated with the call (if required), and the call details are transferred to a magnetic tape. The contents of this tape is later used as an input for a commercial computer process used to obtain billing and statistical information.

13.9 TYPICAL SERVICES PROVIDED

The TSPS No. 1 system provides facilities for a number of different services. Some of these are briefly mentioned below.

The TSPS operator may, whenever required, serve a Centralized Automatic Message Accounting (CAMA) operator by obtaining the necessary information from the calling party and then keying the required data into the system. This routes the information to the CAMA office over a CAMA-TSPS No. 1 trunk line where the information is recorded. However, in this case, the information is not recorded on the TSPS Automatic Message Accounting (AMA) magnetic tape.

Person-to-person calls may originate at either coin or noncoin telephones. To obtain operator assistance the customer dials "0" (for Operator) plus the called number which may include an area code. By obtaining the called person's name and then by conversing with whoever answers the called number (and possible keying out a new telephone number for connection to a telephone at an alternate location,) the operator eventually (if successful) reaches the called person on the telephone line. When the conversation between the parties begins, the operator activates the automatic charge calculation process by pressing the ST.TMG (start timing) button. She then depresses the POS RLS (position release) button which causes the call to "float" with no further attention from the TSPS operator required. A call is said to "float" when the TSPS position is disconnected from the trunk circuit after the necessary operations to establish the connection have been performed. The call is then monitored by the SPC No. 1A equipment and at the conclusion of the call, if the call had originated at a noncoin station, proper charge entries are made on the AMA magnetic tape. If the call had originated at a coin station, it may at this time be returned to a TSPS position for further operator assistance.

For Station-to-Station calls, operator assistance is usually not required except if the call originates at a coin telephone. In such a case assistance is always required for the collection of the coins. When a toll call originates

at a noncoin telephone, operator assistance is required only if Automatic Number Identification (ANI) equipment is not available in the local office. When this occurs, the calling number must be obtained by the operator so that it may be recorded by the AMA equipment.

The customer may dial "0" (for Operator) without dialing any called number. This is commonly referred to an "0-" type call. When this occurs, the operator must obtain the called number as well as the calling number (and any other required information) from the calling customer, so that the call can properly be established and the required information be recorded on the AMA magnetic tape.

To provide "Sequence Calls" service, the TSPS operator keys into the SPC No. 1A equipment the numbers of the called parties in order in which the calls are to be made. The necessary connections will then be established in sequence (one after another) by the Base Unit. Such calls may also be established on a delayed basis. For these calls, the time that the calls are to be made is keyed in by the operator. The SPC No. 1A equipment will then establish the connections at the proper time.

"Collect" calls may originate at either coin or non-coin telephones. Whenever the TSPS operator handles this type of a call, she must ask the called party if the charge will be accepted. For business purposes, an "Auto Collect Call" arrangement can be established (also known as "enterprise" calls) by which all calls to the called number are charged as "collect" calls. This arrangement enables a sponsor of a radio or television commercial to request the listeners to call a certain telephone number at the sponsor's expense.

A "Hotel" call differs from other types of calls in that it arrives into the TSPS No. 1 position as a noncoin call and the hotel or motel switchboard attendant announces it as a "guest" call. If it is to be charged to a Credit Card number, to a third number or to a Special Billing number (sometimes called a "Q/Z" call,) the operator depresses a GST (guest) button which causes a special entry to be stored in memory until required by the AMA recording of the call data.

On Credit Card calls, the operator must obtain from the customer (whether it is a hotel, coin or noncoin call) the 10-digit Credit Card number, and then by using the outpulsing buttons on the keyshelf, key it into the SPC No. 1A memory.

Similarly, on "Charge to a Third Number" calls, the operator must key in the number of the person charged. However, in this case, she must also verify if the third number customer will accept the charges.

Many other types of services and calls are possible with the TSPS No. 1 position. The inherent flexibility of the system (because of the SPC No. 1A equipment, including its memory) allows for many other possible services to become available in the future. In most cases only the changing of the existing programs or the addition of new programs in the memory of the system will be required in order for the TSPS No. 1 positions to handle the additional services.

CHAPTER 14

AUTOMATIC MESSAGE ACCOUNTING

14.1 INTRODUCTION

The Bell System serves upwards of 87 million telephones and completes over five billion long distance conversations a year. In dealing with quantities such as these, it does not take much imagination to appreciate that the accounting and billing problems are great. To carry on such a business the collection of earned revenue becomes most essential, and before this revenue can be collected bills must be prepared and presented to the customer. It is in the preparation of the data that is to be presented on the bills that Automatic Message Accounting (AMA) concerns itself.

Telephone Companies have unique problems in preparing bills. They sell tailor-made service items to millions of customers. Each service item consists of putting temporarily at the customer's disposal, an impressive physical plant, and a skilled human organization to enable him to communicate at will with his family, friends or business associates, whether they be just around the corner or thousands of miles away. A very large proportion of these service items are of truly low price. Although the Bell System is a multibillion dollar concern, much of its revenue is derived from service items, a great many of which cost only 30, 25, 20 cents or even less. There are, of course, toll calls that cost several dollars, but even these fall in a group which can be classified as low price service items. What runs up the system's total annual revenue into hundreds of millions of dollars is the enormous volume of these low priced service items. Therein lie the problems of recording, accounting for, and billing the customer.

14.2 AUTOMATIC MESSAGE ACCOUNTING (AMA)

A. BACKGROUND

Within the past few years, most of the lines within the Bell System have been integrated into the AMA system. This system records all the data required to charge for subscriber-dialed toll and many subscriber-dialed local message rate telephone calls and to mechanically process the records in accounting centers. Both the recording and processing arrangements employ many novel circuit and apparatus components. The use of the system permits

the wide expansion of direct subscriber dialing to nearby and more remote points, with resultant increased speed, and convenience to telephone customers. Although AMA is the first system to carry out automatically both recording and accounting for toll calls, it is not the first step in this direction, but is rather the culmination of a long line of developments.

During the early years of the telephone, subscribers were charged exclusively on a flat monthly or yearly basis; but since the end of the last century, message rate service has been available in many of the cities. Initially, the record of such calls was in the form of tickets prepared by operators. This method was later supplemented by the use of a small electromagnetic counter, called a message register, associated with each message rate line and operated once for each call made. As the metropolitan areas grew larger and subscribers began to call regularly beyond their local areas, zone registration was adopted. It provides circuits that, on each call beyond the local area, operate the message register the proper number of times to represent the cost of the call. Thus, if the charge on a call is 20 cents and each message register operation represents a charge of five cents, the register would be operated four times for this particular call.

Although zone registration is an economical method of charging for short calls, it does not leave any record of the details of the various calls. For calls requiring more than five message register operations, it has generally been felt desirable to have a record not only of the point to which the call was placed but of the day and time it was made. To secure such a record, and at the same time to obtain the economies and increased speed possible from automatic operation, automatic ticketing arrangements were developed. With this system a ticket is automatically printed for each chargeable call, and thus all essential information pertaining to the call is permanently available.

The printing of a toll ticket is only part of the work of charging for calls. Before subscribers can be billed for their calls, the tickets must be brought together and sorted out for each subscriber, computed, and totaled; from this data the bill is prepared. This work is extremely laborious and represents an appreciable item of expense.

It was recognized that the entire process of re-recording calls and preparing the customer's bills could be done mechanically but considerable development was required to make possible an economical automatic message accounting system.

B. GENERAL OPERATION

In the AMA system, the information pertaining to all calls requiring a charge is perforated, in code, on an oil-impregnated paper tape three inches wide. A specimen of the section of the tape after perforation is shown in Figure 14-3. There is space for twenty-eight holes across the tape, which is used for recording six digits in coded form, each representing a single item of information. Adjacent rows are about one-tenth inch apart, and either four, six, or seven rows of information are required per call. The items of perforated information are automatically read and interpreted at the accounting center at a rate of 150 digits (25 reader cycles) per second.

The perforating machines, see Figure 14-1, are installed in cabinets. They are associated with the outgoing trunks in the No. 5 Crossbar and No. 1 Step-by-Step systems, with the district junctors in the No. 1 Crossbar system, or with the incoming trunks of tandem and toll switching systems. One recorder serves 100 trunks or district junctors. Together with their associated equipment, they are installed in the individual telephone central offices. Each day at about 3 a.m. the tapes in all the recorders are automatically prepared for cutting by perforating a readily recognized pattern to indicate the section where the tape is to be manually cut. After cutting they are transported to the accounting center for processing. This accounting center may handle the tapes from many central offices and may be remote from any of them.

Since each tape from a recorder includes the information for all calls handled by a group of 100 trucks or district junctors, calls from a particular subscriber may be distributed over a number of tapes, and the information for any one particular call will usually not be on adjacent lines of the tape. Some of the information is recorded as the call is dialed or shortly thereafter, but the time the called subscriber answers, which is the beginning of the charge period, is somewhat later; in the meantime information relating to other calls may have been recorded on the same tape. The time the conversation is

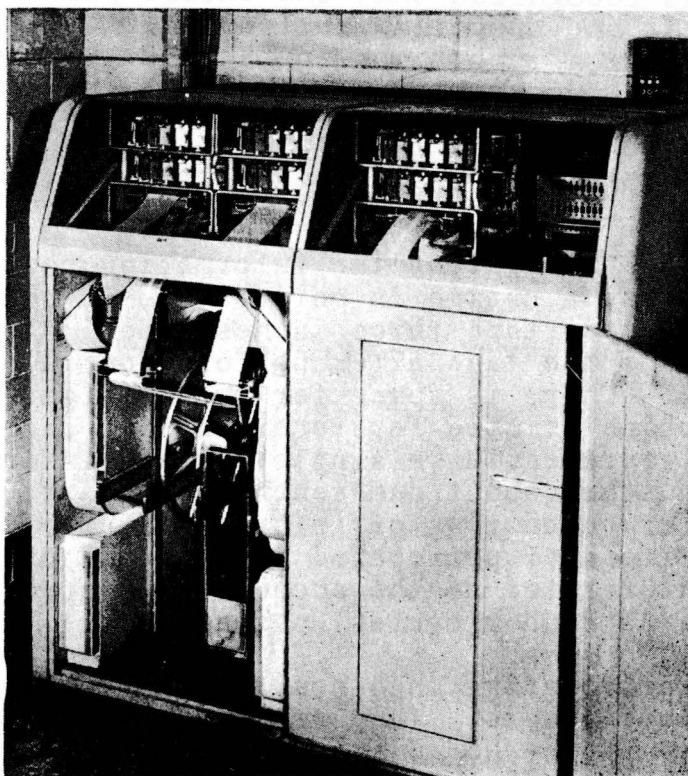


Figure 14-1 Two Tape Perforators

completed will, in general, be considerably later, and thus there will be information pertaining to any calls between the beginning and the ending of any particular call. Each tape, moreover, will include information on calls that are charged for in entirely different ways. For calls that are billed in bulk (message unit basis) it is not necessary to record the office and number of the called subscriber, since the duration of the call and other billing information provided in the call record is sufficient to determine the charge. This type of call requires only four lines on the tape, while six or seven lines are required when information pertaining to the called subscriber must be recorded.

At the accounting centers, all information pertaining to each call is gathered, conversation time is computed and the type of call, (toll, message unit, bulk billed, special) is noted. A printed or punched card with this information is then produced for each subscriber.

C. AMA TAPE FEATURES

In the central offices, recorders perforate, on paper tape, the records of calls routed over trunks arranged for AMA operation. Central office circuits are arranged to provide these recorders with the information required for determining the proper charges for each message. In order to control the processing of this information at the accounting center, the recorders are assigned in recorder groups. A section of tape produced by a central office recorder and its interpretation is shown in Figure 14-3.

It should be noted in Figure 14-3 that a "line" of information actually consists of the alternate holes of each of two adjacent rows. This arrangement permits a greater compactness of perforator equipment than would otherwise be possible. Figure 14-2 shows the staggered arrangement of the plungers for perforating the paper tape. However, the type of diagram representing the information as being on a straight line shown in Figures 14-5, 14-6 and 14-7, is used to simplify the discussion.

The "2 out of 5" code used to represent the call information on the tape is explained in Figure 14-4, the lower box illustrating a typical line of information.

The information for each message is recorded in three main parts on the paper tape in the following manner.

1. Initial Entry

After a subscriber completes dialing a call an initial entry is recorded on the paper tape. (See Figures 14-5, 14-6 and 14-7.) This entry consists of a series of consecutive lines containing information about the calling subscriber, and if needed, similar information about the called subscriber. The last line of an initial entry contains, in addition to other information, a 2-digit code known as the call identity index which identifies the trunk used for this call, and may be any number from 00 to 99. This index, which will be the same for each of the three recorded elements of a message, is used later in the accounting center to associate these elements to compute chargeable time.

2. Answer Entry

When the called subscriber answers, a second entry, called the answer entry, is made by the same recorder on the same tape. (See Figures 14-5 and 14-6.) This entry consists of a single line and contains the tens, units, and tenths of minutes of the hour in which the call was answered, and the call identity index. An Hour entry is recorded on the tape at the beginning of each hour and applies to all subsequent calls until a new hour entry is recorded. Day entries, in like manner, are recorded once a day. The day entry is made at 3 a.m. with the splice entry.

3. Disconnect Entry

When the call is terminated, a third entry, called the disconnect entry, is perforated on the tape. (See Figures 14-5 and 14-6.) This entry is also a single-line entry and contains the tens, units, and tenths of minutes of the hour in which the message was terminated, and the call identity index.

A central office equipment arrangement is available whereby on single message unit (SMU) non-overtime calls, only the initial and answer entries are recorded.

4. Other Entries

In order to insure, as far as possible, smooth and correct accounting center processing of the charge information recorded on the tape, there are numerous other entries perforated on the tape, when required. Information that is common to all messages from a particular central office is perforated only at the beginning and end of the central office tape. Typical of these are the entries denoting the month, day, and recorder number. An hour entry is perforated every hour on the hour, and later aids in correctly timing and associating the correct hour with each message. Cancel entries are perforated, when necessary, which later instruct the accounting center machines how to proceed when certain irregularities are encountered.

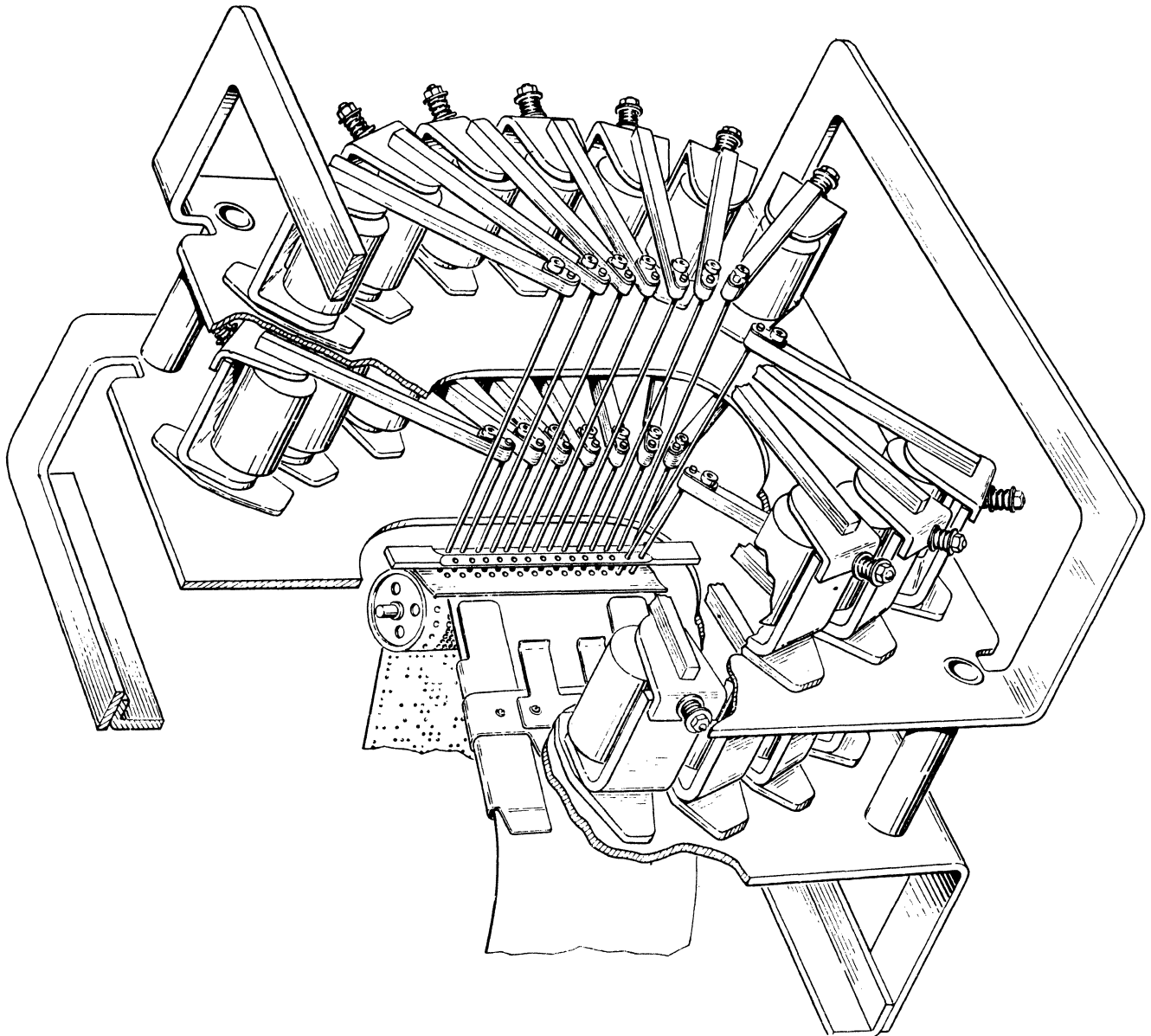


Figure 14-2 Broken Away Perspective View of the Perforator

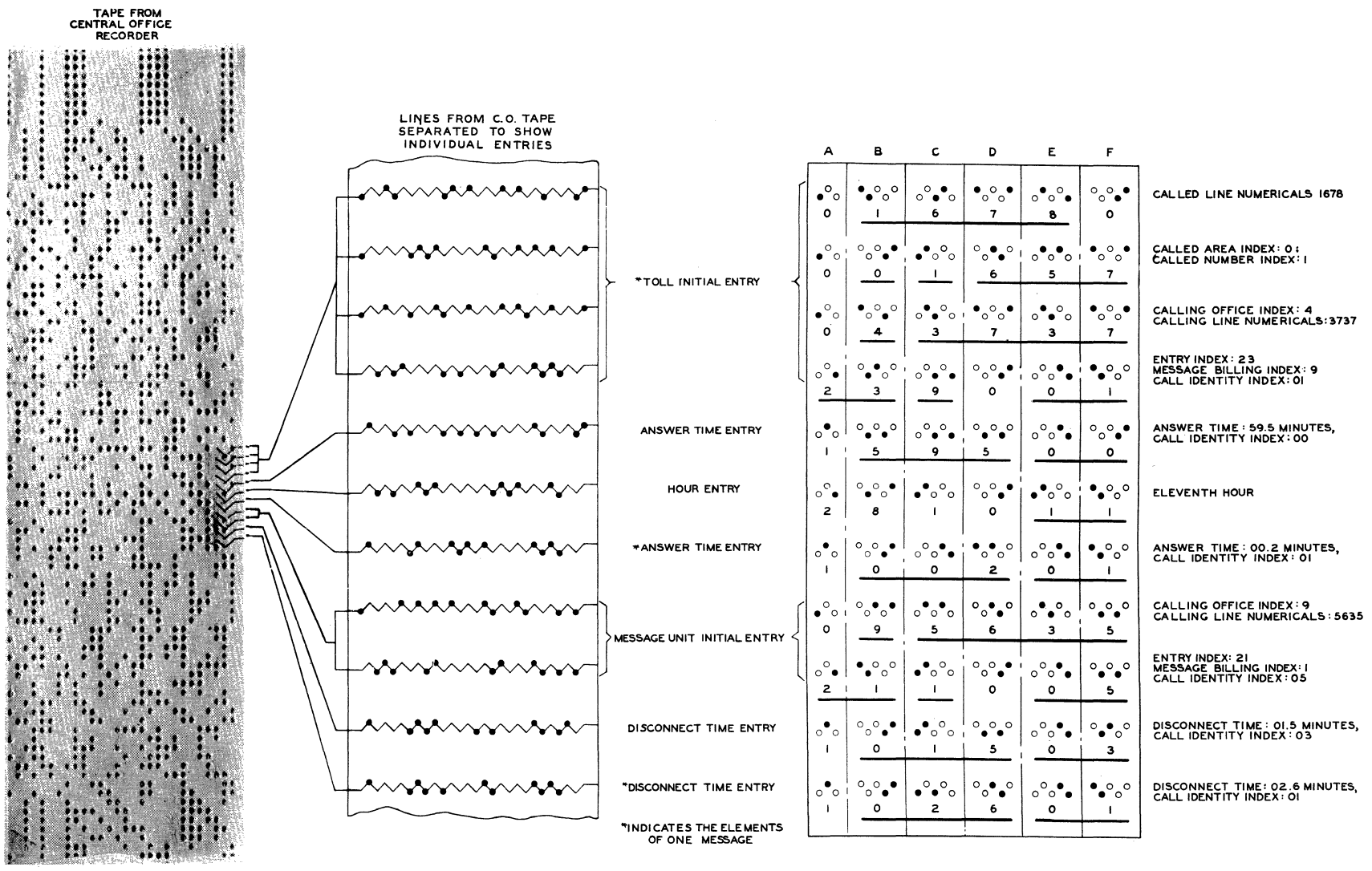


Figure 14-3 AMA Central Office Recorder Tape

A DIGIT CODE

NUMBER RECORDED ON TAPE	HOLE POSITION PERFORATED	APPEARANCE OF A DIGIT		
		0	1	2
0	0	●	○	○
1	1	○	●	○
2	2	○	○	●
3	0,1 AND 2	●	●	●

B TO F DIGIT CODE

NUMBER RECORDED ON TAPE	HOLE POSITIONS PERFORATED	APPEARANCE OF B,C,D,E AND F DIGITS				
		0	1	2	4	7
0	4,7	○	○	○	●	●
1	0,1	●	●	○	○	○
2	0,2	●	○	●	○	○
3	1,2	○	●	●	○	○
4	0,4	●	○	○	●	○
5	1,4	○	●	○	●	○
6	2,4	○	○	●	●	○
7	0,7	●	○	○	○	●
8	1,7	○	●	○	○	●
9	2,7	○	○	●	○	●

TYPICAL ENTRY LINE REPRESENTING 239041

DIGIT DESIGNATION	A	B	C	D	E	F
LOCATION OF PERFORATION	0 1 2 ○ ○ ●	0 1 2 4 7 ○ ● ● ○ ○	0 1 2 4 7 ○ ○ ● ○ ●	0 1 2 4 7 ○ ○ ○ ● ●	0 1 2 4 7 ● ○ ○ ● ○	0 1 2 4 7 ● ● ○ ○ ○
NUMBER REPRESENTED	2	3	9	0	4	1

Figure 14-4 Codes Used to Represent Numerals in AMA Recording

D. CALL IDENTITY INDEX

A group of recorders may have a maximum of 10 or 20 recorders depending on the type of switching equipment employed at the recording office. Each recorder can serve up to 100 separate trunks, with each trunk having a different call identity index assigned to it. After a message is terminated, the trunk over which the message was routed, together with its call identity index is then available to serve another call. While the entries for a particular message will be in time order on the tape, the recording technique may result in the entries for a number of calls being interleaved. It is through the use of the call identity index that the accounting center equipment is able to separate and properly associate the respective elements of each message.

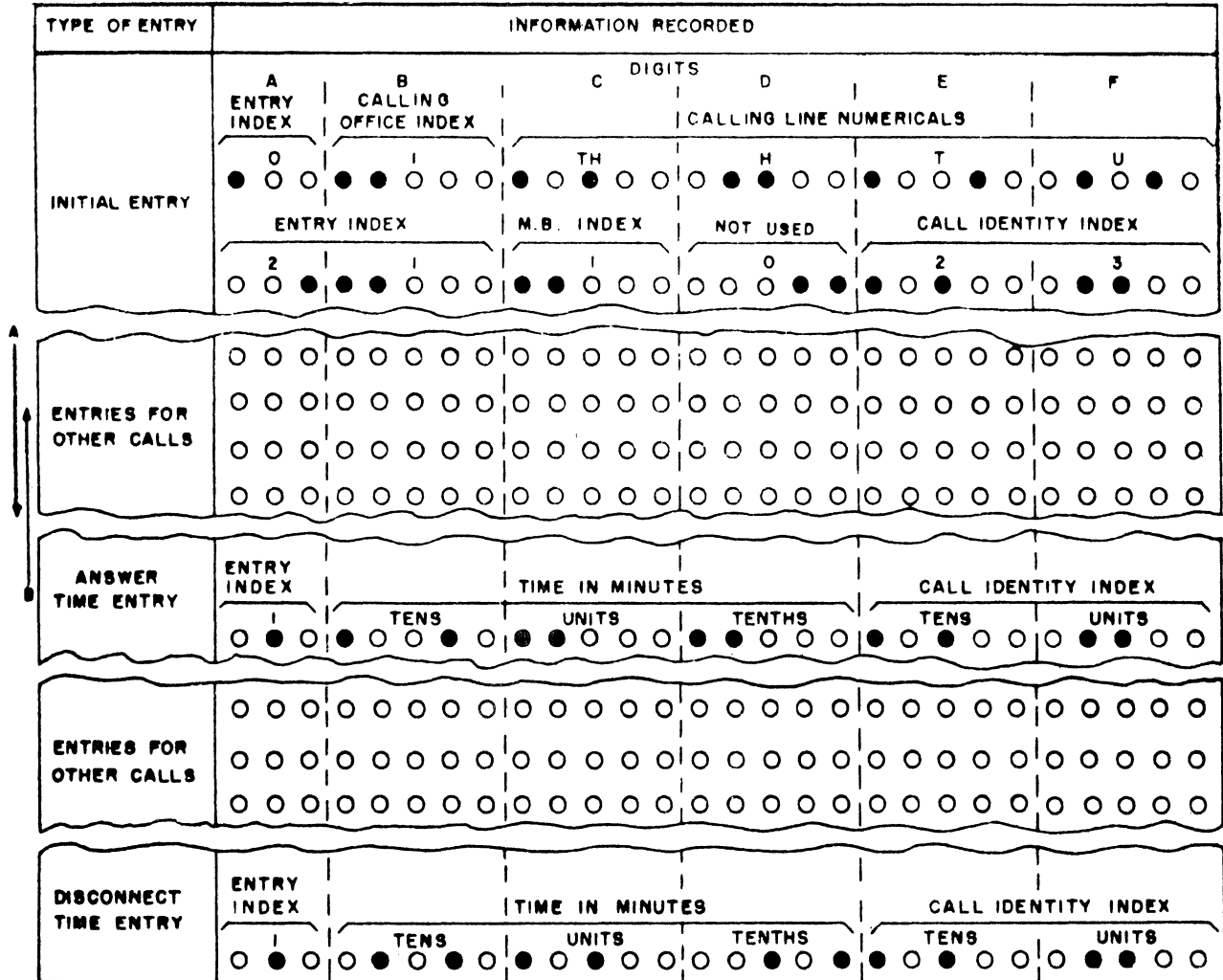
At the end of each day, or several days if a weekend is involved, the tapes from all recorders in a recorder group are cut and forwarded to the accounting center, see Figure 14-16. Collectively, these tapes provide all the information required for the billing of AMA recorded customer dialed, chargeable messages (completed calls).

E. TYPES OF AMA MESSAGES

AMA recorded messages presented to the accounting center fall into two main categories; one type of message is charged on the basis of message units and ultimately bulk-billed to the customer, and the other type is itemized individually on the subscriber's toll statement and referred to as detail-billed messages. These two types of messages are considered separately in the following paragraphs.

1. Bulk Billed Messages

Message unit messages which are bulk-billed to the customer are charged for in terms of message units. These are usually calls made to a point within the local service area of the calling station. Consequently, the accounting center equipment must convert chargeable time to the equivalent number of message units. These machines accomplish this through the use of (1) the message billing index recorded with each message and (2) the chargeable time in minutes for the message, as derived by the computer or



NOTES:

1. ENTRY INDEX 21 SHOWS THAT THIS IS AN INITIAL ENTRY OF 2 LINES.
2. MESSAGE BILLING INDEX 1 SHOWS THAT THIS IS A MESSAGE UNIT CALL.
3. CALL IDENTITY INDEX OF THIS CALL IS 23.
4. CALLING LINE NUMERICALS ARE 2345.
5. CALLING OFFICE IS DESIGNATED AS OFFICE INDEX 1 OF THE RECORDER GROUP.
6. ENTRY INDEX 1 INDICATES THE TIMING ENTRIES OF THE CALL.
7. SINCE DISCONNECT TIME IS 52.9 AND ANSWER TIME IS 41.1 ELAPSED TIME IS 11.8 MIN.

- A. DIRECTION OF TAPE MOVEMENT DURING READING OPERATIONS AT THE AMA CENTER.
 B. DIRECTION OF TAPE MOVEMENT DURING PERFORATING OPERATIONS AT THE CENTRAL OFFICE.

Figure 14-5 Message Unit Call Entries on Central Office Tape

assembler-computer. The initial entries of these messages consist of two consecutive lines of information on the central office tape, except service observed (OBS) and message unit entries shown at the top of Figure 14-5.

2. Detail-Billed Messages

Toll messages, as defined for AMA purposes, are usually detail-billed to the customer and are calls made to points beyond the locally prescribed message unit area. More information is required to be recorded on these than on message unit messages, resulting in a 4- or 5-line initial entry, as shown at the top of Figure 14-6 and in Figure 14-7. In addition to recording information about the calling subscriber, toll messages require the recording of the called office and called number. Also recorded is the called area index and the called number structure. The accounting center computer or assembler-computer calculates the elapsed time to the nearest tenth of a minute after the application of the appropriate timing allowance. The elapsed time is then rounded off to the next highest full minute to give chargeable time. Charges are later calculated by punched card methods and are then individually itemized on the subscriber's toll statement.

When the customer makes certain direct distance dialed (DDD) calls, a 5-line initial entry is required in order to provide for the recording of the 3-digit national area code. An example of such a 5-line entry is shown in Figure 14-7. However, by means of "code compression," calls to nine selected, frequently called foreign areas may be recorded within the standard 4-line initial entry required for a toll call. With "code compression," the 3-digit foreign area code is compressed to a single digit which can be included in the standard 4-line initial entry without resorting to the perforation of a fifth line.

In order to permit correlation of AMA data with service observing results, means are provided for recording all calls that are service observed on a separate perforator in the assembler-computer

or computer. Entries are made on this tape on all service observed calls regardless of whether they are completed or not. All service observed entries are in the detailed form.

An infrequently used feature in AMA provides for recording and processing the details of message unit calls. To do this requires central office entries similar to those for toll calls (4-line entry), and a separate perforator in the accounting center or assembler-computer for message unit detail output. The actual customer billing is on a bulk-billed basis. This arrangement is not expected to be used except in special temporary cases where local conditions appear to demand it.

F. AMA EQUIPMENT

1. Perforators

The perforator performs the mechanical job of punching the paper tape for each entry. It is furnished on the basis of one per 100 outgoing trunks or district junctors.

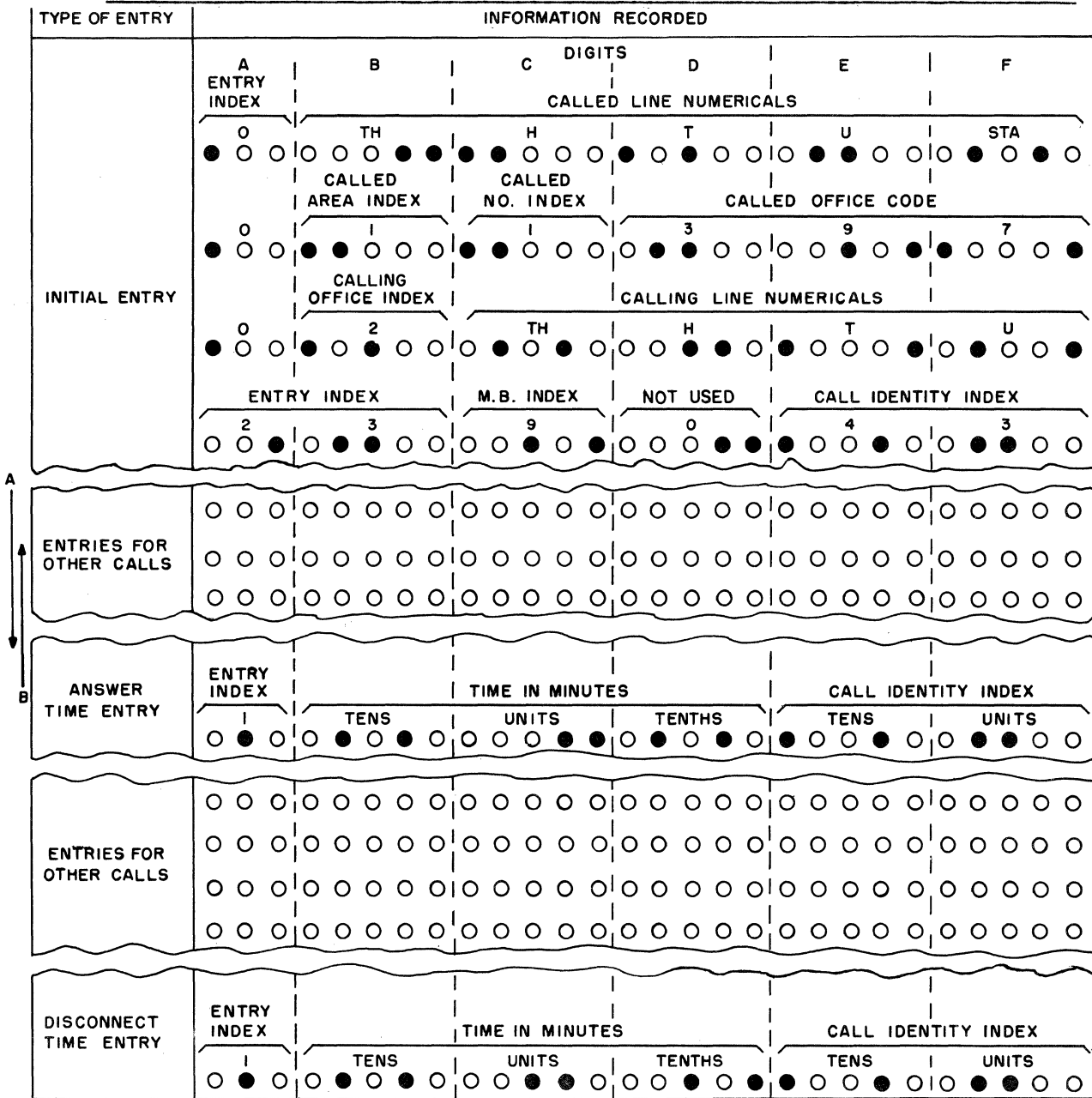
2. Recorders

The recorder controls the perforator in making the record on the paper tape. While the functions of the perforators are very closely associated with the recorders, they are furnished as separate units due to their different physical locations within the office building.

3. Call Identity Indexer

The call identity indexer identifies the one trunk or district junctor out of the group of 100 with which each tape entry is associated. The call identity indexer, the recorder and the perforator form a group to serve the associated 100 trunks or district junctors. These groups are furnished as required to serve the trunks and junctors.

CH. 14 - AUTOMATIC MESSAGE ACCOUNTING

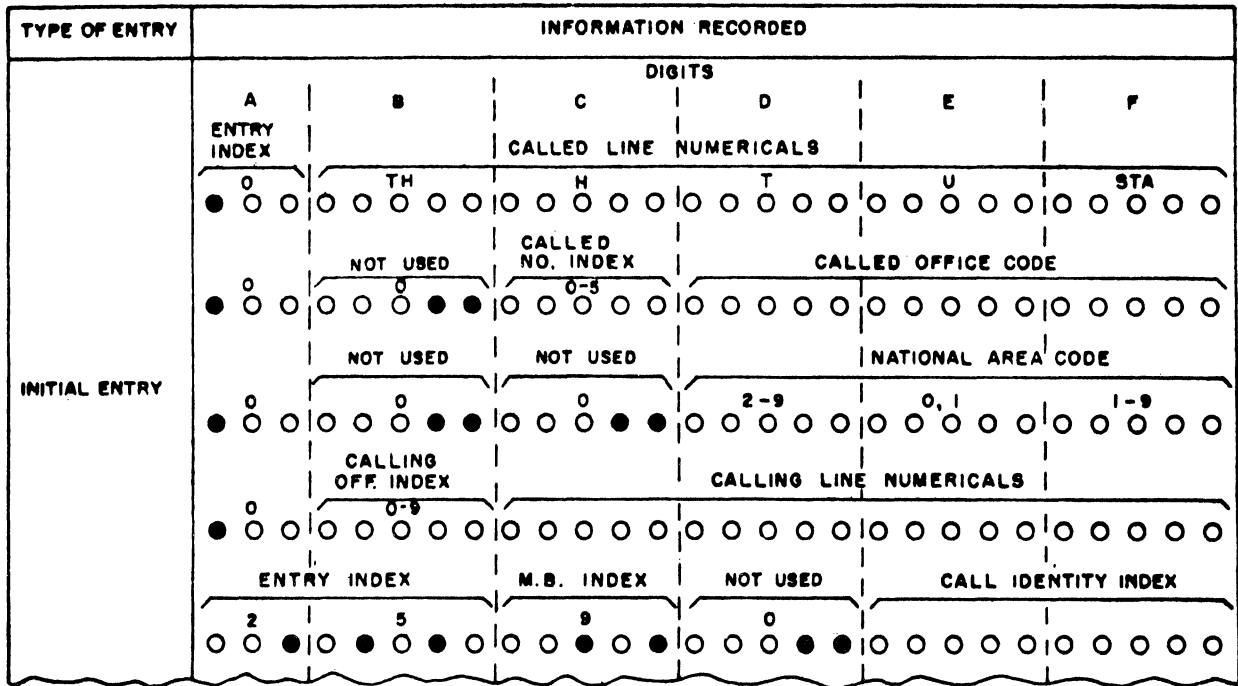


NOTES:

- | | |
|---|--|
| <p>1. ENTRY INDEX 23 SHOWS THAT THIS IS AN INITIAL ENTRY OF 4 LINES</p> <p>2. MESSAGE BILLING INDEX 9 SHOWS THAT IT IS TO BE BILLED AS A TOLL CALL.</p> <p>3. CALL IDENTITY INDEX OF THIS CALL IS 43.</p> <p>4. CALLING LINE NUMERICALS ARE 5678.</p> <p>5. CALLING OFFICE IS DESIGNATED AS OFFICE INDEX 2 OF THE RECORDER GROUP.</p> <p>6. CALLED AREA INDEX IS 1.</p> | <p>7. CALLED NUMBER INDEX IS 1 (INDICATES FOUR NUMERICALS AND PARTY LETTER).</p> <p>8. CALLED LINE NUMERICALS ARE 0123. PARTY LETTER IS J.</p> <p>9. CALLED OFFICE CODE IS 397.</p> <p>10. ENTRY INDEX 1 INDICATES THE TIMING ENTRIES OF THE CALL.</p> <p>11. SINCE DISCONNECT TIME IS 56.9
AND ANSWER TIME IS 50.5
ELAPSED TIME IS 6.4 MIN.</p> |
|---|--|

A - DIRECTION OF TAPE MOVEMENT DURING READING OPERATIONS AT THE AMA CENTER.
 B - DIRECTION OF TAPE MOVEMENT DURING PERFORATING OPERATIONS AT THE CENTRAL OFFICE.

Figure 14-6 Toll Call Entries on Central Office Tape



- NOTES:
1. ENTRY INDEX 25 SHOWS THAT THIS IS AN INITIAL ENTRY OF 5 LINES.
 2. NATIONAL AREA CODE SHOWS AREA TO WHICH CALL IS DIRECTED.
 3. MESSAGE BILLING INDEX 9 SHOWS THAT CALL IS TO BE BILLED AS A TOLL CALL.

Figure 14-7 5-Line (DDD) Initial Entry
On Central Office Tape

4. Master Timer

The Master Timer furnishes information for the timing portion of the entries. It keeps track of the time in six second intervals (tenths of a minute) minutes, hours, days and months. The one master timer frame mounts two timing circuits (odd and even) with either circuit being used to control the time entries. Every minute the two timers check each other and the recorders to see that the timing selectors are in synchronization; any indication of the lack of synchronization will sound an alarm.

5. Trouble Recorder

The trouble recorder performs a maintenance function in that as a trouble condition occurs, a punched card record is made of the equipment involved and the circuit condition within the equipment. With this arrangement the AMA equipment can be freed to serve other calls and the maintenance personnel will have a record of the trouble condition.

6. Translator

The translator's functions are essentially the reverse of the number group or block relay frames in that it translates the equipment location of the calling subscriber into his office indication and directory number. This type of translation is required by the AMA equipment so the initial tape entry can identify the subscriber to be billed. The capacity of the translator is either 1000 or 2000 tip or ring subscriber line locations; the capacity varying according to system and vintage. Translation is obtained by using the "ring" translation technique. A lead for each line location is threaded through a series of coils. When an electrical signal is pulsed through the wire, a voltage is induced in each coil that the wire passes through. This voltage is detected by the electronic circuits, one for each coil. The coils represent the units, tens, hundreds, thousands and office of the calling number.

7. Transverter

The transverter can be described as the marker of the AMA system, in that it controls the other equipment on the initial entry. The transverter receives information from the sender, as covered previously. This information along with the calling line number from the translator permits the transverter to instruct and control the recorder in making the entry.

8. Transverter Connector

The Transverter Connector interconnects the sender and the transverter, for the transfer of information. Each connector has access to all transverters and in No. 1 Crossbar offices serves 10 senders; while in No. 5 Crossbar offices, the connector serves five senders.

14.3 LOCAL AUTOMATIC MESSAGE ACCOUNTING (LAMA)

A. GENERAL

Local Automatic Message Accounting, LAMA, is a system in which recording equipment is located within the local office and serves only subscribers assigned to that office or group of offices.

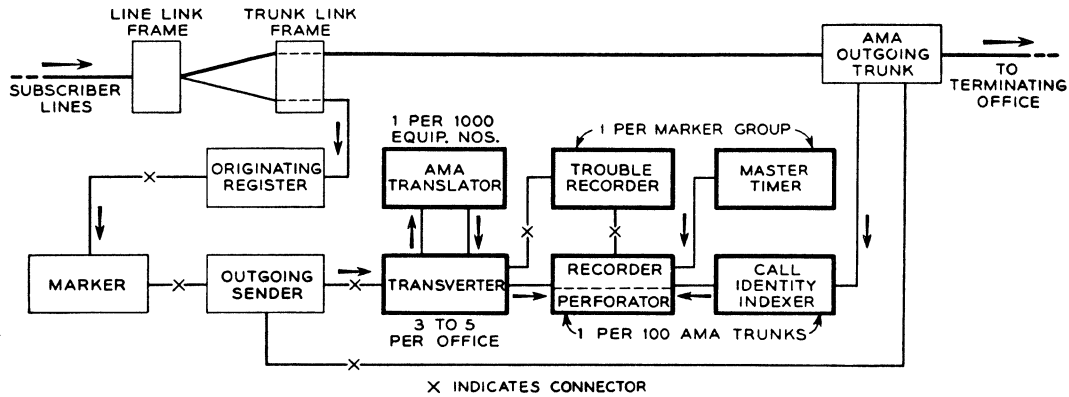
The logic circuits of the central office switching system recognize, on each call, whether the subscriber placing the call has flat-rate or message rate service; they also recognize whether the destination called is to be billed on a local (message unit) or toll basis.

Block schematics of the AMA equipment for use in No. 1 and No. 5 type of Crossbar offices are shown in Figure 14-8. Inspection of these two schematics show considerable similarity between the two systems: the difference being in the switching equipment itself.

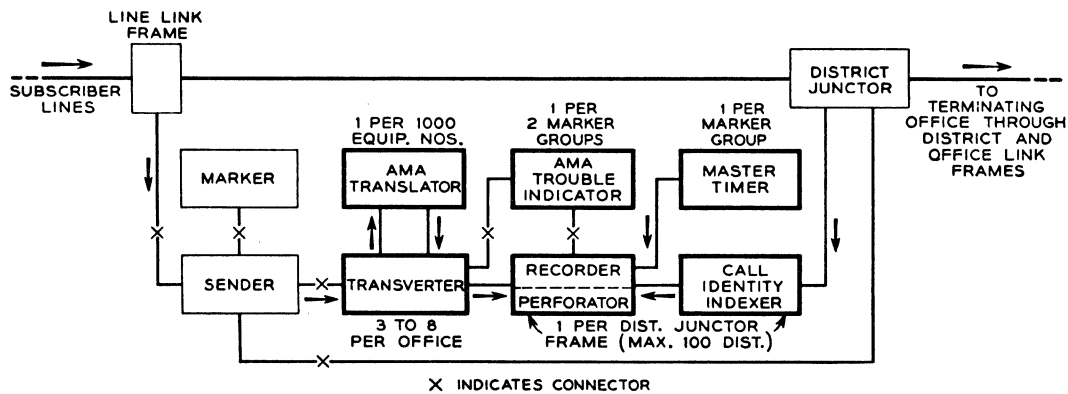
B. TYPICAL OPERATION

1. Common Control Equipment Functions

In No. 1 Crossbar offices the digits dialed by the subscriber are temporarily stored in the subscriber sender. When the originating marker performs the route relay operation, it determines from the class of service of the calling subscriber and the called office code, what charge, if any is to be made for the call. It is capable of recognizing eight different charging rates for message unit charging, message billing index 1-8. All calls for which the charging rate is in excess of these eight message unit rates are grouped into the toll call category, message billing index 9.



No. 5 Crossbar Office



No. 1 Crossbar Office

Figure 14-8 Block Diagrams of the LAMA Circuits Associated With Crossbar Offices

After the marker has informed the sender that the call requires an AMA record and as soon as the subscriber has completed dialing, the sender seizes the AMA transverter. The sender tells the transverter the message billing index, the type of entry required, the number dialed, the recorder number, as well as the line location and party identification of the calling subscriber.

The message billing index and the type of entry is obtained from the marker. The recorder number is represented by the district link number, which is needed to complete the call, since the 100 junctors of one district group are assigned to one recorder. The line location is obtained from the line link controller at the time of sender seizure. Party identification is part of the sender's function.

The No. 1 Crossbar system was designed and installed previous to the development of AMA. Therefore, circuit changes were required in order to obtain and convey the AMA information. Part of these changes could not be incorporated into the existing frames and units. Consequently auxiliary equipment is furnished to transmit the line location from the line link frame to the LAMA equipment. This equipment takes the form of a district group connector frame, a sender group connector unit, and a calling line register frame. A block schematic of this equipment is shown in Figure 14-9. This equipment is furnished as follows: one district group connector per sixteen line link frames, one sender group connector per district group, and one calling line register frame per 30 senders.

In No. 5 Crossbar offices the originating register functions as a temporary storage unit for the calling line location and class of service, in addition to its main functions of counting digits and making party identification. When dialing is completed, all of this information is transferred to the marker. The marker from its route relay operation recognizes an AMA call and determines the message billing index, type of entry required and the number of the recorder that the outgoing trunk is associated with.

When the marker selects an outgoing sender, it gives it the AMA information: message billing index, type of entry, dialed number, recorder number, calling line location, party identification, as well as all of the information needed for outpulsing. If the call is intraoffice, an outgoing sender is selected to permit the AMA record to be made even though the sender performs no outpulsing functions.

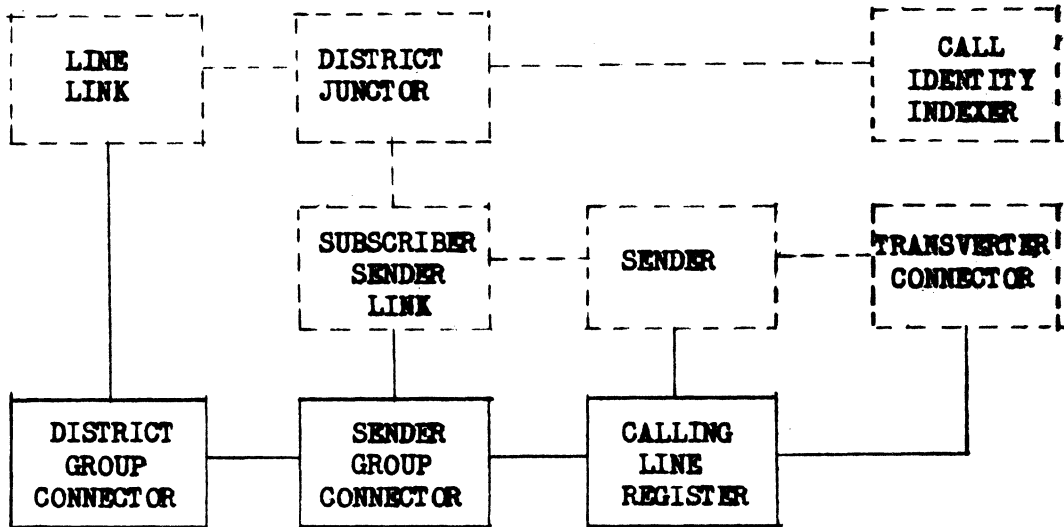


Figure 14-9 Auxiliary Equipment in a No. 1 Crossbar Office for Transmission of the Line Location

2. AMA Equipment Functions

The action of the AMA equipment is essentially the same for both crossbar systems; therefore, the following explanation will apply to either system.

As soon as the sender has stored in its memory circuits all of the AMA information and the call has progressed to the stage where the AMA entry is to be made, the sender sends a start signal to the transverter connector. The connector seizes an idle transverter and connects 120 or 150 leads, depending upon the system, from the sender to the transverter. Information that has been stored in the sender is transferred to the transverter over these leads.

The transverter by using the calling subscriber's line location and party identification, seizes the proper translator frame, signaling to it the identity of the line placing the call. The translator translates the line location into directory number information and sends this information back to the transverter. The transverter then seizes the recorder that the trunk or junctor is assigned to, and instructs it as to what is to be recorded on a 2-line, 4-line or 5-line initial entry. During the recording process, a signal for the trunk or junctor to identify itself is sent via the sender. The call identity indexer recognizes the trunk or junctor requesting identification and gives the 2-digit identity index to the recorder for entry on the tape.

The sender does not output all of the digit information until the transverter informs it that the initial entry is completed. Should trouble be encountered in the AMA equipment preventing a successful entry, the call can still be blocked by the sender. In practice, local calls are permitted to be completed without charge in case of failure in the AMA equipment while toll calls are blocked.

When the recorder completes its recording job, it signals the transverter; the transverter then releases the recorder. The transverter signals the sender that a record has been made and releases itself from the connector, making itself available for other calls.

There will be a time lapse before the called party answers. During this time the recorder and perforator can be used for entries involving any of the other 99 trunks or junctors. At the time the called subscriber answers, the off-hook signal is recognized by the trunk or junctor; whereupon it signals the call identity indexer. At this time if the recorder is idle or as soon as it becomes idle, a 1-line answer entry is recorded. The 1-line entry is a time entry showing the time in minutes, tenths of a minute and the identity index of the trunk as covered previously.

At completion of the call, the trunk or junctor will recognize the on-hook condition of the subscriber's line and again signal the call identity indexer for disconnect entry. The disconnect entry is a 1-line time entry, the same as the answer entry except for recorded time. Therefore, each completed call will have three entries, initial and two time entries; while "don't answers" will have only two entries, initial and one time entry, which will be discarded by the accounting center.

14.4 CENTRALIZED AUTOMATIC MESSAGE ACCOUNTING (CAMA)

Extended customer dialing, as provided for by the original AMA equipment, had certain limitations. For instance, there are many offices in areas where the dialable traffic to charge points is relatively light and the installation of AMA equipment would not be economical. Also, in offices actually equipped with AMA, the equipment for the automatic identification of the calling customer for charge purposes recognizes only individual and two-party customers; therefore, other multi-party customers must place their charge calls through an operator. In the existing dial offices of the panel type, the design of LAMA equipment would prove rather costly and, even if available, might well be prohibited by the lack of floor space in the existing office. Centralized Automatic Message Accounting (CAMA) was developed to care for these subscribers that could not be served by LAMA. This system locates the recording equipment in a central location which serves a number of central offices.

CAMA arrangements were initially available in crossbar tandem offices on a PCI basis only. PCI pulsing was available from Panel, No. 1 and No. 5 Crossbar offices; thus, the maximum number of lines was served by this type of pulsing.

Dial Pulsing and Multifrequency pulsing is now available for the tandem offices. The CAMA technique has been expanded to other systems, No. 4 (type) Crossbar, No. 5 Crossbar, and intertoll SXS offices. Also, any type of local mechanical office can be handled by a CAMA system.

In addition to the work functions of LAMA, CAMA has other problems to solve. In LAMA the equipment must be able to identify a maximum of ten calling office designations. CAMA has the additional problem of identifying one of a possible 20 recorder groups with a maximum of 200 originating

offices. These offices may have widely differing rate treatments even though the actual charge on a particular call is one of 13 message billing indexes. Two central offices, for example, may have identical rates on calls to 25 other offices but different rates on calls to the 26th, and the CAMA equipment must provide for the various combinations. Identification of the calling customer, of course, is necessary for proper billing. There are two techniques used to identify the calling subscriber. The first method used is operator identification. The second method is automatic and is covered under the heading, Automatic Number Identification.

The charging rate (billing index) is obtained from the billing indexer frame. In this frame the originating point of the call is compared with the destination of the call, as well as the rate treatment of the calling subscriber, to determine the message billing index number (0-12). While the function of the billing indexer is closely related to the transverter circuitry, the physical size and cost of the billing indexer exceeds the transverter. Since the operating time of the billing indexer functions is a fraction of the transverter operating time, fewer billing indexer circuits can be furnished by separating them from the transverters. Twelve transverters, which is the maximum size of a transverter group, can be served with three billing indexers.

The identification of the calling subscriber as it was done initially, and still is in many offices, was accomplished by the CAMA office setting up a connection to an operator before seizing the transverter. The operator requests the number of the calling subscriber's telephone from the party originating the call. This number is keyed into the sender for transfer to the transverter. Considerable operator effort is saved since she does not make out a ticket, obtain routing, select a trunk, time or supervise answer and disconnect of the call.

In order for each sender to have access to a CAMA operator for obtaining the calling number, position link circuits are furnished. Each position link frame has capacity for 40 senders and 100 positions. If more than one frame is required for sender capacity, each frame has access to the same positions. The links through the position link frame are established on crossbar switches by the controller. Provision is made so that during a light load period one operator does not receive the majority of the calls while others are idle.

A. CROSSBAR TANDEM CAMA

The block schematic for the CAMA portion of the crossbar tandem office is shown in Figure 14-10. The call is received and routed through the office in the normal manner. Near the end of the incoming pulses the sender sends a signal to the position link requesting connection to an operator position. This signal is started so the operator position is seized by the end of pulsing. A lamp indication informs the operator that she has a call connected to her position. After the operator has asked for and received the calling subscriber's number, she key-pulses this number into the sender.

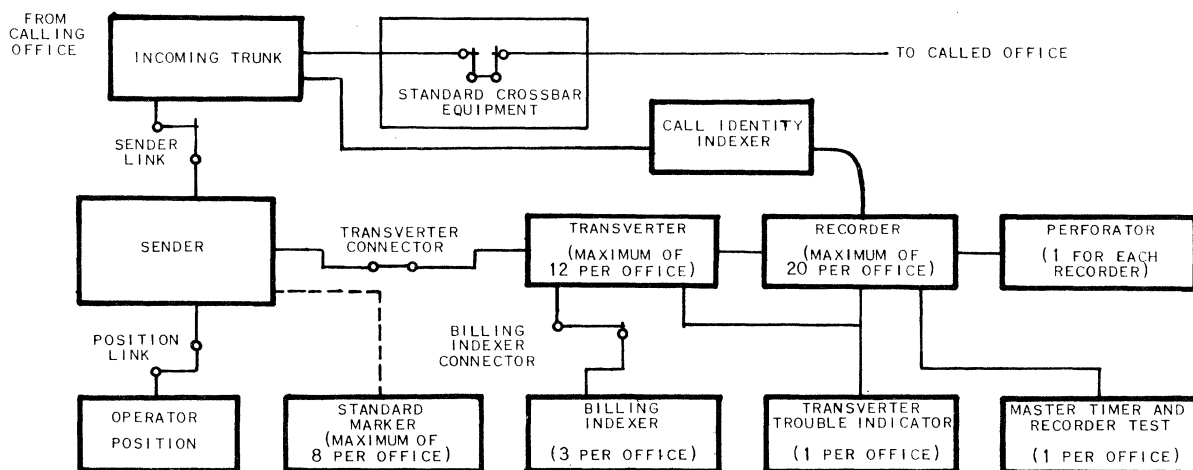


Figure 14-10 Block Diagram Illustrating the Operation of CAMA Equipment in a Crossbar Tandem Office

The sender has now been connected to a transverter. The transverter compares the calling and called number. If they are the same, a reorder signal (flashing lamp) is returned to the operator. Since this indicates that the customer has mistakenly given the called number, the operator again requests the calling number and keys this number into the sender. If the transverter had found that

the two sets of numbers it receives are different, as they should be, it will instruct the sender to release the connection to the operator and proceed to make the initial entry.

The transverter seizes a billing indexer in order to obtain the billing index and type of entry. The remaining operations are the same as in a local office; in that the transverter seizes a recorder for recording the initial entry and causes the call identity indexer to identify the trunk.

Operation with local step-by-step offices, without common control, differs in the method of receiving pulses; however, the AMA operation remains the same. When the tandem office is receiving pulses from a common control type of office, the transmission of pulses is not started until the tandem sender is connected to the incoming trunk. When the tandem office receives pulses from direct control offices, the sender must be attached during the interdigital timing interval, unless the subscriber has been instructed to wait for second dial tone. This connection may require a longer period of time than the interdigital time of the calling subscriber's dial pulses and could cause the sender to miss some of the digits, in all, or in part.

Incoming registers are used on trunks incoming from these local step-by-step offices. By-link paths are established between the trunk and register to avoid missing any of the dial pulses. When the regular link path is established, it parallels the by-link path, which was established very quickly after trunk seizure. The by-link path is now released. The first three digits are stored in the incoming register. By the time the incoming register has recorded the third digit a connection has been established from the trunk to a DP sender. The first three digits are transferred from the register to the sender and the call will now proceed the same as other CAMA calls. A partial block schematic for this portion of a call is shown in Figure 14-11.

B. #4 TYPE CROSSBAR CAMA

Figure 14-12 is a partial block schematic showing the CAMA circuits in a #4A Crossbar office. Inspection of this figure will show the same equipment, by name, is used in the #4A office as is used in the tandem CAMA office, except for the addition of the trunk class translator.

In crossbar tandem the class of the trunk and the recorder number are obtained from the trunk and given to the sender for temporary storage. In #4A Crossbar the trunk class translator makes this translation and gives the class information to the decoder and translator at the time it is required, relieving the sender of this storage function.

Another difference in operation from tandem is in the incoming register and incoming sender. The CAMA sender is of the MF pulsing type. If the local office is capable of sending MF pulses the local office will pulse directly into the sender. If the local step-by-step office is not equipped with senders, the DP incoming register is required. This register and associated register link is of the by-link type for quick connection to the trunk. Instead of receiving only the first three digits the register receives all the digits and then when connected to a sender through the trunk, transmits the digit information to the sender by MF pulsing.

The trunk class mark, which is needed for routing as well as by the billing indexer, is obtained by decoder. The connection to the operator position and the recording on the AMA tape is done in the conventional CAMA manner.

C. Step-by-Step Intertoll CAMA

1. Equipment

CAMA features can be added to the step-by-step intertoll office by the addition of common control equipment; registers, senders, decoders, etc.

The block schematic of the step-by-step intertoll office arranged for CAMA is shown in Figure 14-13. The switching network of the office still uses trains of step-by-step switches; however, the control of the switches is under control of a sender.

The principal common control units, other than AMA units, used in step-by-step CAMA offices are:

a. Registers

The principal function of the register is to store all of the incoming dial pulses and then to transmit these digits to a sender by means of MF pulsing.

b. Senders

The senders store the called number as well as control outpulsing. The sender also provides various circuits with information about the call; this information is used for selection, switching, and charging. As a result of the various exchanges of information the sender is advised as to what type of outpulsing (MF or DP) is required and then proceeds to outpulse the called number.

c. Decoders

From information received from the sender, the decoder determines the routing of the call, including the routing through the SXS office. The primary function of the decoder may be classified as translation.

d. Trunk Class Translator

The trunk class translator circuit is only provided in larger offices. Its function is to supply additional information to the decoder about the call in the form of trunk class marks.

2. Method of Operation

A subscriber in a local step-by-step office must first dial an access code to reach a CAMA office. A typical access code is 112. When the customer dials this code he is connected at the local step-by-step office to an outgoing trunk to the CAMA office. When the incoming CAMA trunk at the step-by-step CAMA office is seized, it causes a link circuit to select an idle register (connections #1 and 1A). This connection is established during the interdigital time between

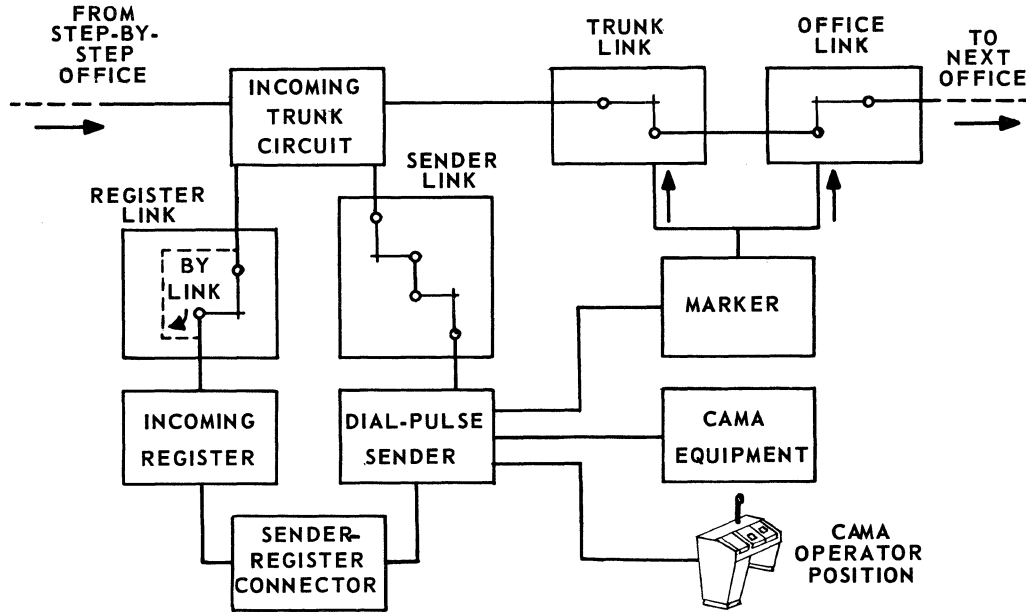


Figure 14-11 Block Diagram of the Arrangement in a Crossbar Tandem Office for CAMA to Work with Step-by-Step Offices

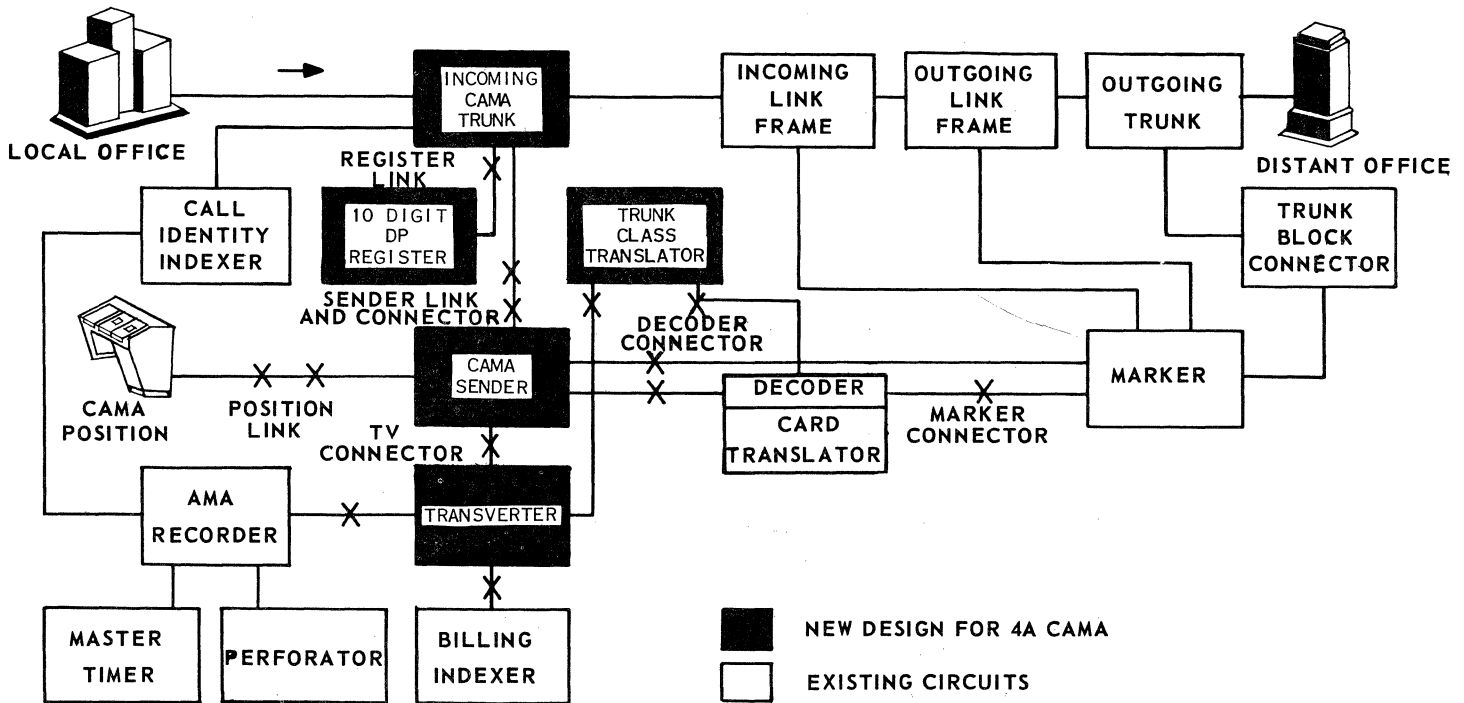


Figure 14-12 Partial Block Schematic of the New Design for 4A CAMA

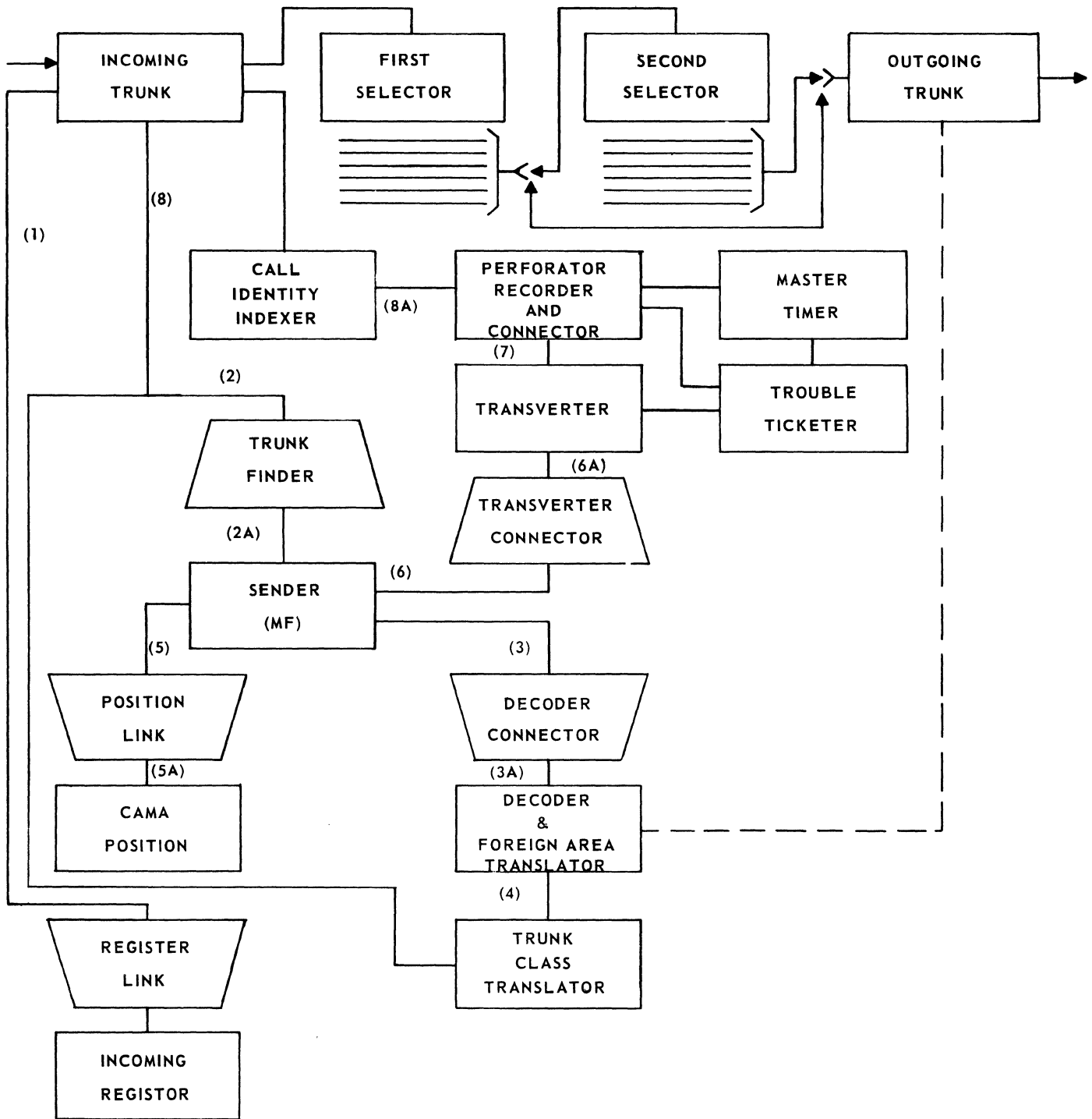


Figure 14-13 Block Schematic of Step-by-Step Intertoll Office arranged for CAMA Office

the dialing of the directing code and the dialing of the area code or the office code. No indication is returned to the customer that a register has been attached. The customer continues to dial the called number without pause. If a register is not attached in time to receive the incoming digits, the trunk is arranged to return reorder tone to the customer.

The incoming digits are registered in the register, which has a maximum capacity of 10 digits. After the sixth digit of a 7-digit call has been received or when the ninth digit of a 10-digit call starts to come in, the register causes a signal to be sent through the trunk for connection to an idle sender (Connections #2 and 2A).

The trunk secures access to the sender through the trunk finder. When the sender is attached, it signals the register that it is ready; then the register output pulses on an MF basis the digits it has registered. After outputting the called number, the register is released.

If the call originates from a No. 5 Crossbar office on a MF basis, a sender is attached immediately after the incoming CAMA trunk is seized. The called number is then registered directly in the sender.

When the sender has registered the sixth digit of a 7 or 10-digit call, it proceeds to call in a decoder through the decoder connector. (Connections #3 and 3A).

When the decoder is attached, the sender presents to it the first six digits it receives. The decoder uses this information (and in some cases other information) to determine the routing necessary for the call. It instructs the sender which of the received digits must be outputted, what digits are to be prefixed, and the type of the outputting that must be used. After transmitting this information, the decoder is released.

Associated with the decoder are circuits and features which may be provided on an optional basis (these circuits are shown in dotted lines on the block diagram). One of these circuits

the foreign area translator, actually functions as a part of the decoder. The foreign area translator is used to provide additional routing information when required (six digit translation).

Another optional circuit is the trunk class translator. This circuit is provided when the incoming trunks require different class marks. When this is necessary, the trunk class translator provides the class marks of the incoming CAMA trunks to the decoder (Connection #4).

A group busy feature is also provided on an optional basis. This feature permits the decoder to determine if there is an idle trunk available in a trunk group. The group busy test feature does not verify that a path through the switching network is available, but does verify that one or more trunks in the desired group is available. This feature may be used in conjunction with the alternate routing feature of the decoder.

While the decoder is engaged, the sender completes its registration of the called number. When it has registered the last digit, the sender proceeds to make a bid for a CAMA position (Connection #5 and 5A). If for some reason there is a delay in obtaining an operator, audible ringing tone is returned to the customer until the talking path is established.

When a position is attached, the operator is given order tone and a talking path is established between the operator and the customer. The operator then obtains the calling number and MF keypulses it into the sender.

On calls which route to or through common control offices, the sender begins outpulsing with the start of registration of the calling number. However, if the call does not go through a common control office, the sender will not start outpulsing until the decoder has been released. In either case the last digit is not outpulsed until the CAMA recording is completed. With this method of operation, level hunting connectors in terminating offices must be modified to wait until the units digit is received before they start hunting for an idle line.

A transverter is seized by the sender after the latter has received the units digit of the calling number (Connections #6 and 6A). The transverter receives from the sender the details necessary to make a record of the call. It translates this information into a form satisfactory for recording and the call is recorded in the conventional manner (Connections #7, 8 and 8A).

The CAMA equipment constitutes a separate train designed to handle CAMA calls. The only exception to this is for calls which have originated from and already been recorded at a No. 5 Crossbar LAMA (local AMA) office. These calls may be received on a non-CAMA MF basis. Use may be made of the CAMA senders and decoders to route through the CAMA selectors and to alternate route if desirable. This is the only non-CAMA traffic which this system is designed to serve.

14.5 AUTOMATIC NUMBER IDENTIFICATION - ANI

Automatic number identification is designed for use in offices served by various types of CAMA centers. It is a means, as the name implies, of making an automatic number identification of the calling party for recording on the AMA tape. This will eliminate the necessity for operator effort in making the identification.

The equipment for this identification is located in the local office (any mechanical type) and responds to signals from the CAMA office for transmitting the calling number. The identified number is transmitted to the CAMA office via MF pulsing.

A. STEP-BY-STEP, PANEL, #1 CROSSBAR

The general method of operation for these three systems is so similar that they have been grouped together under one description.

The block schematic of the ANI equipment is shown in Figure 14-14. Identification is made one number at a time by applying a 5800-cycle tone to the subscriber's sleeve lead and detecting this signal with electronic detectors.

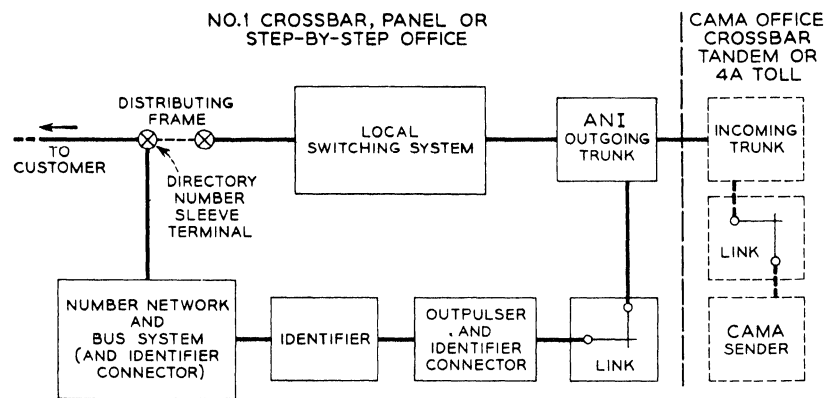


Figure 14-14 Block Diagram of Automatic Number Identification System

1. Number Network Frames

The number network frames contain a network field, which furnishes a network termination for each line, and a two-stage bus system. Each frame has a capacity of 2000 lines; five frames being required for a 10,000 number series. The network and associated bus system are passive systems in that they furnish a channel for transmitting in identification signals from the line to the detector circuits.

The bus system consists of a primary and two secondary systems for each 10,000 directory numbers. The primary buses are arranged in a 100 by 100 grid system so that each cross point represents one directory number. The two secondary bus systems are 10 by 10 grid arrangements using resistors instead of the R-C buses of the primary system. Primary buses are not scanned directly because it would require a large number of detectors. The secondary bus system converts the one-out-of-a-hundred signals of the primary system into decimal digits. The principle of the two-stage bus system is shown in Figure 14-15.

Cross connection between the primary and secondary systems provide a means of grouping directory numbers to reduce the number of detectors required.

Each cross point in the primary bus system is formed by the intersection of five buses. The vertical buses provide a tip, ring and multi-party connection for each directory number while the horizontal buses provide tip and ring connection. This arrangement produces a tip field and a ring field completely independent of each other. These independent fields are used in identifying numbers associated with two-party lines.

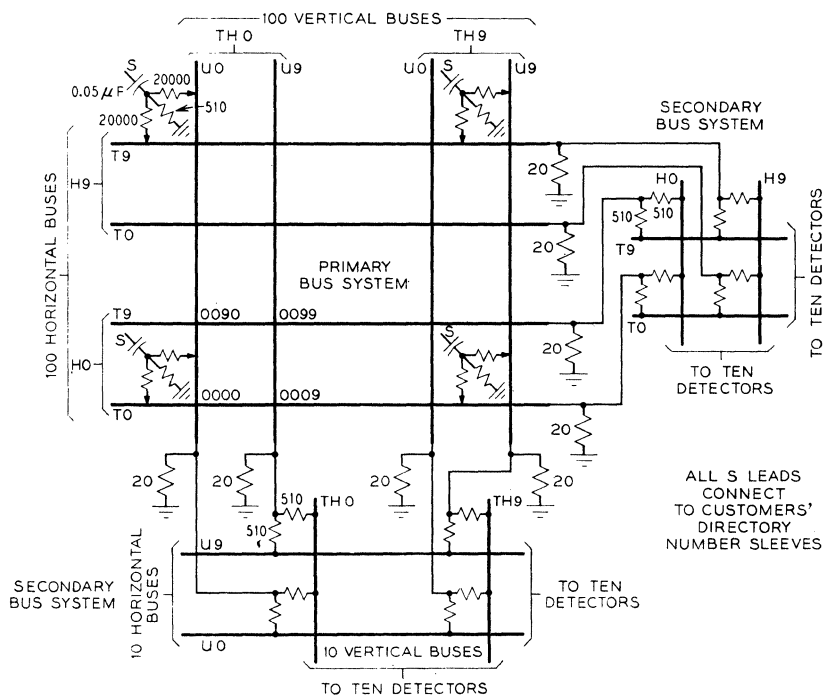


Figure 14-15 Number Network and Bus System

2. Identifier

The identifier is made up of detectors, steering circuits and translators. Ten number detectors under control of the steering circuits scan the output leads of the secondary busy systems. The signal applied to the number network and identified by the detectors is a 5800-cycle tone. The steering circuits connect the detectors to the thousands, hundreds, tens and units digits in sequence.

In addition to the number detectors, supplementary detectors are provided to identify calls from four-party and multi-party lines and calls being observed.

Only one identifier can make an identification at a time. One identifier will serve up to sixty thousand directory numbers. The average identification time is less than one third of a second, varying slightly with the number of offices to be scanned. The one identifier will care for traffic originated by most groups of six offices. Normally, however, a second identifier is provided for maintenance. If a building contains more than six offices, a second identifier group including passive network and outpulsers must be provided. Separate out trunk groups must also be provided.

3. Outpulsers

The outpulser is the equipment unit that controls the identification process. It receives party test information from outgoing trunks or obtains this information itself, when required, by making party test. It verifies that the calling customer has not disconnected before proceeding with the identification.

As the digits of the directory number are identified by the identifier, they are registered in the outpulser. The outpulser translates the office identity it receives from the identifier into the three digits of the calling office code. When all seven digits of the calling customer's directory number have been obtained, they are outpulsed, along with the appropriate information digit to the CAMA office by means of MF signaling.

The outpulser is provided with checking and timing features so that it can detect a trouble promptly. In this event, the outpulser calls in a trouble-recording medium known as the "trouble ticketer" and provides it with information for printing the trouble record. After making the trouble record, the outpulser makes a second trial identifier seizure.

Outpulsers are provided as required by the volume of Direct Distance Dialed traffic. An identifier group is arranged for a maximum of seven outpulsers to provide for traffic and maintenance usage. If more than seven outpulsers are required, a second identifier group must be established.

4. Outpulser Connector

All outgoing trunks in an identifier group have access to all outpulsers in that group. Connection of a trunk to an outpulser is established through an outpulser connector.

5. Method of Operation

When a CAMA office has advanced the call to the stage where the number of the calling subscriber is required, a signal is sent to the ANI outgoing trunk of the local office for calling number identification.

In the local office the call has been completed through the switching network in the normal manner. Upon receipt of the signal from the CAMA office, the trunk signals its outpulser connector for connection to an outpulser.

The outpulser seizes the identifier. At the same time it is connected to the identifier, it signals the trunk and the 5800-cycle oscillator to apply the 5800-cycle signal to the holding ground of the sleeve lead.

At the primary network, this signal goes through both the tip and ring networks. Only one of these primary networks is connected to the secondary network of the identifier. The tip or ring party identification of the calling

party determines which primary network is connected to the secondary network. The identifier scans the ten leads representing the thousands digits; then the leads for the hundreds, tens, and units digits; thus, reducing the number of detectors required.

The identifier group has a capacity of 60,000 subscribers; therefore, in addition to the four digits identifying the subscriber's number, office identification is also required. The identification of the office is obtained by the identifier scanning the leads representing the thousands digits of each office until a signal is detected. The identifier then informs the outputter which group of thousands leads (office indication) the signal was found on and proceeds to identify the last four digits of the subscriber's number.

As was indicated previously there are two primary networks, one for tip party subscribers and one for ring party subscribers. The identifier must know party identification in order to make the proper connection.

The party identification is obtained in a different manner in each of the three systems; No. 1 Crossbar, Panel, and Step-by-Step. In the No. 1 Crossbar system, tip and ring party information is registered in the originating marker in the standard manner while the call is being switched. This information is forwarded to the ANI trunk while the marker is setting up the switch linkages. From the trunk, the information is passed on through the outputter link to the outputter and then to the identifier. In the panel system the district selector makes the party test and records party information but it is not feasible to pass the information forward to the trunk. Therefore, the ANI equipment must make a party test of its own. This is done by the outputter, which recognizes the conventional ringer ground through the switchhook as indicating a tip party. In the Step-by-Step system, a party test is made by the ANI trunk during the interdigital time between the first two digits dialed

after the trunk is reached, and the result is forwarded to the outputer, as in the case of the No. 1 Crossbar trunk.

Party identification cannot be made on lines with more than two subscribers. The ANI equipment is not capable of identifying those numbers. The fact that an identification cannot be made is recognized by the identifier.

When the information obtained by the identifier is recorded in the outputer, the identifier releases. The outputer transmits the recorded information to the CAMA office and then releases its connection to the outgoing trunk.

B. NO. 5 CROSSBAR

The approach used in No. 5 Crossbar offices for ANI is different than that used in the other local offices. Some of the same equipment is used for ANI as is used for LAMA and the operation of the equipment is basically the same. The equipment used is the translator, the transverter and the transverter connector.

At the completion of outputting the called number, the outgoing sender summons a transverter in the normal manner, giving it the calling subscriber's line location. The transverter seizes the translator for the translation of line location into directory number. At this point instead of attempting to call in the recorder, perforator and call identity indexer, which are not furnished, the transverter passes the calling number to the outgoing sender for transmission to the CAMA office. The AMA equipment then releases.

C. TRANSMISSION OF INFORMATION TO CAMA

With any of the previous methods of ANI operation, the CAMA Office sends a signal to the local office requesting the calling number. The outputer or the outgoing sender sends the information by multifrequency pulsing.

The information is sent in the following order: KP signal, information digit, three-digit office code, four numerical digits and ST signal. The KP and ST signals

use the conventional frequencies that serve to actuate a receiver at the beginning and end of a sequence of information. The information digit serves to indicate one of four conditions:

1. Calling customer identified automatically.
2. Calling customer on a four-party or multi-party line, and therefore requires identification by the CAMA operator. No office or numerical digits are sent for these calls.
3. Calling customer is under service observation, and therefore the AMA record for his call requires a service-observing mark in addition to the usual information.
4. Calling customer could not be identified because of trouble in the automatic equipment. This condition requires identification by the CAMA operator. No office or numerical digits are sent for these calls.

When all digits have been outpulsed, the outpulsing is released, or the outgoing sender releases and the trunk is closed through for the talking condition.

14.6 AUTOMATIC MESSAGE ACCOUNTING CENTER

A. GENERAL

Although the charging information for telephone calls is recorded in the central offices, all the work of telephone message pricing, billing, and bookkeeping for the Bell System is concentrated in the accounting centers (Figure 14-16), their related punched card toll units and revenue accounting offices. In addition to its magnitude, this message accounting job has, of course, very exacting requirements of accuracy and promptness. Perhaps the most challenging factor in message accounting is, however, the need for the highest efficiency, since the accounting costs must add but a negligible amount to the low price of billable telephone messages.

These basic characteristics of the message accounting job had a controlling influence on the design of the machinery for the AMA center. The original message data for

the AMA center's system is recorded in central offices as patterns of perforations on paper tapes. These tapes are then sent periodically to the accounting center where machinery performs the various data-processing tasks.

The accounting center consists mainly of machines into which the central office tapes are fed. Each machine contains a reader which recognizes the arrangement of the holes in each line of tape and provides means for (1) perforating new tapes, (2) printing of the last set, or (3) punching a card for subsequent processing, using punched card procedures. The final output of these machines provides material from which charges can be computed in the punched card accounting office.

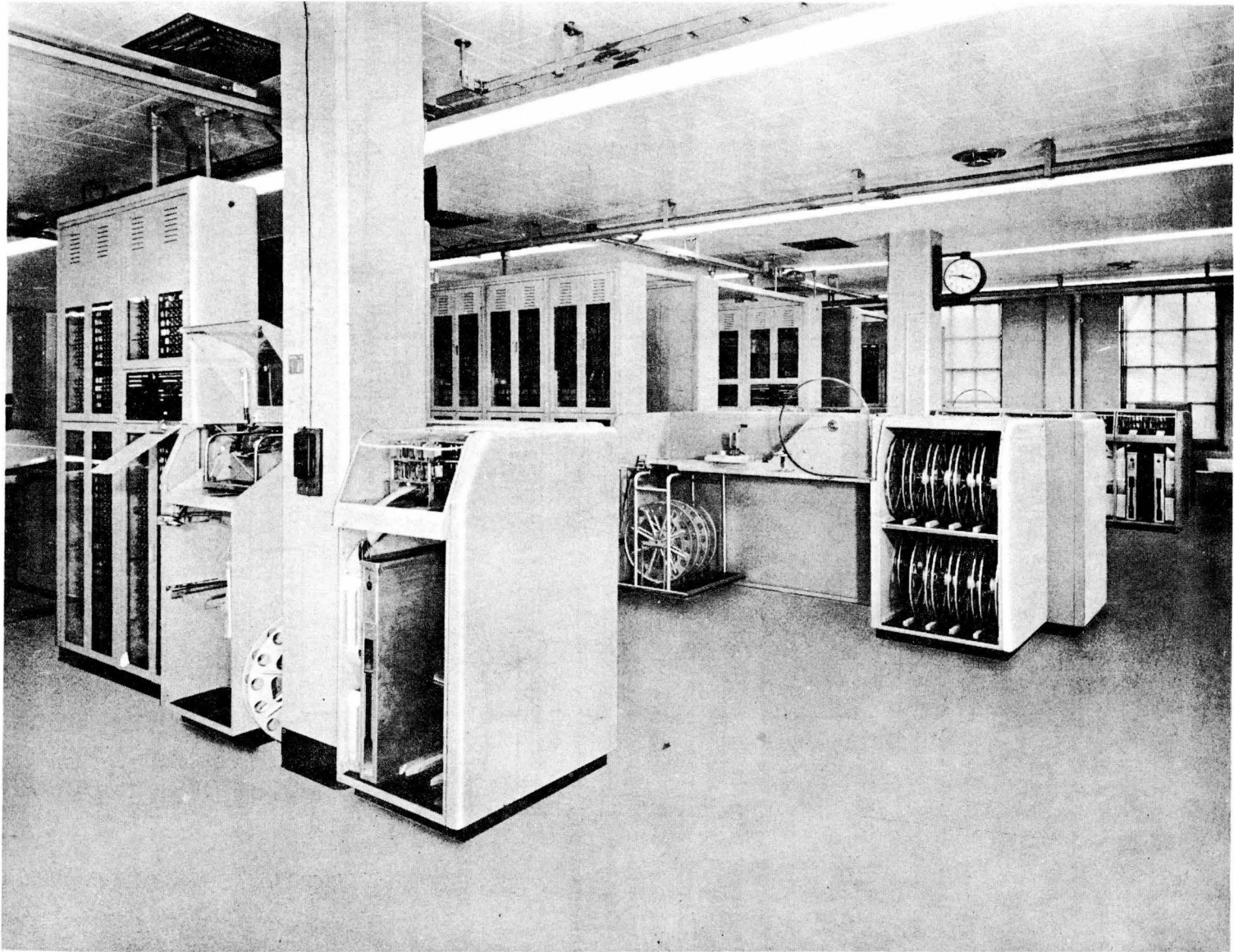
B. PROCESSING ORDER

The machine operations involved in accounting center processing are shown in Figure 14-17. The central office tapes of a given recorder group are fed to the assembler-computer or to the assembler as shown at the top of the diagram. The assembler-computer, Figure 14-18, was developed to combine, in a more economical way, the features previously incorporated in individual assemblers and computers. It will be used in new AMA centers and for additions on replacements in existing centers.

Subsequent sorter, summarizer, and converter processing for message unit messages, and converter processing alone for toll messages, result in a punched card output which is then processed on commercial business machines.

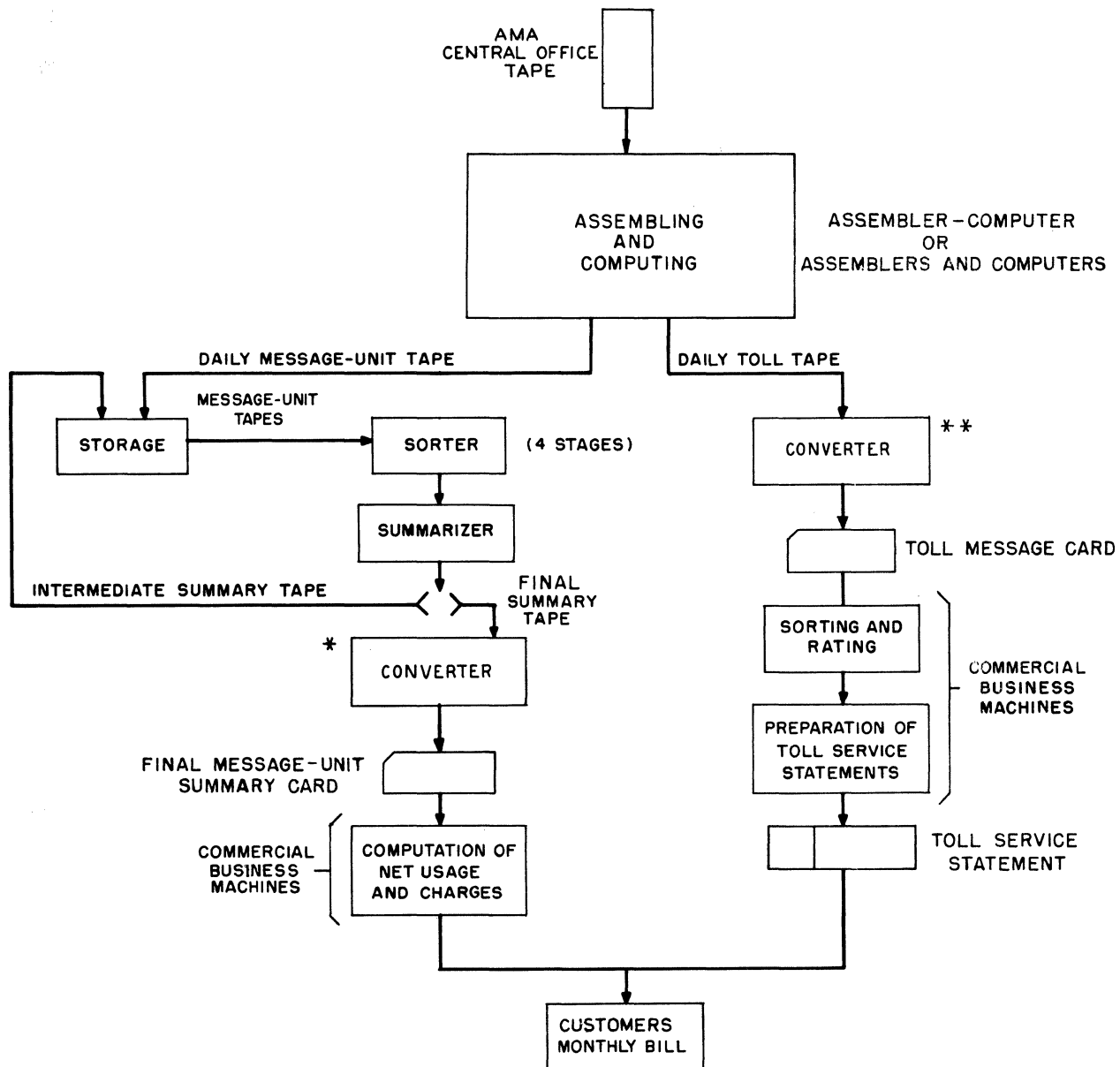
In each of these stages, the processing consists of feeding tapes into a machine in the proper order, collecting the output, storing it when necessary, and arranging them for input to the next stage.

The operations performed in any of these stages are controlled by manually setting the control panel switches of the accounting center machine involved. The leading end of the tape contains identification information which corresponds to the setting of the control panel. The machine checks the tape identification against this setting before the operations can proceed. In transferring the output tapes from one stage of operation to the next, all tapes are tagged or stamped to indicate the processing already completed.



14.41

Figure 14-16 Accounting Center



NOTES:

* THE AMA PRINTER-COMPARER-SCANNER OR PRINTER IS USED TO PRINT INTERMEDIATE MESSAGE UNIT SUMMARIES AND MAY ALSO BE USED TO PRINT FINAL MESSAGE UNIT SUMMARIES.

** THE AMA PRINTER MAY ALSO BE USED TO PROCESS DAILY TOLL TAPES, IN WHICH CASE THE OUTPUT IS IN THE FORM OF PRINTED TOLL SLIPS.

Figure 14-17 Processing of Central Office Tapes

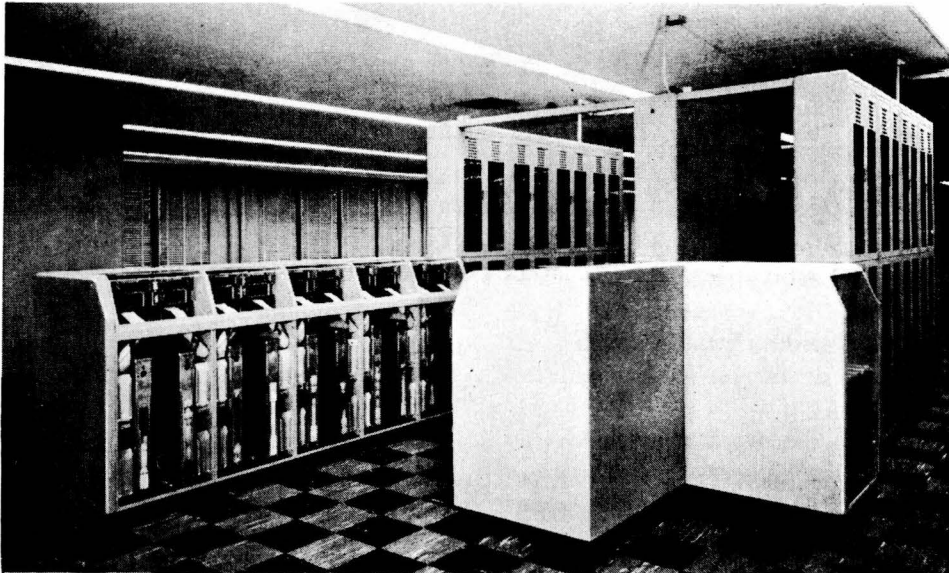


Figure 14-18 Assembler-Computer

In one assembler-computer stage or a combination of two assembler stages and one computer stage, the initial, answer, and disconnect entries of each call are brought together. Unanswered calls are eliminated and the chargeable time of completed messages is computed. For message unit messages, the chargeable time is converted to message units. Chargeable time for each toll message is derived and the complete call record is preserved. Message unit messages are separated from the toll messages during the assembler-computer or computer processing. In the four sorter stages, all the message unit messages dialed by a customer during a processing round are brought together on the output tape in line number order. In the summarizer stage, the message units of a processing round for each customer are totaled and added to the summary tape record of the previous round, except for the first processing round of the billing month.

Intermediate message unit summary tapes from the AMA summarizer are printed by the AMA printer-comparer-scanner, Figure 14-19, or the AMA printer to permit ready access to an individual customer usage to date, should a need for it arise.

Final message unit summary tapes from the AMA summarizer are fed to the converter, Figure 14-20, which provides a single punched card for each summary entry.

Toll output tapes from the AMA assembler-computer or the AMA computer are fed to the converter which produces a card containing the complete record of each toll message.

14.7 AMA FOR NO. 1 ESS

A. GENERAL

Taking full advantage of the data processing capabilities of No. 1 ESS, Bell Laboratories has programmed the AMA operation for the electronic system. The only special central-office equipment required for the ESS-AMA function is a magnetic tape unit. Besides holding considerable data the tape is stored and transported easily and it is compatible with the electronic computers already in service at most Bell System accounting centers.

In No. 1 and No. 5 Crossbar switching offices, AMA systems require control equipment and added features in trunk circuits in order to record call data as perforations on paper tape. Since there is no memory associated with the tape perforating equipment, all the data for each call cannot be punched together in sequence on the tape. Separate tape reading and computing equipment is required at accounting centers for sorting and assembling, as well as computing the charges for each call.

The AMA system in the No. 1 ESS is simpler in its operation. All its actions are contained in two programs, a data accumulating program and a data transfer program. The first records the charge details of all calls classified as billable, then encodes the data and transfers it to a memory buffer block. When this buffer block is full, the second AMA control program takes over and transfers the buffer block data to the AMA magnetic tape. All the while, the transfer program continually checks the tape unit and data-transfer circuitry for errors. The final output of both programs is a reel of magnetic tape containing all billing entries for a specific period of time.

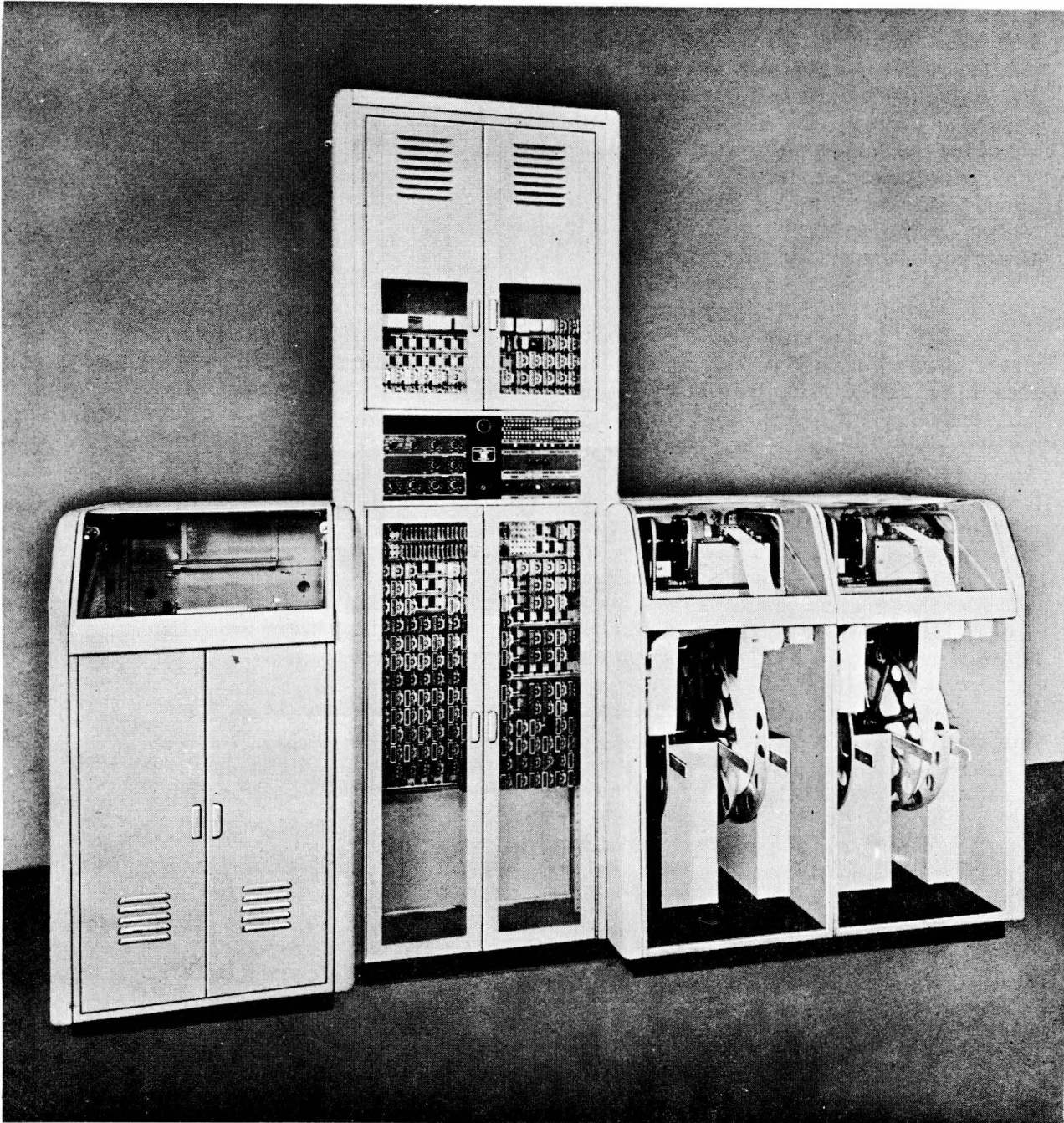
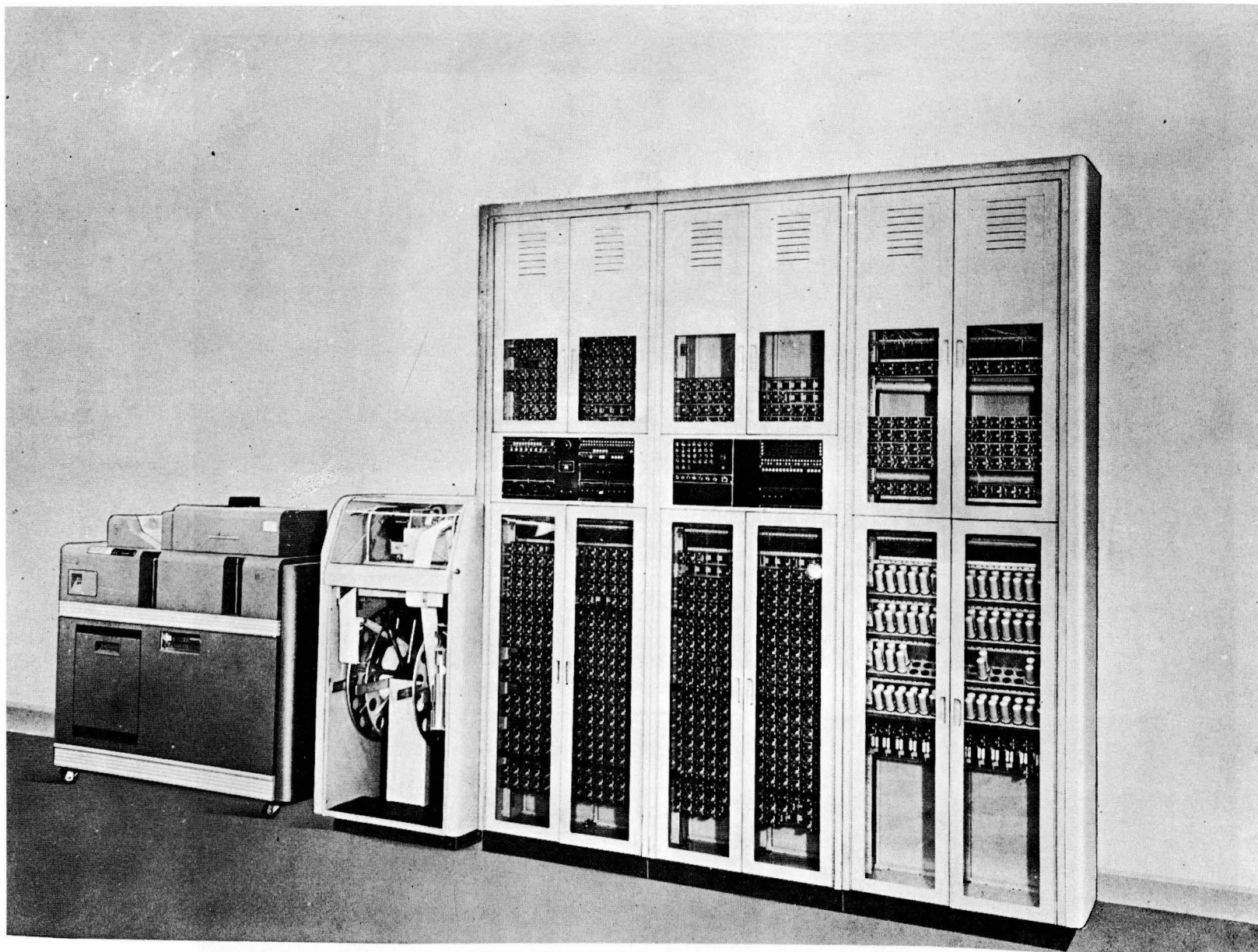


Figure 14-19 Printer-Comparer-Scanner



14.46

Figure 14-20 Tape-to-Card Converter

B. TYPICAL OPERATION

1. Data Accumulation

When a customer wishes to make a call, see Figure 14-21, his line is connected to a digit receiver which is associated with a block of temporary memory called the originating register. This register, which temporarily stores the customer's dialed digits and the control information for processing the call, performs basically the same function as the originating register circuit in the No. 5 Cross-bar system.

As each digit is received, a report is made to the digit analysis program which controls the originating register. After three digits have been received, the digit analysis program requests a translation of these digits to determine a routing for the call. At this time the telephone customer has dialed either an office code, an area code, or a service code. The dialed office code may or may not be within the local calling area. If the call is not an intraoffice call, the requested translation includes routing information and an indication of whether or not the call is to be billed. If the call is billable, the digit analysis program then requests that an AMA register be linked to the originating register.

The AMA register is thus one of the key parts of the entire ESS-AMA system. This register is actually a block of temporary memory that accumulates pertinent data on the call as it progresses. It usually remains associated with the call for its entire duration. It contains 13 call store words, each with 23 information bits. The first four words comprise a standard format for all No. 1 ESS call registers and are used primarily for administering the register. The next three words store information about the network path used for the call connection. The remaining six words store the necessary charging information as it becomes available. (See Figure 14-22 for a typical call store register layout.) The number of AMA registers in any one ESS switching system depends on such factors

as the type and volume of traffic. There are always sufficient registers to insure an extremely low probability of a blocked call because of an unavailable register.

When the customer has completed dialing, the digit analysis program transfers initial call data from its own originating register to the linked AMA register. This initial entry includes such items as called and calling number, type of call, and a message billing index. After the transfer, programs route the call to an outgoing trunk. The originating register is then released and the AMA program assumes control. All changes of state detected by supervisory scan programs will then be reported to the AMA program.

The first report received will indicate either that the calling line has abandoned the call or that the called number has answered. For an answer report, the AMA program takes the time of day from the system clock and records it in the answer slot of the AMA register. The system clock, another temporary memory location, offers an accurate time base that is updated every 10 milliseconds. Times entered in the AMA register are in units of hours, minutes, seconds, and tenths of seconds. This timing accuracy suits the ESS-AMA charge details for such calls as DATA-PHONE, which formerly required their own high-accuracy timing devices.

When the calling or called party terminates the call, a supervisory scan program detects the change and reports to the AMA data accumulation program. The disconnect time is entered in the AMA register, and programs take down the network connections, restoring the trunk and line circuits to idle condition. All information needed for determining charges on the call now exists in the AMA register. This data must be transferred to the magnetic tape.

Because billing data in the AMA register are in a compact code not acceptable at the accounting center, they must be converted to standard form. A series of output data formats offering high efficiency and flexibility is available for this conversion. Each type of call gets a

CH. 14 - AUTOMATIC MESSAGE ACCOUNTING

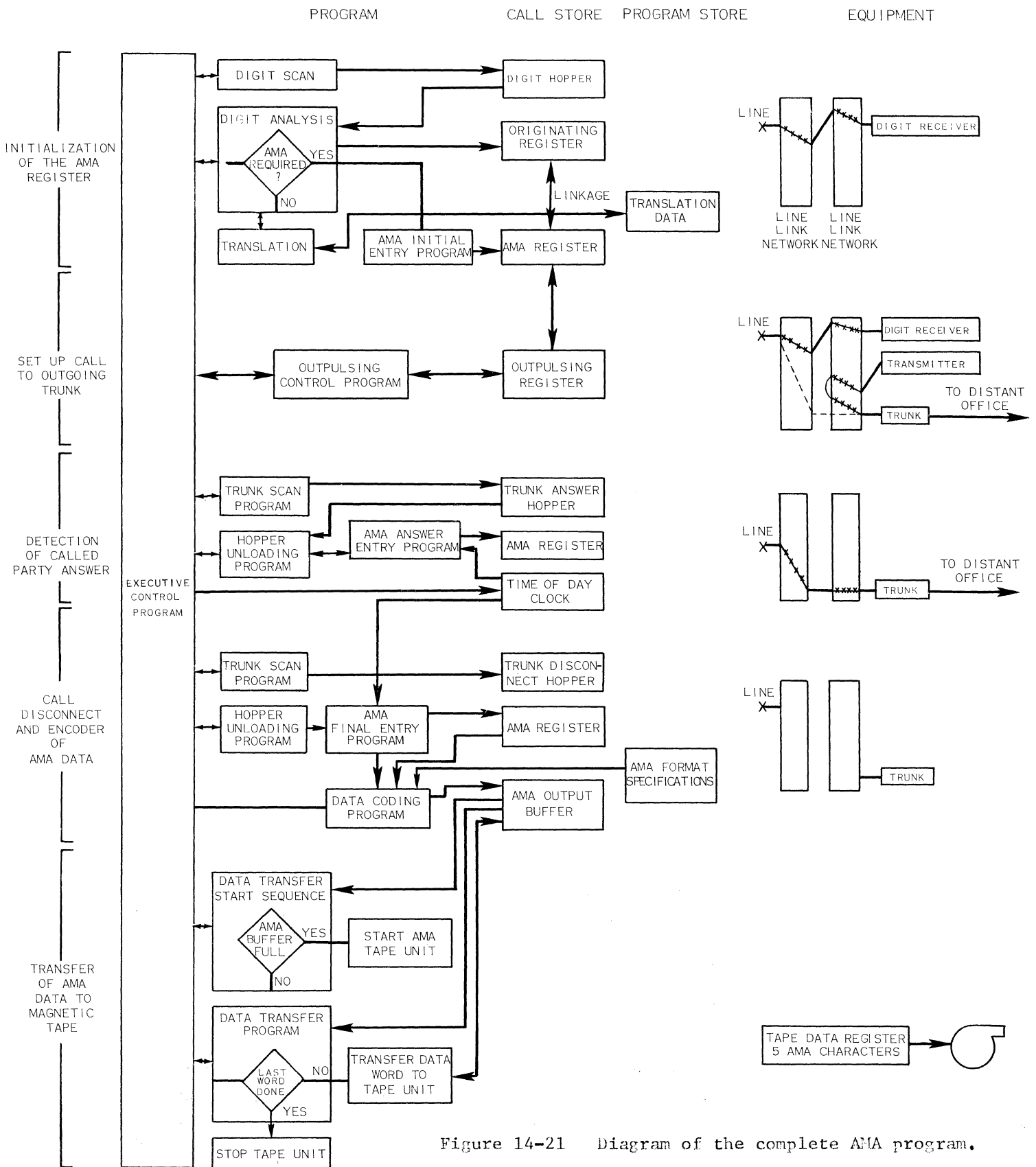


Figure 14-21 Diagram of the complete AMA program.

distinct format consisting of series of binary coded decimal (BCD) four-bit characters arranged in a fixed sequence for identification by the processing computer at the accounting center.

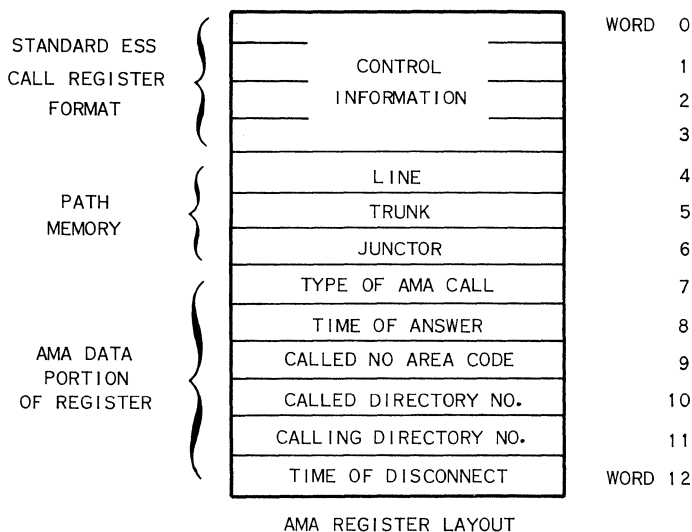


Figure 14-22 Simplified layout of an AMA call store register.

Three information digits directly precede the data for each call recorded on the AMA tape. Table 14-1 shows a typical format. The first digit informs the accounting center that this is the start of a new entry. The next two digits identify the data format. At present, the No. 1 ESS system has formats for 21 types of chargeable calls, ranging from station-to-station calls to custom calling services such as dial conference. New formats can be added and old ones deleted as the requirements for billing information change.

Since calls are completed randomly in time, it would be neither feasible nor economical to copy the data of each call onto the magnetic tape as soon as that data has been encoded in the proper format. There must be sufficient data to warrant starting the tape unit. A block of

buffer memory, therefore, temporarily stores the data until 500 BCD characters have been accumulated. In normal operation, this means information from 10 to 20 AMA registers, depending upon the data format used by each.

After the data in the AMA register have been encoded and stored in the buffer memory, the register is released for assignment to a new chargeable call. If the buffer area is full at the time an AMA call is completed, special facilities keep the AMA register in a waiting list until the AMA data transfer programs transfer data from the buffer to the tape. This prevents loss of charging data because of overload conditions.

Table 14-1

Binary coded digits (BCD) used to convert data from the AMA register to a standard billing format.

NAME	NO. OF BCD CHARACTERS REQUIRED
START OF ENTRY CODE	1
TYPE OF ENTRY = STATION PAID REGULAR = 01	2
SPECIAL ACCOUNTING INFORMATION	3
CUSTOM CALLING SERVICE USED	2
CONNECT TIME	7
CALLING NUMBER	7
MIDNIGHT INDICATOR	1
DISCONNECT TIME	7
CALLED NUMBER	10
TOTAL	40

2. Data Transfer

When the base-level executive-control program finds the AMA buffer full (it periodically checks the states of the buffer) program control passes to the second major AMA program--the data transfer program. This program has two basic parts. The first, operated at base level, starts the tape drive unit and prepares it for recording. While the tape unit is getting up to speed, this program checks that the basic hardware is satisfactory, that the tape unit motors are running, and that there is sufficient tape on the reel to record the data block. If these checks are affirmative, actual data transfer begins.

Actual data transfer is the primary function of the overall data transfer program. (See Figure 14-21.) In time, however, data transfer is controlled by the second part of the program. Because of the stringent timing requirements on data transfer circuitry, this operation occurs at the interrupt level. (See Figure 14-23.) The data transfer sequence is entered every five milliseconds until the entire buffer area is recorded on tape. At each entry, one 21-bit data word (five four-bit AMA characters plus a parity bit) is transmitted from the buffer to the tape unit circuitry. Special circuitry divides the work into five characters, computes an odd parity bit for each character, and records it on the magnetic tape.

The tape unit has seven tracks, uses four for the BCD character and one for the parity bit. The remaining two are presently unused. It takes about one millisecond to record each character, and after five milliseconds, the tape unit is ready for another word from the central control unit. If the system fails to transmit a data word to the tape unit in time, tape-unit circuitry recognizes this and records a dummy character on the tape. The AMA accounting center ignores these characters when processing the tape. Dummy characters are necessary because adjacent blocks of data on the tape are normally separated by blank sections. Since the central control unit processes all data in a real-time

mode, there occasionally may be enough I/O activity at higher priority than AMA to cause central control to miss a five millisecond time spot.

When all 500 AMA characters are recorded on the magnetic tape, the recorder stops. The entire sequence of starting the tape unit, recording the data block, and stopping the tape takes about one second and uses about 3.5 inches of tape.

Major goals of the AMA design in No. 1 ESS were long-term reliability and high accuracy in the recording of customer billing data. These dictated the use of a simple, rugged tape recorder. Duplication of hardware, including recorders and access and control circuitry, further insures system reliability. One tape unit records while the other stands by. In normal operation, the tape units interchange from active to standby once each day, usually at midnight. This enables craftsmen to remove the tape containing each day's information.

For greater dependability, the data transfer program continually monitors the tape unit for malfunctions during data transfer. Trouble indications include improper tape speed, broken tape, bad parity words from the central-control unit, and bad parity from the tape itself. If any malfunction is detected, the faulty unit is switched out of service and the standby unit activated. Diagnostic programs then test the faulty unit, usually locating the trouble within a matter of seconds. The results are quickly reported on the maintenance teletypewriter.

Automatic message accounting in No. 1 ESS, by taking advantage of stored programs and using magnetic tape recorders, has evolved into an efficient, reliable, and economical system. It can record the charge details of about 40,000 calls an hour. The tape reel has enough storage capacity for about 100,000 entries.

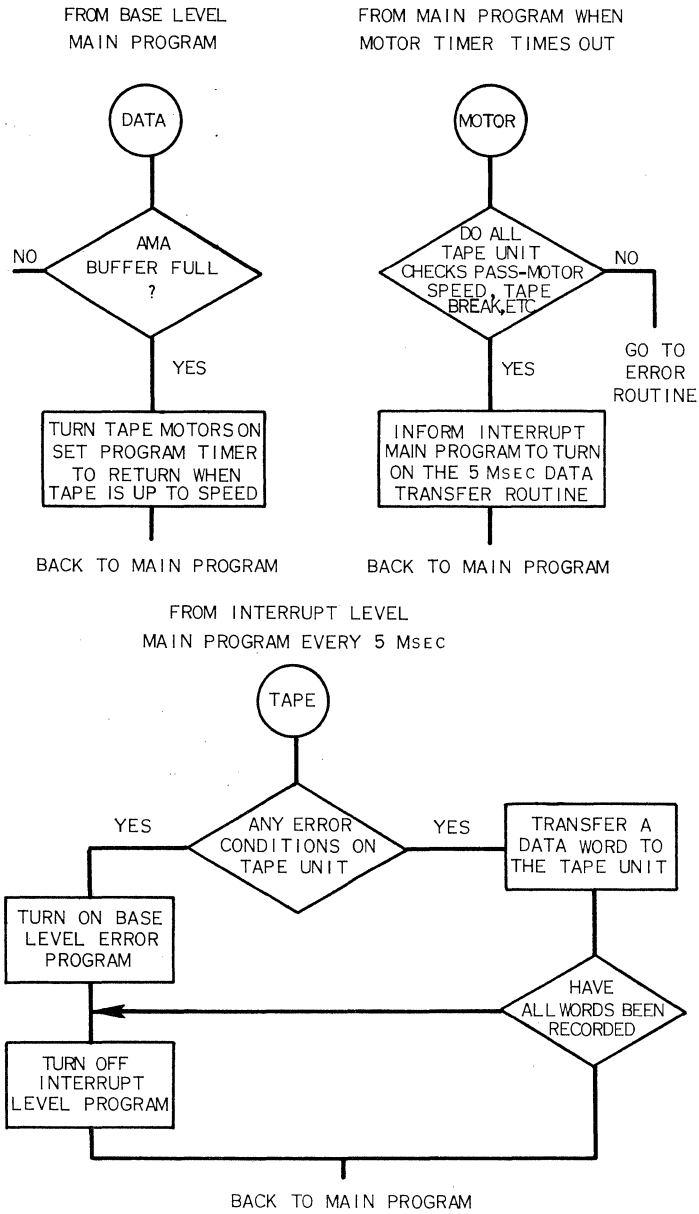


Figure 14-23 The AMA Data Transfer Program.



Western Electric