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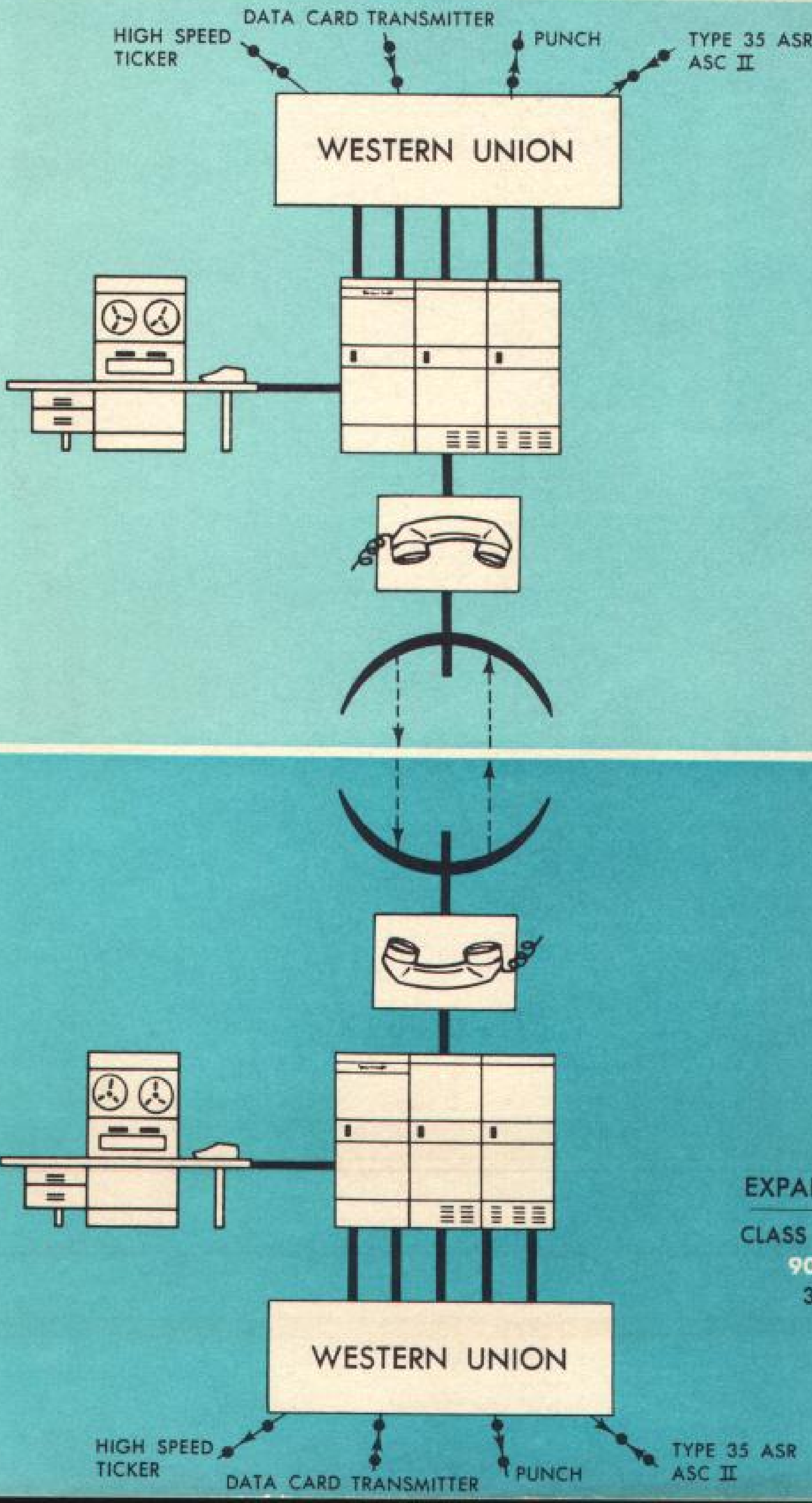
JULY 1964



EXPANDED PWS

CLASS "D" SERVICE
900 TICKER
3—PATS

THE WESTERN UNION TECHNICAL REVIEW

Cover: Representation of a
Private Wire System
using Class "D" circuits
with high-speed interchange

presents developments in Voice and Record Communications for the Western Union's Supervisory, Maintenance and Engineering Personnel.

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JULY 1964

Class "D" Service

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Expanded Private Wire Service
for New York Stock Exchange

•

Interconnection of Three
Private Automatic Telephone Systems

•

Message Protection
in the
AUTODIN Message Switch

Volume 18
Number 3

THE WESTERN UNION TELEGRAPH CO.
60 HUDSON ST., NEW YORK, N. Y. 10013

WESTERN UNION ***TECHNICAL REVIEW***

July 1964 Issue

ERRATA — **Pg. 104**

The illustrations above the captions in Figures 11 and 12 should be interchanged.

Pg. 129, Line 3

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The Editor

WESTERN UNION

Technical Review

Volume 18
Number 3

JULY 1964

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H. F. Krantz, Senior Engineer, Transmission Dev. Div.—P&E Dept.

CLASS D SERVICE

The interchange of information at rates below one hundred words per minute has become too slow for many up-to-date means of data accumulation. Faster data processors and communication equipment developed within the past year are being incorporated in various private industry and government transmission services. Western Union Class D service offers the most efficient transmission facilities for operating these new systems at rates between 100 and 180 bauds.

The first such major network is currently being installed for the New York Stock Exchange's 900 character per minute tickers operating at 135 bauds. This network, like the present slower speed ticker service, covers approximately 34,000 circuit miles and 650 cities throughout the United States. The Stock Exchange has planned the full cutover to 900 characters per minute tickers on October 1st. A large network of duplex way circuits, Plan 137, for Weyerhaeuser Company is scheduled for complete circuit operation on December 1, 1964. These way circuits operate into G.E. Data Net 30 computers which are connected over a Western Union 2400-baud circuit. On Jan. 1, 1965 the General Service Administration—Advance Record System (Phase 1) will become operational, and will include the most advanced Class D network in the country. This system contemplates a final installation of 1700 drops involving 600 cities during 1965, and consists mainly of the new ASCII format, eight level, 110 baud teleprinters.[1]

The AUTODIN Switching System which operates at 150 bauds is a forerunner of Class D Service.[2, 3] The concentration of terminal equipment and assignment of Message or Circuit switching subscribers, all for full duplex operation, made it possible to utilize carrier transmission for each customer drop. This has been adequately handled by Western Union Data Carrier Transceiver 10210 and associated equipment better known as the Type 70 Channel Terminals.

Varied Circuit Arrangements

Unlike the specialized full duplex network of the AUTODIN Switching System, Class D Service customers will require a wide variety of circuit arrangements. These will be similar to those used in slower speed telegraph customer service and will include half duplex or full duplex networks, point-to-point connections, controlled duplex waywire networks and one way distribution.

- *Half Duplex Multipoint Arrangement*—Figure 1 shows a typical half duplex circuit with the customers' drops hubbed in network repeaters. Any customer drop can "talk" to any other drop either collectively or by selection, but transmission in only one direction at a time is possible. As shown in Figure 1, duplex facilities are available throughout the circuit except in the network repeater where the two directions of transmission are combined. Networks of this kind are common when a master computer at the customer's control station "polls" the other drops. It would be limited by the amount of traffic required in communicating between the drops and the control center, since only one drop at a time can be polled.

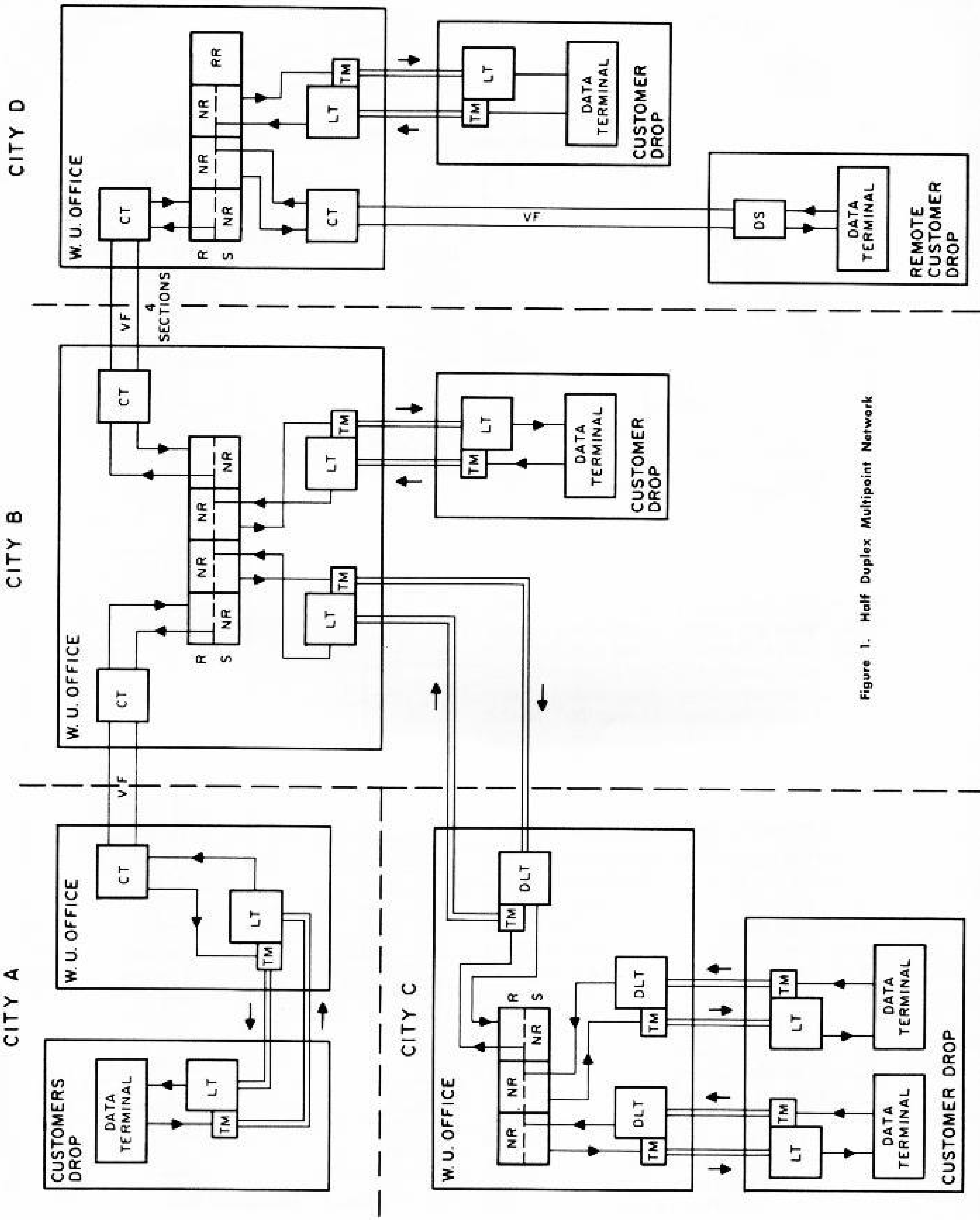


Figure 1. Half Duplex Multipoint Network

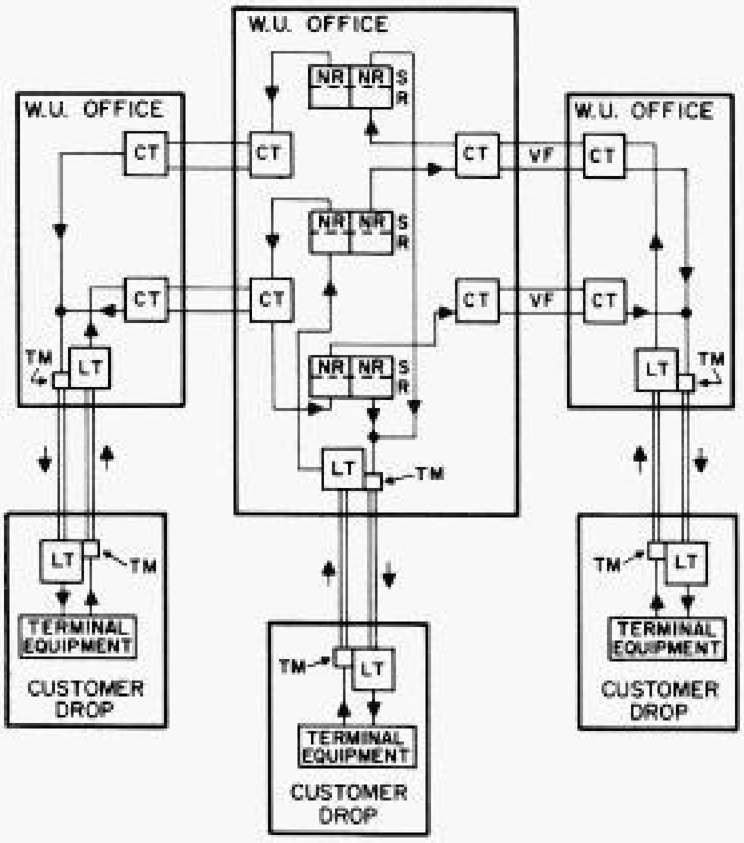


Figure 2. Full Duplex Network

• *Full Duplex Arrangement*—Figure 2 illustrates one means of providing a truly full duplex network where simultaneous two way communication is possible between any two drops. A prohibitive number of voice facilities are required for this arrangement which uses existing designs. The complexity of this network makes it unlikely that it will be found in actual practice until a suitable full duplex network repeater is developed when required.

• *Point-to-Point Arrangement*. The simplest circuit connection possible is the point-to-point communication between two drops shown by Figure 3. The circuit arrangement will be the same for either full duplex (simultaneous two way) or half duplex (one way) communications.

• *Controlled Duplex Way Wire Arrangement*. Perhaps the most common circuit configuration, where a central computer can "poll" a selected drop and then receive its communication while transmitting data or "priming" another drop for its polling character, is shown by Figure 4. This type of multiple network will be used most often to conserve valuable computer time, and increase the efficiency of data interchange. This may also serve as a full duplex multipoint network where any drop can "reach" any other drop through the central computer. However, this arrangement is somewhat difficult to program, and would "tie up" computer operation to all drops during the special communication.

• *One Way Distribution*. Figure 5 gives the arrangement for distribution of data traffic from a central transmitting point. This application of Class D service is limited in scope to such customers as stock exchanges where the same communication is required simultaneously to a number of drops.

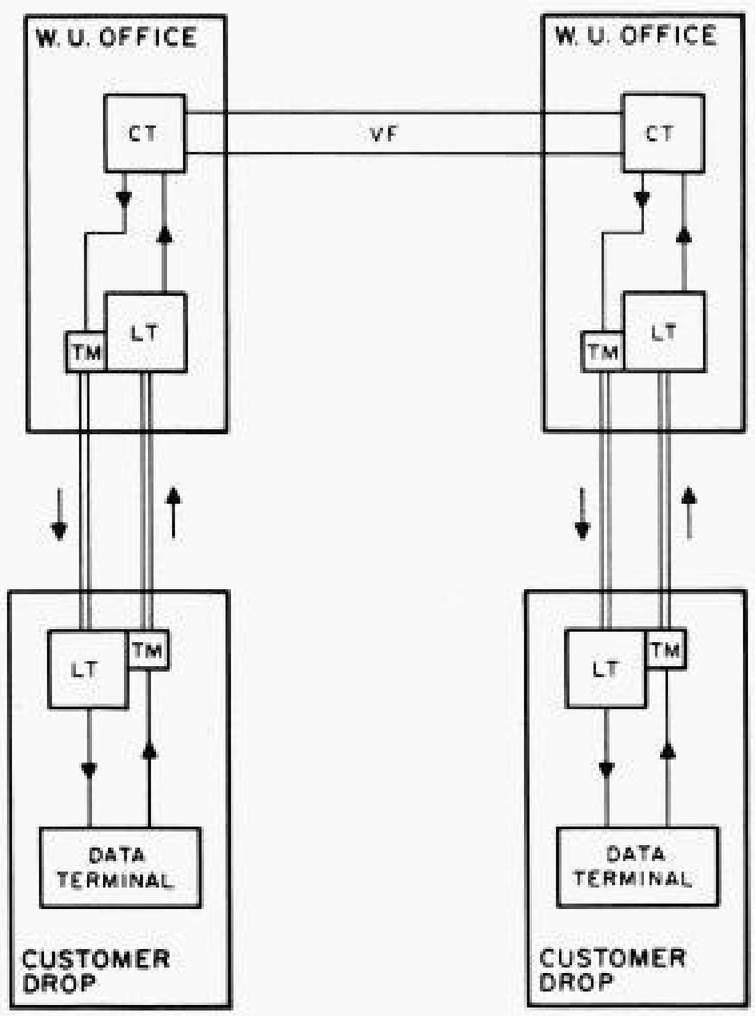


Figure 3. Point-to-Point Network

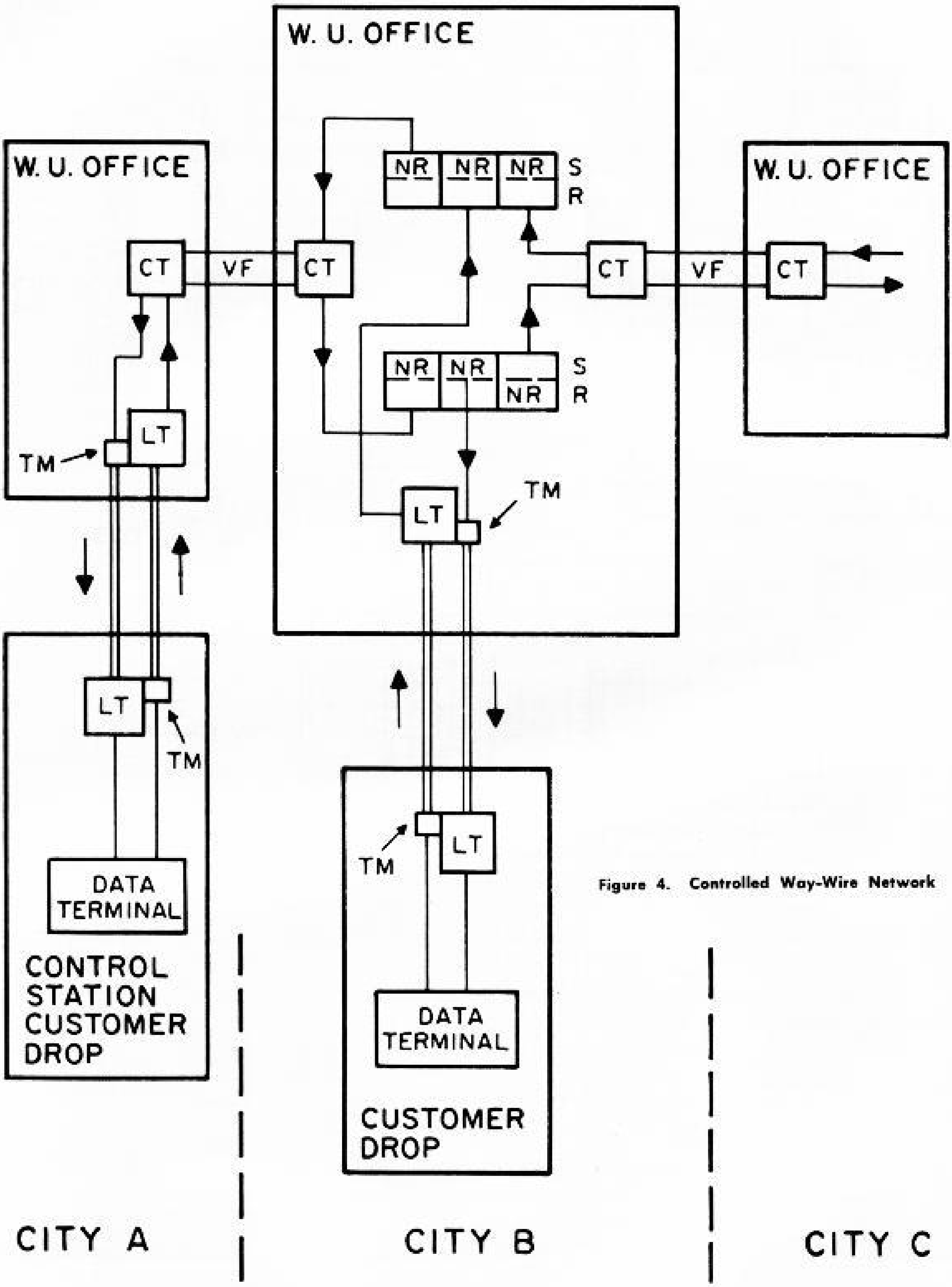


Figure 4. Controlled Way-Wire Network

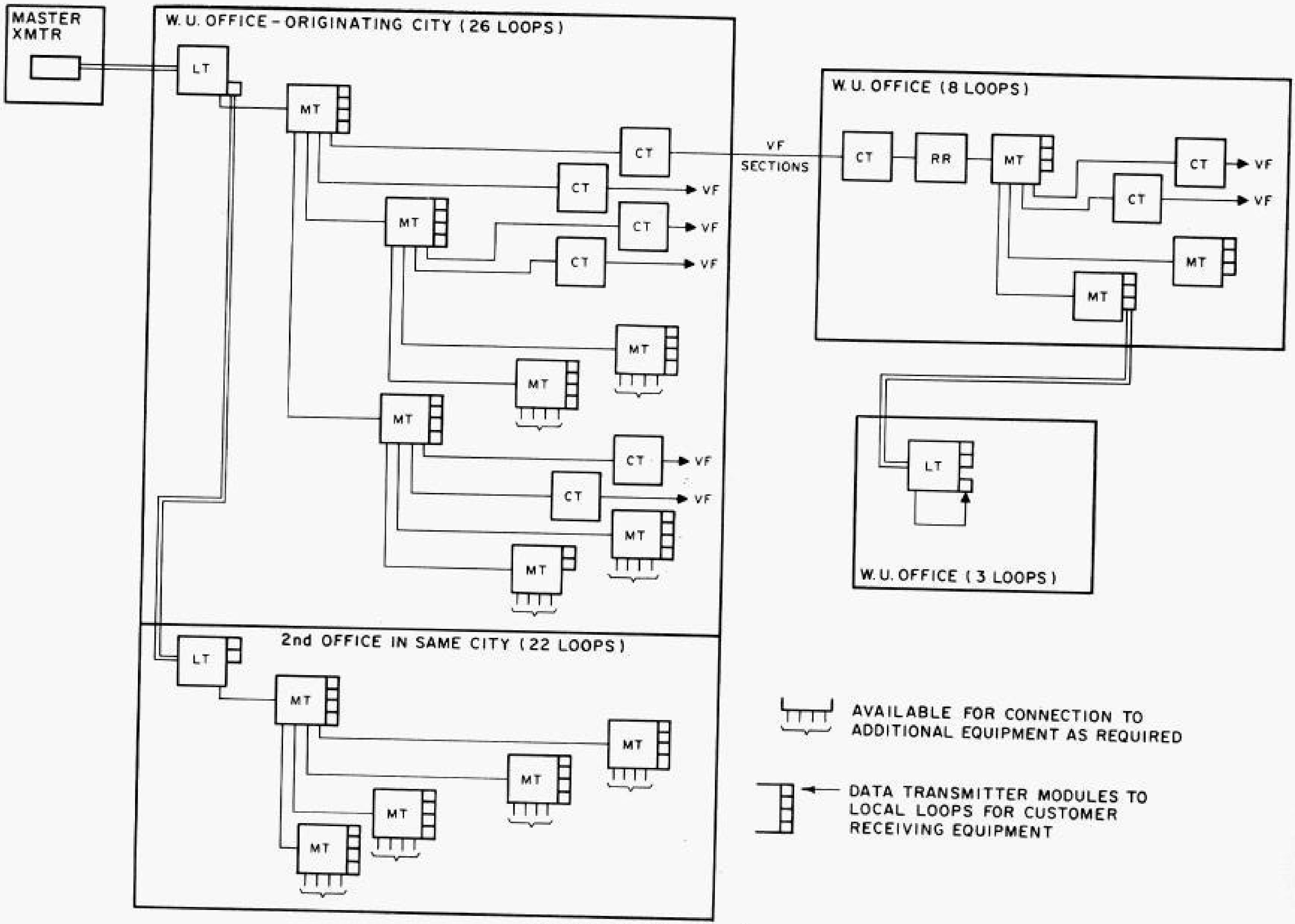


Figure 5. One Way Network

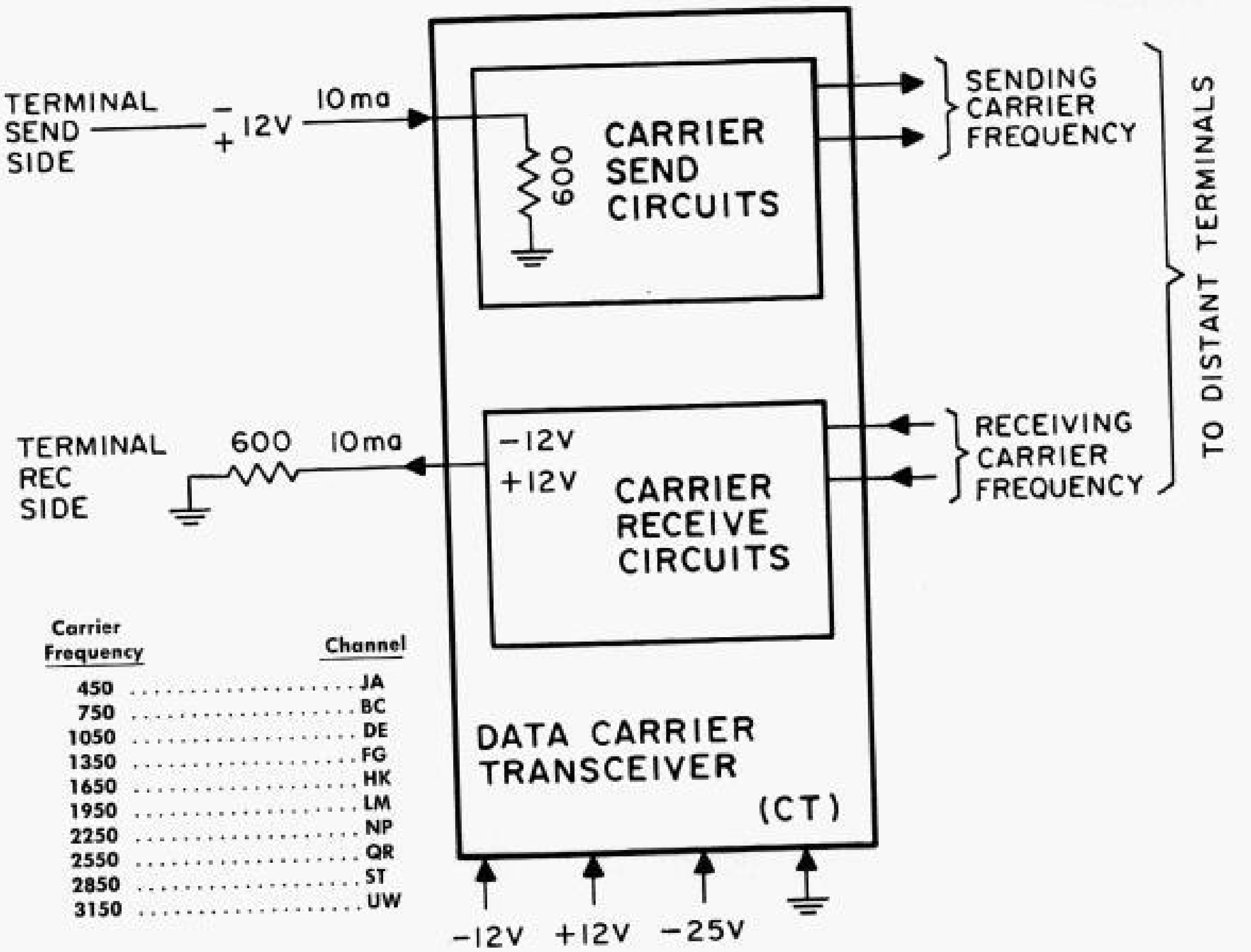
Equipment Functions

Each of the above circuit arrangements illustrates common equipment types to perform the various operational functions. CT, LT and TM are designations for equipment which appear in virtually every circuit layout. Other equipment designations are used to complete the circuit configuration for particular applications. Table I lists the existing types of apparatus and the intended use of each. The main line facilities are terminated in Type 70 Carrier Channel Terminals (Data Carrier Transceiver 10210). These channel terminals have proven their reliability in the AUTODIN Switching System. Inplant dc network facilities are furnished by a new family of transistorized equipment types. In order to minimize installation time and complication, these integrated units are arranged on a common basic equipment chassis. A data rack shelf is provided with slots to accommodate the plug-in chassis. The right hand slot of each shelf is reserved for a power supply of similar design to the basic equipment chassis. This supply provides power for units inserted in the four remaining shelf positions.

TABLE I

DESCRIPTION	PLACE USED		DESIG-NATION	REMARKS
	W. U.	PATRON		
DATA CARRIER TRANSCEIVER	10210	–	CT	TYPE 70 CARRIER
DATA SET		1181	DS	
DATA SET		1181.1	DS	PROVIDES EIA INTERFACE
DATA RACK SHELF	11619			PROVIDES SLOT FOR POWER SUPPLY & 4 OPTG UNITS
DATA TRANSMITTER MODULE	11621	11621	TM	BALANCED LOOP KEYER
DATA MASTER TRANSMITTER	11620	–	MT	BROADCAST TRANSMITTER
DATA LOOP TRANSCEIVER	11624		LT	
	11624.1		LT	PROVIDES OPEN LOOP DETECTION
		11860	LT	
		11725	LT	PROVIDES EIA INTERFACE
DATA NETWORK REPEATER	11622	–	NR	PROVIDES BLIND BREAK & OPEN LOOP PROTECTION
	11724	–	NR	PROVIDES 3 DROPS WITH NO BLIND BREAK PROTECTION
DATA REGENERATIVE REPEATER	11623	–	RR	
DATA POWER SUPPLY	11625	*	PS	1 AMPERE EA + & – 12V
	11625.1	*	PS	1 AMPERE EA + & – 12 & 24V
	11625.2	*	PS	2 AMPERE EA + & – 12V
SELECTOR MAGNET DRIVER		11835	SMD	HIGH SPEED TICKER DRIVER CARD

* Patron Sets are all self powered From A Commercial A-C voltage source



Carrier Frequency	Channel
450	JA
750	BC
1050	DE
1350	FG
1650	HK
1950	LM
2250	NP
2550	QR
2850	ST
3150	UW

Figure 6. Data Carrier Transceiver

Equipment for patrons' office installation is provided on a suitable chassis with a distinctive cover for mounting outside and away from the other confines of Western Union equipment tables or cabinets. In many cases, these patrons' sets employ the same circuit assemblies as are provided in the central office chassis.

• *Data Carrier Transceiver.* Type 70 Carrier Channel Terminal Data Card Transceiver 10210, provides the main line transmission path, combining a number of dc signalling circuits into voice facilities for trunk handling. A functional diagram of these terminals is illustrated in Figure 6. These units are the plug-in type and provide wide-band carrier paths. They may be used to fill an entire voice facility, or may replace two narrow band channels (Type 20, 30, 40 or 60) in a partially utilized facility.

• *Data Set.* When dc facilities cannot be obtained to a customers premises, a voice facility carrier will be terminated by a Data Set 1181 whose function is the same as shown by Figure 6. This set is packaged for the patrons' office, and may be equipped with a distinctive cover when not housed inside Western Union consoles containing certain switching or selection apparatus. (Type 1181.2 is a lower carrier frequency model of this set.)

Data Set 1181.1 is identical in use with the Type 1181 but provides the necessary interface connector and signal levels to meet EIA (Electronic Industry Association) standards as set forth in RS232-A (Type 1181.3 is a lower carrier frequency model of this set).

• *Data Transmitter Module.* In order to obtain satisfactory operation at Class D transmission rates, balanced keying of the local loop facilities is necessary. The

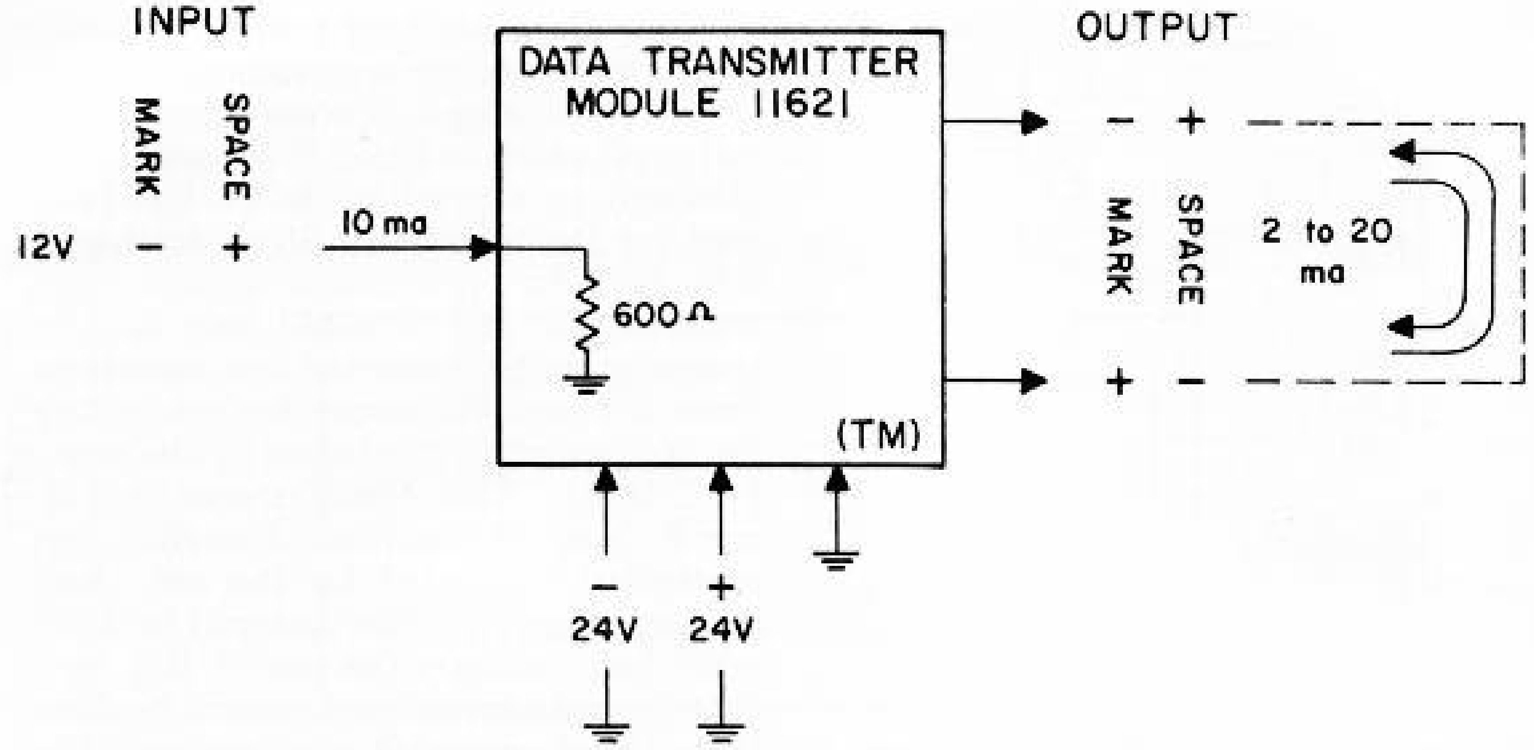


Figure 7. Data Transmitter Module 11621

Data Transmitter Module, 11621, shown in Figure 7, acts as an electronic double-pole-double-throw switch to reverse a grounded center tap 48-volt supply. The switch is keyed by a 12-volt polar input and acts to reverse the loop connection of positive and negative 24-volt batteries which are referenced to ground. This unit is a small, plug-in module approximately 3″ x 1½″ x 1″ mounted on an 11-pin plug. It is used to provide the transmitting function of all data loop transceivers and the data master transmitter.

• *Data Loop Transceiver.* There are various types of Data Loop Transceivers used in the Class D Service. Termination of a local loop being keyed by the balanced transmitter module is accomplished in the receiver portion of a Data Loop Transceiver. The plug-in transmitter module provides the corresponding transmitting function, Figure 8. The Data Loop Transceiver 11624 plug-in chassis for central office use provides two optional operating applications:

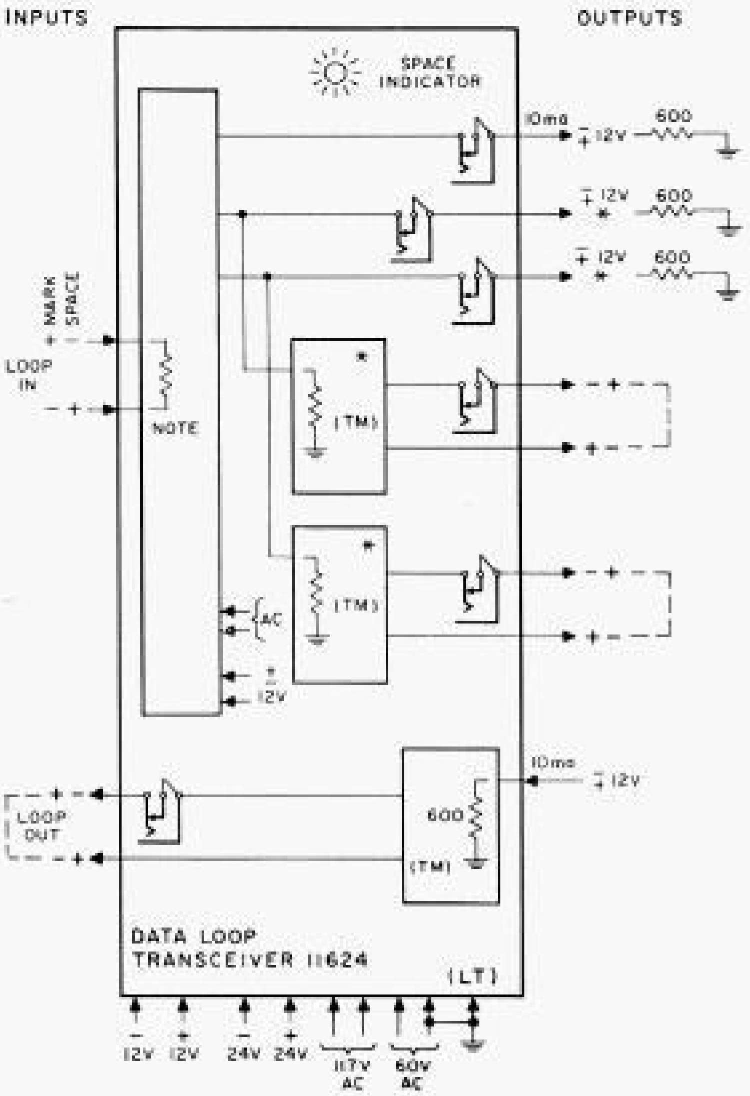
a) As a transceiver between plant distribution equipment and a local drop, it interfaces intra-office 12-volt grounded polar signalling circuits and local balanced battery loop transmission for both directions of transmission.

b) When used as distribution receiver for one way traffic, it provides a maximum of three local balanced battery loop transmitters from a single input loop. Optional use of the plug-in transmitter modules will allow an equal number of intra-office 12-volt polar signals for further distribution to master transmitters or carrier transceivers.

The Type 11624 Transceiver is entirely transistorized and will not introduce any measurable signal distortion, making its application in main-line transmission paths quite practical.

Data Loop Transceiver 11624.1 is a plug-in chassis similar to the Type 11624 Transceiver, but provides the additional feature of an open loop detector on its receiving side. This feature is particularly necessary when local drops are a part of half duplex networks and it is necessary to maintain a marking input for circuit continuity.

Patrons equipment operating via controlled duplex signalling networks require a conversion from the internal signalling levels to the balanced battery loop transmission, and this is provided by the Data Loop Transceiver 11860. Its function is the same as that shown in Figure 8, although the circuitry used is somewhat different. A mercury relay is utilized in



*Two Loop Outputs may be Substituted for line Outputs.
Note: D.L.T. 11624.1 Equipped with Open Loop Detector.

Figure 8. Data Loop Transceiver

the 11860 Transceiver which necessitates its being mounted in a particular position. Since other Western Union equipment is usually necessary in this application, the 11860 Transceiver will be mounted inside a console or cabinet and can be properly positioned. A bias control is provided to allow correction of a possible bias introduced by the mercury wetted relay or if make-break operation is required.

Data Loop Transceiver 11725 is identical in use to the Type 11860 Transceiver but provides the necessary interface connector and signal levels to meet EIA standards. Since its use is not restricted to application within other Western Union equipment, the circuitry is entirely transistorized and a distinctive cover provided. This unit may be mounted in any position and is interchangeable with the Data Set 1181.1 when dc facilities to the customer are available.

• *Selector Magnet Driver Card.* A special application of Class D service in one direction to a printing device has been used for the New York Stock Exchange 900 characters per minute tickers. This requires that the balanced loop battery transmission be converted into signals to drive a power transistor for controlling the 500 ma current required by the selector magnets. This device, shown in Figure 9, is a plug-in printed circuit card particularly intended for the 900 characters per minute ticker designed by Teletype Corporation.[4] The use of this card for other selector magnet control applications is not presently contemplated but may become a standardized item in the future, since it is in effect a data loop receiver.

• *Data Network Repeater.* Operation of complex networks having drops in various locations requires a means of distributing signals to the desired location and maintaining contact with all other locations. Figure 10 shows the functional operation of a Data Network Repeater 11724. Since it is unnecessary to provide for the distribution of less than two local drops, Data Network Repeater 11724 contains three "leg circuits," one for the mainline connection and one for each

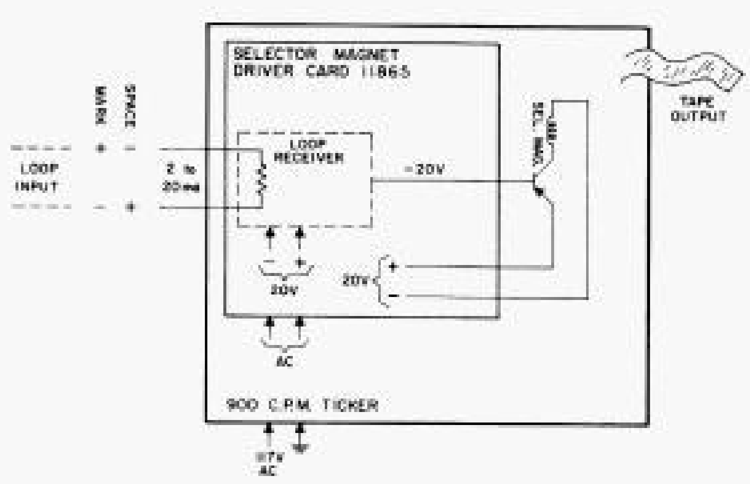


Figure 9. Selector Magnet Driver Card 11835

local distribution (either local loop connections or diverse carrier locations). No provision is made in this repeater to protect the network from "hits," "opens," or "garbling" due to noise or faulty opera-

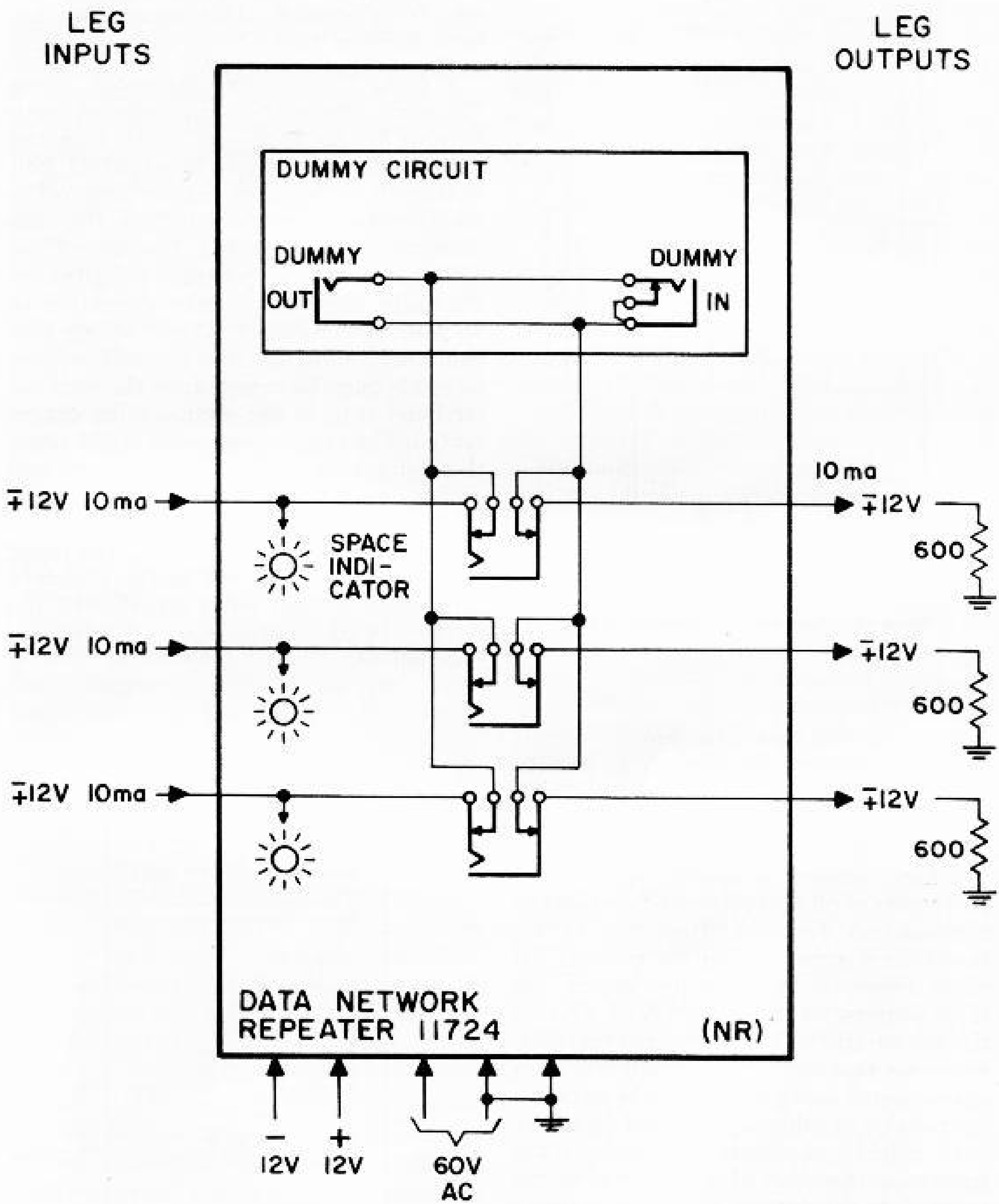


Figure 10. Data Network Repeater 11724

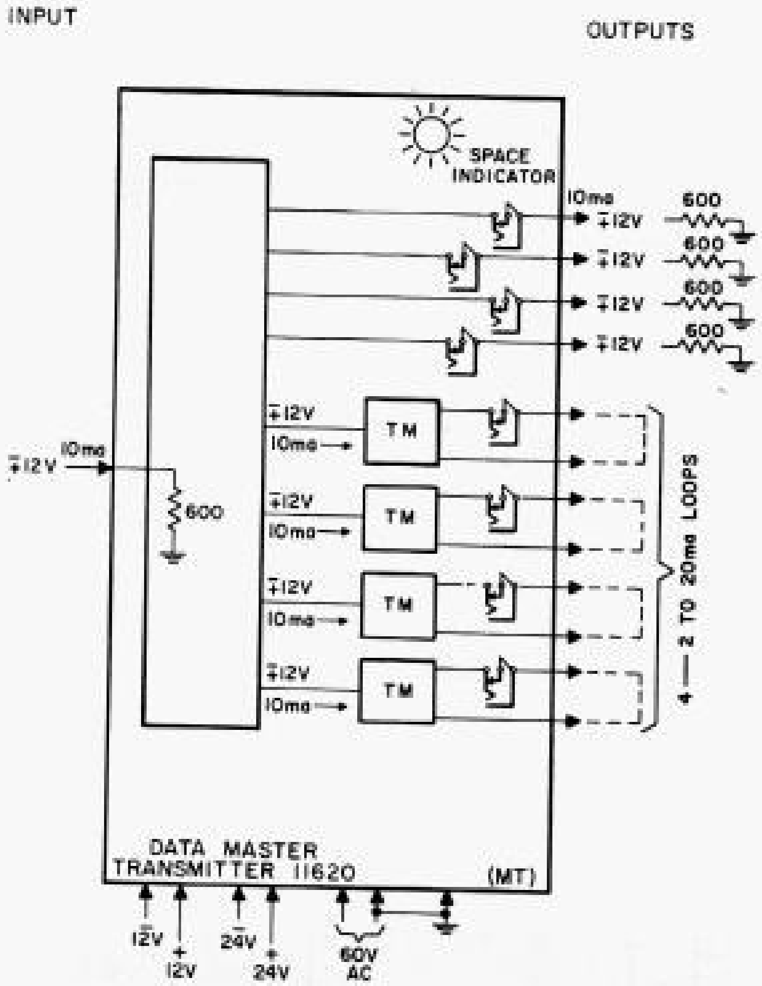


Figure 11. Data Network Repeater 11622

tion on various legs. The dummy circuit may be connected to as many as twenty drops by placing the units side by side in the rack shelves and cording "dummy in" to "dummy out" jacks.

When complex networks require the protection of blind-and-break functions or regeneration Network Repeater 11622, shown in Figure 11 shall be utilized. In other respects, this repeater serves the same purpose as the Type 11724. Due to the complexity of the additional features, only one repeater can be mounted on a chassis, each being corded to the network by a series of "dummy in" and "dummy out" patches on the front panels of the repeaters. Insertion of a regenerative repeater into the dummy will allow as many as fifty drops. This repeater has provision to lock out all drops except the one sending, and will give an alarm on an attempt to break into a working dummy. It also will "blind" a drop which sends spacing for one second or more. The provision of locking out all but the leg sending requires a time delay of one to two characters between the end of transmission from one drop and the start of transmission from another. This time delay has been referred to as "turn around" time.

• *Data Regenerative Repeater.* When the main line carrier transmission path exceeds five sections—or can be expected to exceed five sections in switched networks, the effects of carrier and other additive distortions will require that the dc signal be regenerated. Repeater Type 11623 is a crystal controlled digital regenerator that will correct distortion of 45 percent to within 1 percent at any rate contemplated within the Class D service. Crystals must be inserted for the particular baud rate of the service being regenerated. The crystal frequency is 256 times the baud rate. Wire strapping options within the unit allow selection of character intervals to accommodate the various start-stop signalling codes. The input and output of this unit is the standard intra-office 12-volt polar signal with the output being continuously delayed by one-half bit.

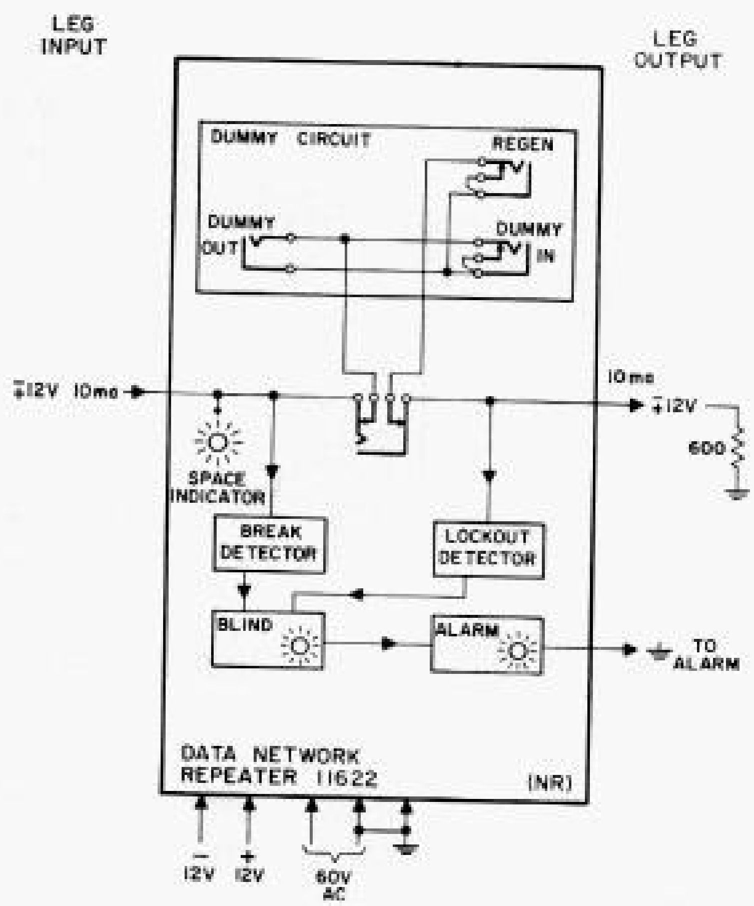


Figure 12. Data Master Transmitter 11620

• *Data Master Transmitter*—Transmission of Class D data in a one-way service requires a number of outputs, (both balanced battery loop and intra-office 12-volt polar) from a single intra-office input. Figure 12 shows the functions of a Data Master Transmitter 11620 which accomplishes this distribution. Four outputs are provided to connect to other intra-office 12-volt polar input equipment (additional MTs or CTs). Four other outputs drive self-contained plug-in transmitter modules to provide balanced battery loop keying.

• *Data Power Supplies.* Each rack shelf will provide all the power necessary to accommodate the various units assigned to its four active positions. The right hand position of each shelf is reserved for the power supply. These supplies are regulated so that the voltages remain within 2 percent from no load to full load. They are completely self-contained units.

Data Power Supply 11625 will be required for shelves equipped entirely with Data Regenerative Repeater 11623 and Data Network Repeaters Types 11622 and 11724, since these units require only plus and minus 12 volts. One ampere for each pole of twelve volts is provided.

Data Power Supply Type 11625.1 will be required for shelves where Data Master Transmitter Type 11620 or Data Loop Transceiver Types 11624 and 116-24.1 are used since these units require the balanced 24-volt loop batteries in addition to plus and minus 12 volts. One ampere for each pole of each battery is provided.

Special provision of intra-office polar 12-volt signal battery can be accomplished with Data Power Supply 11625.2. Two amperes for each pole of twelve volts is provided. It is not expected that these supplies will be required in connection with Data Rack Shelf 11619; however it may be used as a substitute for the Type 11625 power supply.

Major Assemblies

The Class D networks will extend to all Western Union distribution points. Several major assemblies are available to accommodate the installation of this equipment. Two divisions, according to the size of installation determine the particular major assembly to be used:

1. Those offices having little or no Type 70 carrier terminals.
2. Those offices with a large number of Type 70 facilities.

• *Data Repeater Bay* 11857-A is an assembly of equipment on a standard repeater rack to be utilized in offices where it is not necessary to provide facilities for terminating Type 70 Carrier Channel Terminals. Jack Circuits NRL (Figure 13) are provided for connection to a number of remotely mounted Type 70 Channel Terminals. Jack Circuits "NA" (Figure 13) are provided for connection of equipment and loop facilities in the usual manner. This bay may be expanded to a Data Terminal Bay 705.

• *Data Terminal Bay* 705 is a rack assembly with provisions for a variable number of Type 70 Channel Terminal rack shelves, depending upon the number of transceivers to be installed in a particular office. This bay will accommodate a maximum of eight Type 70 Transceivers with associated jack facilities, and up to twelve data equipment types as required.

In very large offices, where a high concentration of carrier terminals appears, Data Terminal Bay 701.1 is used to mount up to 24 Data Carrier Transceivers 10210. No jacking facilities are provided since they will be concentrated on a Data Switchboard Bay 11913.

• *Data Switchboard Bay* 11913 provides the mounting positions, cross-connection and jacking facilities required in offices with a high concentration of carrier terminals and data equipment. Initial installations may be expanded to a total capacity of approximately 160 circuits. This bay also provides NRL circuits to terminate the channels mounted on Data Terminal Bay 701.1.

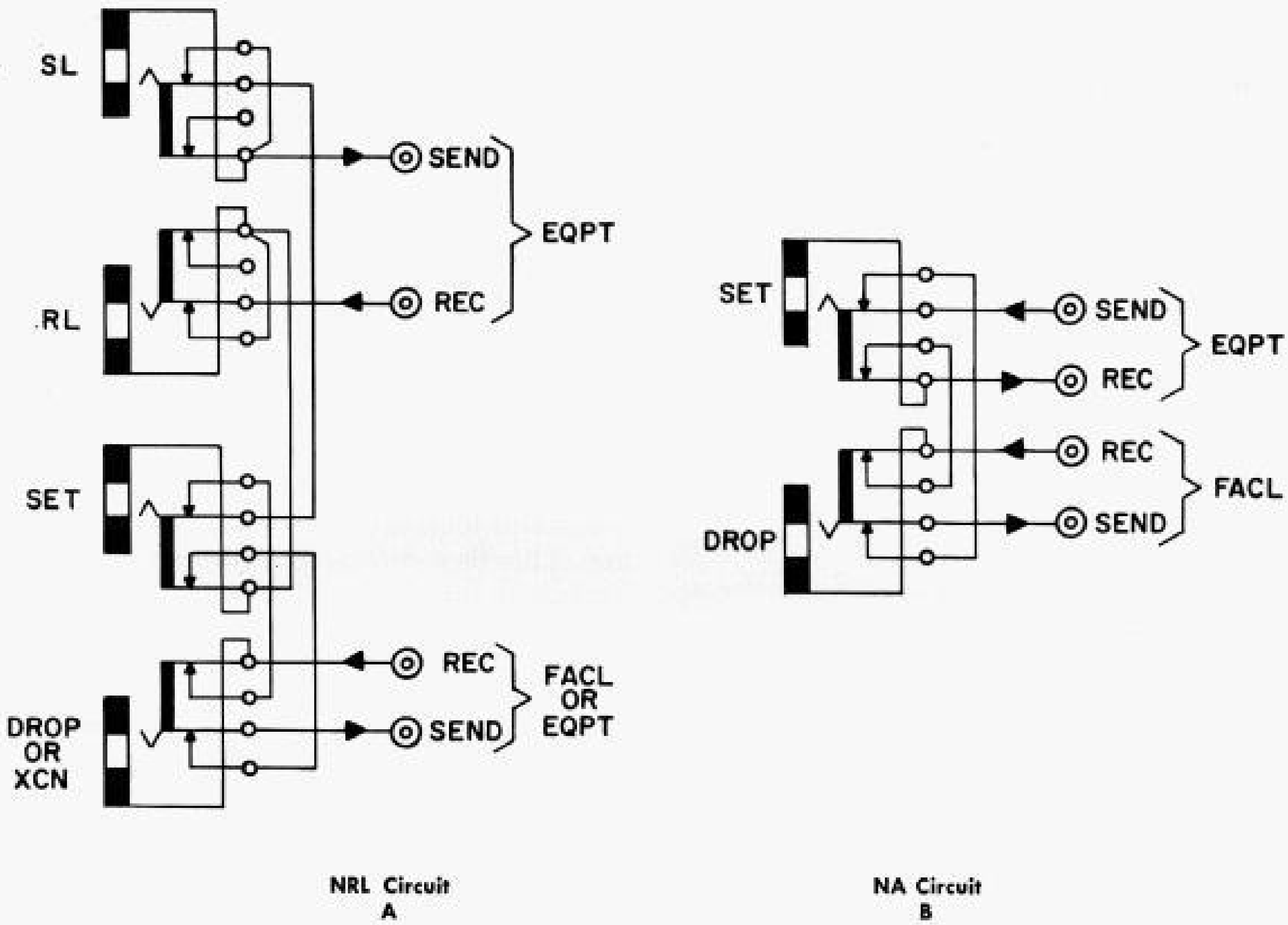


Figure 13. Jack Circuits

The very special requirements and large concentration of Class D circuits into the circuit switching and message switching centers of GSA district and junction offices necessitated the design of monitor testboard assemblies. These rack or cabinet-mounted jack fields and distribution frames are used by maintenance personnel at the switching centers and provide 100 trunk and line jack circuits in appropriate combinations depending upon the designated office. These circuits are equipped with shunt monitoring, facility or leg talk capabilities which may be used with any of the various types of "drop" equipment, as shown in Figure 13. Circuits in trouble may be "cut" to provide the normal idle condition which will prevent false seizure of switching trunks and erroneous operation of outstation equipment. Additional switches are provided for selective control of line load conditions. Various classes of service may be prevented from being transmitted through a district switch or through a junction switch as desired.

Service Reliability

Laboratory tests and several months of field application of prototype equipment models give every indication of long and trouble-free service from the new family of data equipment. Installation and cutover of the first customer loops in New York City started in June 1964 for the New York Stock Exchange. The transistorized system design uses a uniform chassis for many of the equipment types. This has proven economical in both manufacture and installation estimates. With these advantages, Class D Service should become a long term asset to Western Union's diversified customer applications.

Applications

The equipment system concept employed for the Class D Data Apparatus will have many applications because of its compactness and maintainability. Many new components are already in the design stages, and additions to some of the existing equipment is under consideration to make them more applicable to slower rate and higher current telegraph circuits. A relatively simple test fixture is being designed which will be applicable to all Class D Equipment for the maintenance and repair of units which become faulty.

* * * *

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2. AUTODIN — System Description, Part I — Network and subscriber terminals—H. A. Jansson, Western Union TECHNICAL REVIEW, January 1964, Vol. 18 No. 1.
3. AUTODIN—System Description, Part II—Circuit and Message Switching Centers—H. A. Jansson, Western Union TECHNICAL REVIEW, April 1964, Vol. 18 No. 2.
4. New High Speed Ticker for Improved Private Wire Service—by C. Turner and G. A. Straub, Western Union TECHNICAL REVIEW, July 1964, Vol. 18 No. 3 (this issue).

Mr. H. F. Krantz is a Senior Engineer with the Transmission Development Division. He has been responsible for the equipment and circuitry associated with Class "D" service.

He had previously been assigned to the Manager of the U.S.A.F. Technical Control project to assist in the design, development and final acceptance of various equipments involved in that program. This was written up in the January and April 1962 issues of the TECHNICAL REVIEW.

Mr. Krantz received his education in communications engineering at the Georgia Institute of Technology, and served with the U.S. Navy before joining the Applied Engineering Department of Western Union in 1946. Since then, his main work has been with the development and application of equipment for telegraphy, carrier and ocean cable systems.

C. Turner and G. A. Straub, Maintenance Supervisors—Plant and Engineer Dept.

Expanded Private Wire Service

for

New York Stock Exchange

Figure 1. Pedestal Unit

A completely new "900" Stock Ticker was introduced into Western Union service on June 21, 1964. This new high-speed ticker will replace approximately 2600 5-A tickers which have been leased to the New York Stock Exchange for the past 33 years. It will up-grade the previous service so that the system will be able to handle an 80 percent greater volume of stock broker sales than it did previously.

Western Union is planning to invest $5 million in improved line facilities and a new ticker repeater plant to handle the increased speed of the new 900 Ticker.

During the conversion to high-speed operation, all New York Stock Exchange tickers in the United States and Canada will continue to operate at 500 characters per minute. The total conversion to 900 characters per minute operation will be completed about October 1, 1964.

It is expected that the ticker tape, used in the new ticker, will be easier to read, because the start-stop motion of the present tape will be eliminated. This was made possible by the variable-speed operation of the new electronically-controlled motor in the tape puller unit.

Description of Ticker

The new high-speed ticker manufactured by the Teletype Corporation will increase the operating speed of the New York Stock Exchange leased wire service from 500 characters per minute to 900 characters per minute.

Two types of tickers will be used in the expanded Western Union service: a pedestal unit and a projector unit. The pedestal type, shown in Figure 1, comprises a printing unit with base, full cover, and pedestal containing shelves for tape storage. The projector type, shown in Figure 2, with a partial cover has a tape-puller motor control, and an electrical service unit, which is different from the pedestal type. Figure 2, also shows the tape puller and printing unit on its redesigned base. This Trans-

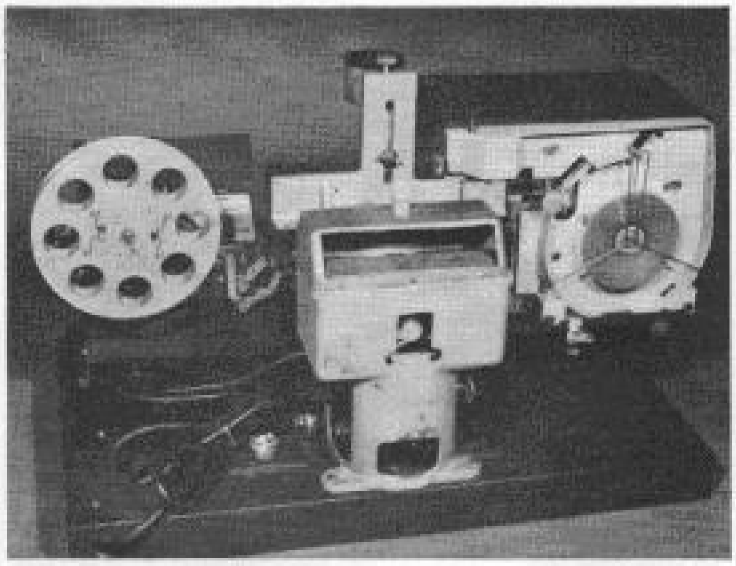


Figure 2. Projection Unit

Lux base supports the optics necessary for copy projection and a pivotal sub-base for the ticker.

The pedestal type ticker will be used in all instances where projection of printed sales is not required. The projector type ticker employs a cellophane tape to permit projection of printed copy.

Components of Ticker

• Printing Unit—The printing unit is an electromechanical motor-driven unit, capable of receiving an input signal of 6-level, 9-unit code at a speed of 900 characters per minute, and providing a modulation rate of 135 bauds. The unit converts the line signals into printed characters on a tape one inch wide.

The Printing Unit consists essentially of a selector mechanism, and a mainshaft assembly with a selector clutch, a code bar mechanism, an aggregate motion transverse positioning mechanism controlled by four all steel clutches, a dual print hammer assembly, a type box, a ribbon mechanism, and a tape feed mechanism shown in Figure 3.

Selector Mechanism—The selector mechanism is basically a Model 28 2-cycle selector converted to 6-level. It consists of 2 selector magnet coils and an armature, selector levers, push levers, and bails necessary to convert the electrical input pulses of the start-stop code to mechanical motions, as the 2-cycle, all steel, internal expansion selector cam-clutch rotates. The mechanical motions set up by the selector, govern the characters to be printed and the functions to be performed.

Main Shaft and Code Bar Mechanism—The code combination received by the selector is transferred to the code bars upon operation of the 2-cycle code bar clutch, through the code bar shift levers, thus positioning the code bars to the selected marking or spacing condition.

The six individual code bars are designed so that an extension on each will operate a bell crank for performing its specific function when shifted either marking or spacing. Each of the number 1, 2, 3, and 4 code bars through its extension and bell crank, trip a clutch in the aggregate motion mechanism (Typebox Horizontal positioning). The number 5 code bar through its extension and bell crank trips the type box clutch, located on the extreme right end of the mainshaft. This clutch is a one stop clutch in design but it is stopped in two positions depending on whether number 5 code bar is marking or spacing. The position in which the 5th pulse clutch is stopped determines the front and rear positioning of the type box (Type rows 1 and 3 spacing, Type rows 2 and 4 marking). The number 6 code bar determines which of the two print hammers (Ltrs. or Figs.) will operate. (Use of a single bit of one character to accomplish Figs./Letters shifting contributes greatly to the high speed output of the unit.)

After the type box has been positioned, the main shaft function clutch trips the selected print hammer, and feeds the tape and ribbon, through their associated linkage.

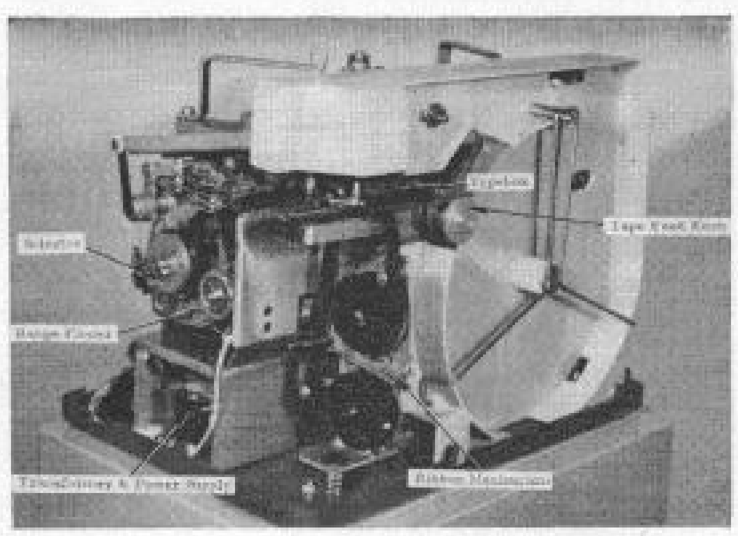


Figure 3. Ticker Mechanism Uncovered (Front View)

Aggregate Motion Mechanism — The four-clutch aggregate motion mechanism, shown in Figure 4, is located on the top of the printing unit. It determines the horizontal position of type box, which is so arranged that it can be positioned in any one of sixteen horizontal positions. To accomplish this, the four-clutch aggregate motion is only required to provide a maximum of fifteen units of movement to move the type box from the all spacing to the all marking position, since the print hammers are always located over one of the sixteen horizontal positions. There is no "home-position" and "No motion is one position." The number 1 clutch (1st pulse) provides 8 units of type box movement, the number 2 clutch (2nd pulse) 4 units of movement, the number 3 clutch (3rd pulse) 1 unit of movement, and the number 4 clutch (4th pulse) 2 units of movement. (Although all eccentric links move equidistant the fore-going multiplied motions are obtained through proper pivot locations on the associated linkages.) This then in conjunction with the 5th and 6th pulses provides a maximum of sixty-four possible character selections in the type box. A drive link is eccentrically mounted to each of the four clutches and they are attached to the aggregate motion output link which positions the type box horizontally through the type box link to the character selected by the code combination. The clutch drums of these four clutches are driven continuously through a gear train from the mainshaft.

Print Hammer Assembly—The print hammer assembly shown in Figure 5 consists of two spring-loaded print hammers, latching pawls, accelerator levers and a selecting slide. These hammers are released and reset by a cam on the function clutch. The hammers are selected by the number 6 code bar. If the number 6 code bar is in the spacing condition the letter hammer operates—if in marking, the figure hammer operates. The figure hammer strikes type pallets in type rows 3 and 4 in the type box and the letter hammer in type rows 1 and 2.

Type Box—The type box arrangement and code chart are shown in Figure 6. If the letter R, having a code combination of

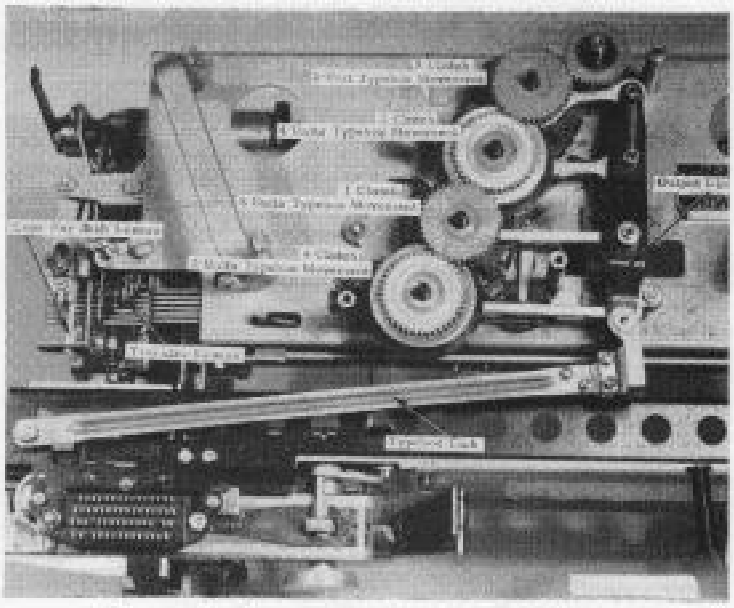


Figure 4. Aggregate Motion Mechanism

2, 4 marking 1, 3, 5, and 6 spacing, is to be printed the number 2 and 4 code bars will trip their respective clutches while number 1 and 3 will remain disengaged. Under this arrangement the aggregate motion will place the type box horizontally in the seventh position from the left. Since the number 5 pulse is spacing, the type box clutch will position the type box in its

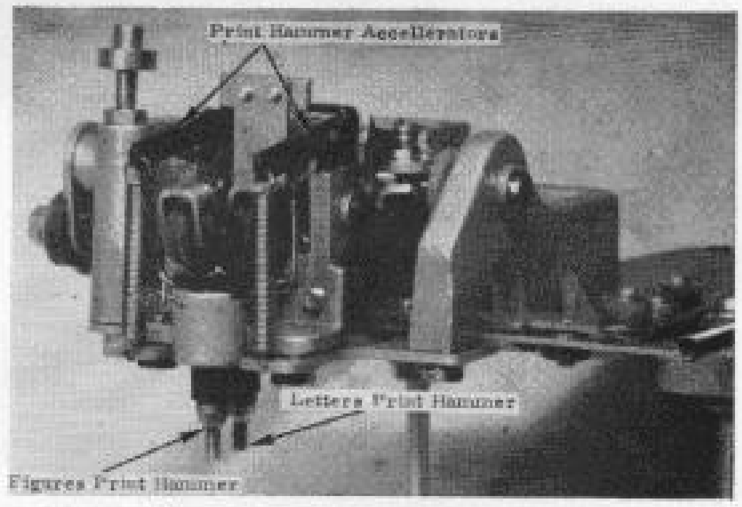


Figure 5. Print Hammer Assembly

forward position (type rows 1 & 3). Since number 6 pulse is spacing, the "letters print" hammer will be tripped by the function clutch on the mainshaft. Thus the letter R is printed.

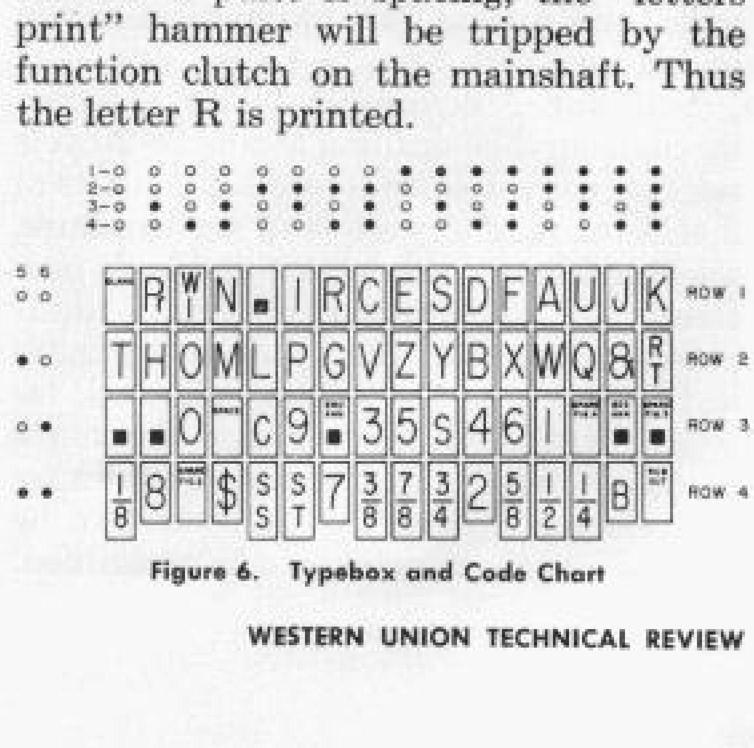


Figure 6. Typebox and Code Chart

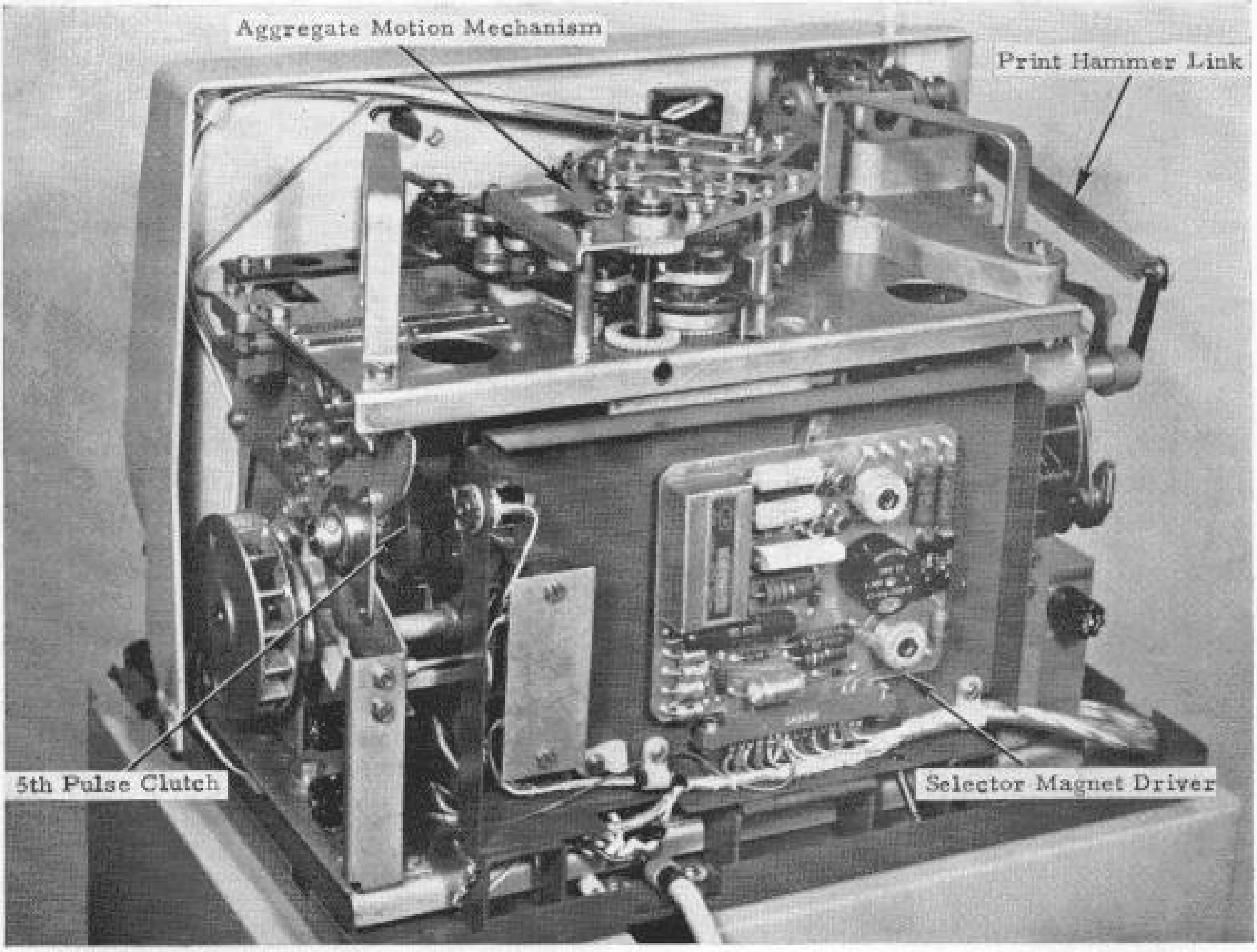


Figure 7.

Ticker Mechanism Uncovered

Rear View

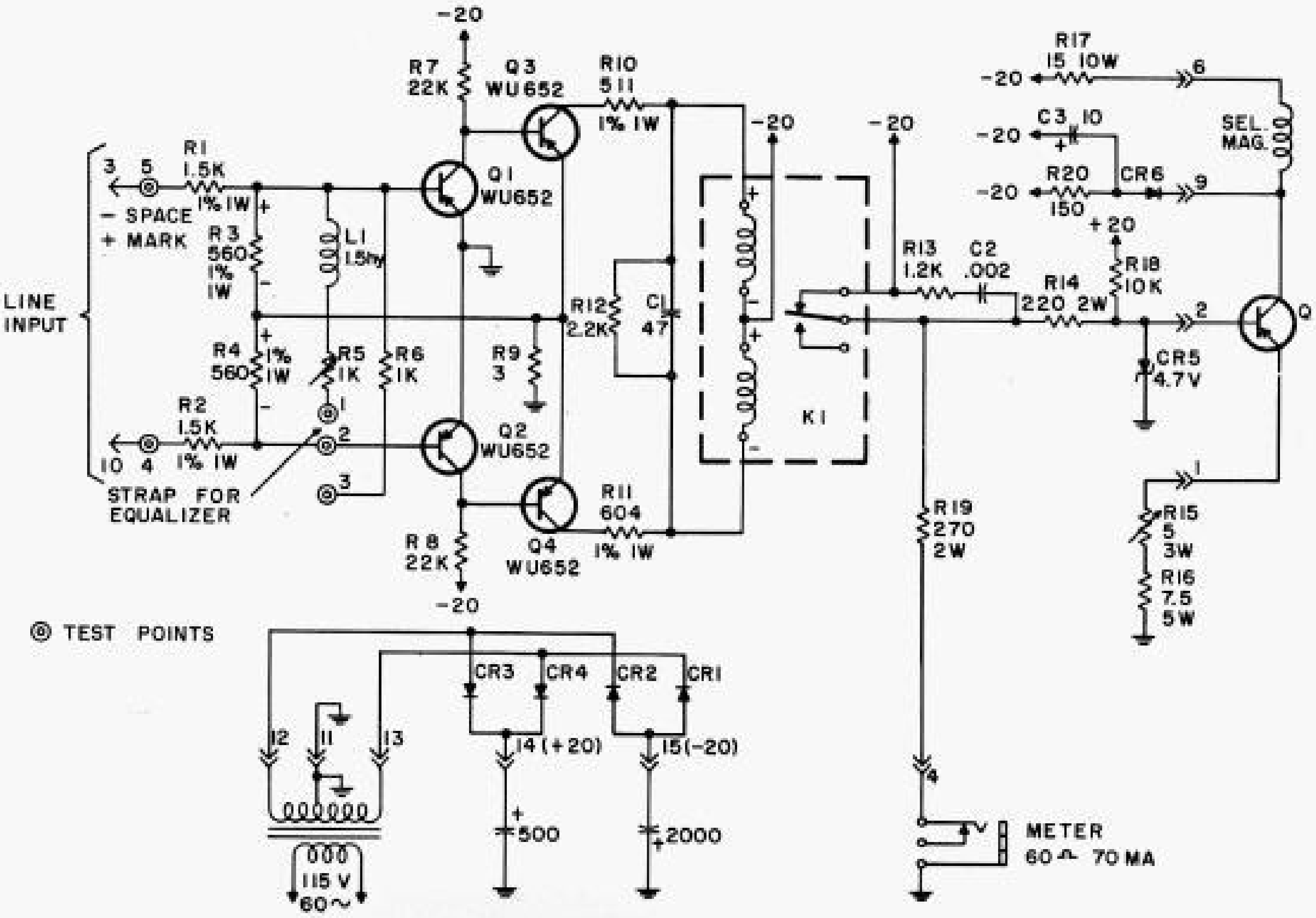
Ribbon and Tape Feed Mechanisms—The ribbon and tape feed mechanisms are operated through a common drive link and shaft arrangement by a cam on the function clutch.

Base and Cover — Both pedestal-mounted and projector-mounted tickers will use a similar base, which supports a motor unit with intermediate gear assembly, terminal block, and fuse receptacles, in addition to anti-noise and vibration mounts for the printing unit.

There are two types of covers available. One completely encloses the ticker, and has a clear plastic front to permit reading the last character printed on the tape, as shown in Figure 1. The second shown in Figure 2 is essentially a half cover, which encloses all of the ticker except the tape container and printing area.

- Circuitry

Selector Magnet Driver Card 11835-A shown in Figure 7 was designed by Western Union for use with the new High Speed ticker. This driver card provides the electronic circuitry, shown in the schematic in Figure 8, necessary to derive control current for the operation of the selector magnet circuit from balanced cable loop signal currents ranging from 2 to 20 milliamperes. The Selector Magnet Driver Card was specifically designed for use in our Class D Service. Class D Service is described in detail in this issue on page 94. The 500 milliamperes selector magnet operating current is obtained through the combined operation of the Selector Magnet Driver Card, a power supply assembly, and an associated power transistor located under the left end of the ticker.



ALL RESISTORS ARE IN OHMS, ± 5%, 1/2 WATT, EXCEPT AS NOTED.
ALL CAPACITORS ARE IN μf.
SYMBOL FOR GROUND (⏚) IS NOT GROUNDED BUT IS THE CENTER OF THE POWER TRANSFORMER SECONDARY.

Figure 8. Schematic of Selector Magnet Driver Card

• Tape Puller and Winder

The tape puller unit is used only with the projection ticker, shown in Figure 2. It is completely different in design from that used heretofore.

This unit consists essentially of two motors (one dc and one ac), a tape reel and a pressure roller assembly which pulls the transparent tape, (as it is fed from the ticker) across the projection unit at a constant speed and winds the projected tape onto a storage reel. A fullwave rectifier and a tape control assembly, both of which utilize printed circuitry, provide the dc voltage source and speed control of the Tape Puller motor.

The tape control assembly incorporates a printed circuit card containing a resistive decade. It is so designed that the lower end common contact segment of the tape arm, which is rotated about its pivot by the amount of tape loop, wipes across the terminating contacts of these resistances thereby increasing or decreasing series resistance for constant speed control of the dc puller motor from a full 900 cpm to a complete stop. This tape control assembly is located on the ticker base and immediately under the printing station and tape chute.

The function of the ac motor is to rotate the tape reel to take up the projected tape as it is fed through the pressure roller assembly. It is so designed as to remain stalled when no tape is being fed to it.

The dc motor drives the knurled tape puller roller to advance the tape being fed from the ticker across the projector. The tape is held in positive contact with the knurled puller roller by a set of spring-loaded pressure rollers mounted to the latch bail. The direct current supplied by the printed rectifier for operation of the dc puller motor is applied through the tape control arm assembly, which is in series with the armature winding.

Advantages of the New Ticker

Comparison of the new 900 characters per minute ticker with other tickers now in other stock exchange services reveals some special advantages.

• Greater Longevity

The all steel Model 28 internal expansion clutch used throughout its mechanism will provide *greater longevity* for the ticker since it is less troublesome, from a maintenance point of view, than the felt friction clutches used on older equipment. Also since 90 percent of its mechanism is operating ½ cycle to enable the printing of two full characters for each revolution of the mainshaft, it can be readily anticipated that overall wear will be substantially reduced. Smooth motion of the tape permits better readability with the constant-speed tape puller.

• Reliability

From all observations made of this new ticker, up to the time of the publication of this article, it is expected that it will provide Western Union with one of the most reliable pieces of telegraph apparatus introduced into the Western Union Network of Systems in many years.

Mr. Charles Turner, General Maintenance Supervisor in the Maintenance and Operations Section of the Plant and Engineering Department, is presently active in the coordination of the conversion of the New York Stock Ticker Lease. He had been coordinator of two previous ticker conversions.

He came to Western Union in 1929 as a maintainer and later was promoted to City Foreman, New York City. He was then transferred to Washington, D.C. in 1942 where he rose to District Plant Supervisor and remained until transferred to the Maintenance and Operations Section of the Plant and Engineering Department in 1960.

Mr. Turner is a graduate of Old Fort High School, Old Fort, North Carolina and attended North Carolina State College in 1927-1928 prior to his employment in 1929.

Mr. George A. Straub, Maintenance Supervisor in the Maintenance and Operations Section of the Plant and Engineering Department and is also active in the New York Stock Exchange Conversion. He is also engaged in the maintenance of all Telex out-station equipment.

He was employed in 1947 as a Materials Inspector after spending two years with a commercial airline as an Aircraft and Engine Mechanic. He was promoted to Technical Assistant in the Specification Engineer's office in 1949 and to Senior Technical Assistant in the office of the Director of Maintenance in 1951. He was promoted to his present capacity in 1955.

Mr. Straub is a graduate of Machine and Metal Trades High School and Radio-Television Institute, New York City and is presently working toward a degree in Electrical Engineering at New York City Community College.

Chong, G. R., Engineer, Broadband Switching Division—P & E Dept.

Interconnection of Three PATS for Philadelphia Stock Exchange

The first leased private automatic telephone system, PATS, was placed in service by Western Union in February 1964 for the Philadelphia Stock Exchange and its member brokers in Washington and Baltimore.

This special application of PATS interconnected three "UP" PATS units and thus provided twenty-seven brokerage firms in Washington and Baltimore with private voice connections to the trading floor of the Philadelphia Stock Exchange. Brokers in these areas can execute buy and sell orders with greater speed and more accuracy.

Terminal Equipment

At the Western Union office in Philadelphia, a converted 100-line Philips "UP" telephone exchange with tie line relay sets (trunk repeaters) was installed along with DX signalling units and Altec Lansing telephone terminating units. In Washington and Baltimore, similar signalling and terminating equipments were used, but the "UP" exchanges were 50-line units. Four trunks were used to tie the "UP" in Philadelphia to the "UP" in Baltimore and four trunks to tie the "UP" in Philadelphia to Washington.

Tie Line Equipment

A tie line set (TLS) provides a means of establishing calls between two telephone exchanges. In the case of the Philips "UP" exchanges, a specially designed two-way TLS provides E and M lead signalling, optional line supervision, talking battery, and an equivalent line circuit. For proper tie line operation in the Philips "UP" system, it is also necessary to add a supplementary unit to the common control circuit (CCC) and wiring to the selector columns and main frame. Figure 1 shows a block diagram of a standard "UP" exchange. The TLS is connected on outlets of the final selector, (FS).

Tie Line Operation

When subscriber wishes to call a subscriber in a distant exchange, he first goes "off-hook." The connecting circuit finder or hunter (CCF) and the line finder (LF) are positioned in the regular manner. When dial tone is received, the caller dials a single pre-assigned digit (6, 7, 8, 9, or 0). A relay in the supplementary unit to the CCC will operate to close a marking path through the relay tree in the CCC so that the group selector (GS) will be properly positioned. The final selector (FS) will also be positioned via a marking path through the relay tree and the TLS. This relay will also operate another relay in the connecting circuit (CC) so that a metallic connection will be made directly through the CC. This metallic connection is necessary in order that pulses (loop interruptions) may be transmitted directly through the connection without releasing it.

When a TLS is seized, its marking path is opened so that no one else can seize that particular set. At the same time, a pulse of 60-90 ms is transmitted to the distant exchange. This pulse transmitted over the M lead is the pulse which seizes the distant TLS. When the TLS in the distant exchange is seized, the CCF and LF of the distant exchange are positioned in the same manner as if a local call were being made. Dial tone is now transmitted back to the calling exchange. When the caller hears the second dial tone, he proceeds to dial the subscriber's number. The operation which takes place in the distant exchange is the same as if the call were a local one.

When the conversation is completed, either party can clear the connection at both exchanges. If line supervision is used, clearing is accomplished by the TLS transmitting to and then receiving a pulse from the other exchange.

2) Additional wiring for full access to 12 connecting circuits in the Philadelphia 100-line cabinet.

Normally the CCC has access to only 6 CC for making calls from extensions in the first 50 group. Access to the 6 CC is accomplished by the operation of a group relay. Extensions in the second 50 group have access to a second group of 6 CC. This is accomplished by the operation of a second group relay. To provide full access to all 12 CC regardless of which group a caller is attempting a call, the group relays are connected in parallel such that they both will operate at the same time when a call is attempted. If a caller in the first 50 group, in attempting a call, seizes a CC in the second 50 group, the LF associated with the seized CC must be positioned on the calling extension's line circuit. The calling extension, however, is terminated on the LF bank of the first 50 group. In order for the LF of the seized CC to be positioned on the calling extension's line circuit the LF terminals of the first 50 group were connected to the corresponding LF terminals of the second 50 group. Because of the multipling of the LF, the number of usable extensions is reduced to 50.

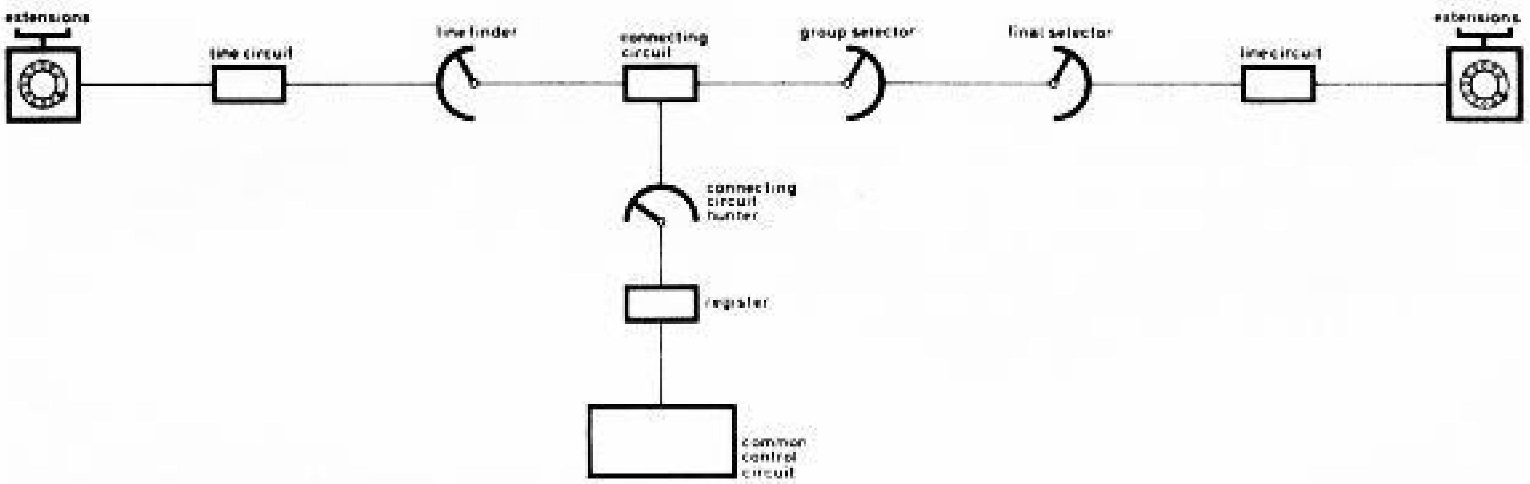


Figure 1—Block Diagram of Standard "UP" Exchange

Special Wiring

In order to meet the needs of this particular application, some special wiring of the "UP" cabinets was required.

1) Strappings to obtain 1-digit trunk access code and 2-digit station dialing.

A 1-digit trunk access code is standard operation. Therefore, it was necessary only to make special strappings on the call discrimination strip of the register. For 2-digit station dialing, strappings were also made in the register such that when the first station digit is dialed, both the hundreds and tens identifying relays are operated at the same time. The register will, therefore, accept the first digit as a tens digit and the output will be two digits. Since the GS is normally positioned by the hundreds digit and it is now necessary for the GS to be positioned on the same FS at all times, the outputs, the hundreds relay tree were all strapped together.

3) Rewiring of supplementary unit to CCC.

The supplementary unit to the CCC was rewired to prevent tandem calling and also to limit calls to those made via a TLS, whether incoming or outgoing. Whenever a TLS is seized, a relay in the supplementary unit is operated. The operation of this relay will cause the "Go Ahead" relay in the CCC to operate which will then be the signal for the GS to be positioned. The positioning of the FS will follow. If a local call is attempted, the special relay in the supplementary unit will not operate. The path for the "Reject" relay will then be closed and the path for the "Go Ahead" relay will be opened. When the CCC tests for the selected number, the "Reject" relay will operate. The CCC will disconnect and busy tone will be transmitted to the caller.

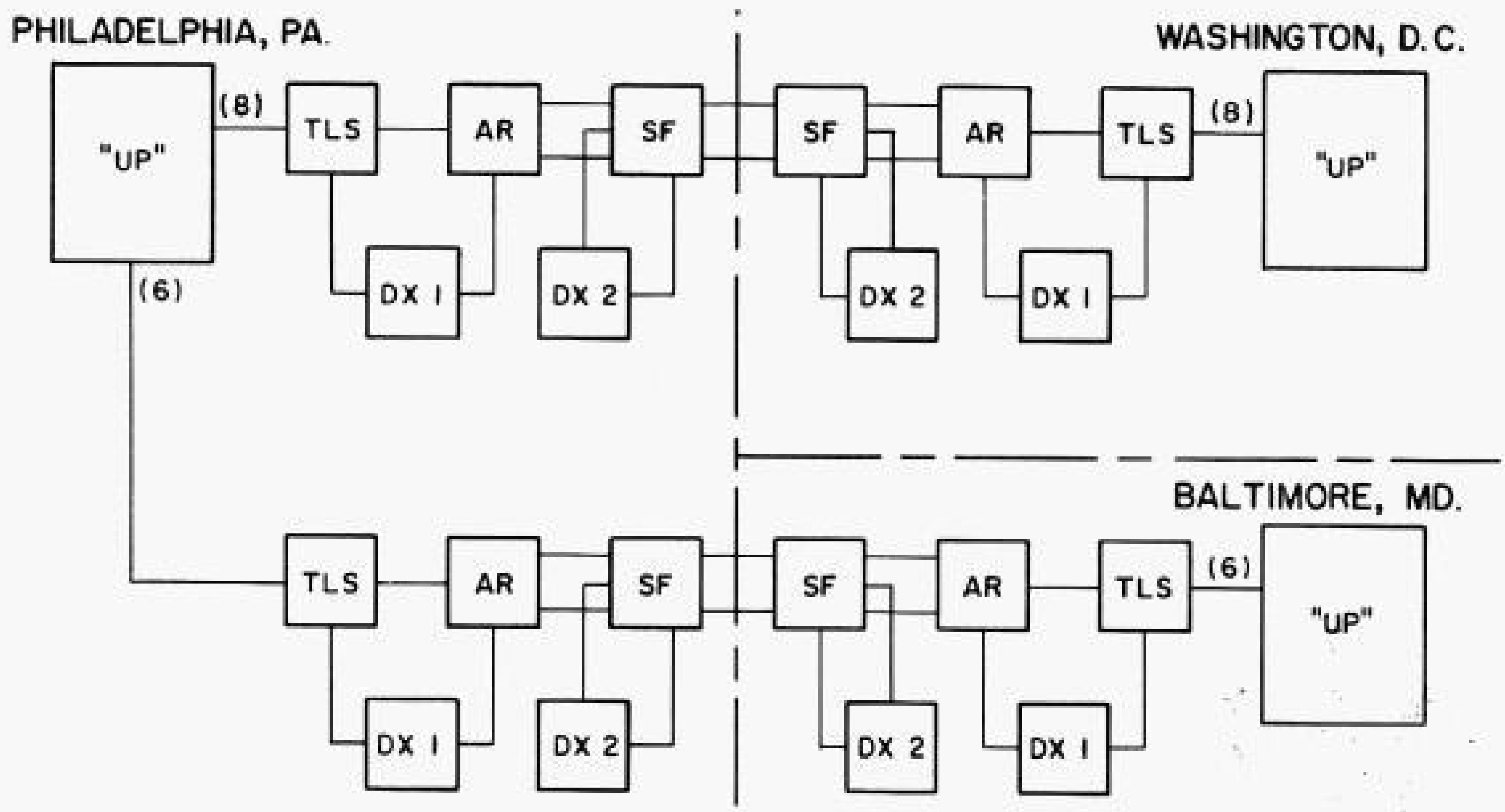
4) Expansion to accommodate 8 TLS's instead of 4 in the Philadelphia cabinet.

The single "UP" cabinet was designed to handle a maximum of 4 TLS's. Some rewiring and additions had to be made to accommodate 8 TLS's. Extra supplementary wiring forms were installed in the spare shelves of the cabinet. The TLS's were terminated on terminals 43-50 of the 54-point FS switch. This means that 46 extensions (54—8=46) are available under this arrangement.

System Operation

Figure 2 shows a block diagram of the system installed for the Philadelphia-Baltimore-Washington Stock Exchange.

If a subscriber in Philadelphia wishes to call a subscriber in Washington, he goes "off-hook," and, after receiving a dial tone, dials the digit 8. He seizes a free TLS which sends out a seizure pulse of 60-90 ms. This dc pulse is repeated by the DX1 signaling set and transmitted on a simplex mode to the DX2 signaling set. The DX2 signaling set repeats and translates the pulse into the proper polarities to key the Philadelphia in-band signaling equipment. (DX1 and DX2 signaling sets were necessary in this installation because the in-band signaling equipment was remote from the TLS). The Washington in-band signaling receiver converts the ac tone to a dc pulse, which is repeated by the DX signaling sets into the Washington TLS. The Washington TLS is now seized, a CCF and a LF are positioned and dial tone is transmitted from the Washington exchange, through the voice path of the TLS, the AR, to the facilities, to the AR, TLS and "UP" exchange in Philadelphia to the caller. The caller,



TLS — Tie Line Set
AR — Altec Lansing Telephone Terminating Unit (2 to 4 Wire Converter)
DX1 — Signaling Set
DX2 — Signaling Set
SF —2600 cps In-Band Signaling Units

Figure 2—Block Diagram of the Philadelphia Stock Exchange System

hearing the second dial tone, dials the 2 digits of the called subscriber. The pulses are transmitted through the "UP" exchange, repeated by the TLS and DX sets in Philadelphia and TLS and DX sets in Washington to the register in the "UP" exchange in Washington. Ringing tone and ringing current are transmitted from the Washington exchange. The subscriber who goes "on-hook" first will send a pulse from his TLS to the distant TLS to clear the connection.

Calls made from Philadelphia to Baltimore are made in the same manner by dialing the access digit, 6. The present Philadelphia Stock Exchange in the system encompasses three cities, however it can be readily expanded to include many more cities throughout the country.

Future of PATS

The initial success of the Philadelphia-Baltimore-Washington Stock Exchange PATS system shows that Western Union's future in the voice field is very bright.

The design of the switching equipment with low maintenance as one of the main factors has resulted in a high efficiency, low maintenance system. A recent check of the system trouble log indicated extremely few cases of troubles resulting from the PATS unit. Maintenance time for the system consists mainly of routine testing of major switching components for normal operation, and cleaning and oiling of the selector switches and shafts.

An example of the system reliability can be seen from this excerpt from the system log:

"January 30 Stock Exchange at Philadelphia lost commercial power due to a defective transformer in the basement of the Stock Exchange building causing all lights and commercial phones to be inoperative. Western Union PATS system worked perfectly through the entire power failure allowing the customer to notify all his Baltimore and Washington subscribers of the trouble and requesting them to route business to New York if possible. Customers were very pleased to find that the PATS phones did not depend on power in the exchange building."

During this crisis, the PATS system was able to handle an abrupt increase in normal traffic load of more than 30% without incident.

The "UP" PATS has demonstrated its speed, efficiency, and flexibility which makes it very attractive to a potential customer.

References:

1. PATS—G. R. Chong, Western Union TECHNICAL REVIEW, Vol. 18, No. 2, October 1964.

Mr. G. R. Chong is an Engineer in Broadband Switching division of the Plant and Engineering Department since October 1963. He has prepared specifications on the operation and installation of Philips "UP" PATS and assisted in the installation and testing of first PATS for Philadelphia-Baltimore-Washington Stock Exchange. Prior to joining Broadband Switching group he was associated with the Facsimile division where he was engaged primarily in the applications of facsimile equipment and systems.

He joined Western Union in February 1961 after spending a year at Bendix Corp., Holmdel, N. J. developing and producing small signal R. F. Transistors.

Mr. Chong received his B.E.E. degree from Rensselaer Polytechnic Institute in January 1960. He is a member of the I.E.E.E.

R. L. Snyder, Systems Engineer, Planning Department

Message Protection in the AUTODIN Message Switch

Errors, failures, and a variety of other fortuitous internal and external stresses are special problems in all real-time systems. As a member of the real-time family, the computer-controlled message switch must cope with all these problems. However, in contrast to some real-time systems, where input data often is highly redundant and past history is not always essential, the message switch may never either ignore its input or fail to provide complete accountability for any past input.

Most of the published descriptions of message switching systems concentrate attention on the primary communications functions which they perform, i.e., message storage, routing, queueing, and retrieval. The purpose of this article is to describe the AUTODIN message switch from the viewpoint of the vital secondary functions: the protection of traffic and the maintenance of operation under conditions of extreme stress.

Because the AUTODIN System is under constant review and new requirements are frequently imposed, additions and modifications in equipment and in computer programs prevent the publishing of a completely contemporary description of the AUTODIN message protection features. An earlier paper on this subject was prepared before the system reached operational status[1]. The present article was motivated by the numerous changes that have since been made. While it accurately describes the system at one stage of its operational history, three stages of subsequent development of the domestic AUTODIN system are currently in progress. As of this publication date, at least the first of these will have been implemented.

System Description

AUTODIN is the Department of Defense's first high-speed, digital communication system using advanced information handling techniques for circuit-switching and store-and-forward facilities[2,3]. Automatic electronic switching centers forward messages on a priority basis. A pair of large-scale, general purpose, digital Communication Data Processors (CDP) control each center. One is on-line, processing all traffic through the center while the other serves as backup, ready to assume on-line responsibilities.

Editorial Note: This is the fourth of a series of articles on AUTODIN.

The AUTODIN message switching network provides facilities for several hundred stations to communicate quickly among themselves through a network of five automatic switching centers. Each station is connected through a two-way communication channel to the switching center in its zone; the centers are also interconnected by communication channels. A station sends a message by transmitting the message, including appropriate address information, to its switching center. The center accumulates the entire message, and sends copies of the message to those addressed stations (addressees) it serves. Other switching centers can act as relay centers in the interchange of messages. The switching center can communicate simultaneously through all of its input and output channels. A subscriber may transmit a message at any time, and receive messages continually.

The CDP nucleus is a high-speed magnetic core memory (HSM) and a basic processing unit (BPU) which performs logical and data manipulation. Seven transfer channels provide communication between the CDP and high-speed printer, consoles, magnetic drums, magnetic tapes, and Accumulation and Distribution Units (ADU). These buffered transfer channels "time-share" the HSM with the BPU, permitting simultaneous operation of peripheral devices and the BPU. An unbuffered transfer channel is used for communication between duplexed CDPs.

The ADU *accumulates* data from each input communication channel independent of the others, and similarly *distributes* data to output channels. The ADU collects characters of a message in groups called line blocks, and simultaneously stores a number of line blocks for each channel, the maximum number depending on the channel transmission speed.

The ADU maintains a status tally for each channel which includes the number of line blocks stored for the channel. Message data transferred between ADU and on-line CDP is composed of various message segments, each containing one or more line blocks.

Message Protection Requirements

The protection of traffic involves the accounting for each transmission of every message. Implicit in this accounting is a clear delineation of responsibility for each copy of a message transferred between system components.

In a line switching system, where stations are connected directly, this responsibility involves only the sender and the receiver. A store-and-forward system introduces complications. The originator and receiver do not communicate directly. Every message experiences at least two transmissions: one from the point of origin into a message switch, and one from a message switch to the destination. Multiple-destination messages and messages that are relayed through several switches experience additional transmissions. In general, a message passing through a number of centers, N, will experience at least $(N+1)$ transmissions. An additional complication in the handling of multi-destination messages is that outbound transmission of the individual copies proceeds independently, rather than in any particular order.

In AUTODIN, the exchange of message responsibility is effected by acknowledgement signals. A message is the responsibility of the sender until explicitly "acknowledged," signifying the acceptance of responsibility for the message by the receiver (another switching center or station). Within a switching center, message responsibility is transferred among the ADU, drums, and magnetic tapes; the CDP transfers the message segments, coordinates the exchange of responsibility, but never assumes responsibility itself.

A special requirement of AUTODIN is fast, automatic recovery from on-line switching center failures without loss of traffic. The on-line recovery facility is backed up by a recorded history (Reference Records) of all traffic and a history of each significant transaction performed by the CDP (Journal Records), on magnetic tape. These records may be processed off-line should the automatic on-line recovery procedures fail.

Basic Programs

The AUTODIN Operational Program is divided into On-Line, Standby, and On-Line and Off-Line Recovery Programs. The On-Line Program, responsible for the actual processing of the traffic in the on-line CDP, stores information in peripheral devices and in the HSM to protect the traffic against system and subsystem failures. The Standby Program, used by the standby CDP, coordinates the transfer in a scheduled switchover to the on-line role or to the On-Line Recovery Program as the result of an on-line CDP failure. The On-Line Recovery Program is used by a CDP to go from standby to on-line and resume processing of traffic after a CDP failure. Since on-line CDP failures can corrupt data stored in HSM, the Recovery Programs use redundant information stored in various peripheral devices, rather than any information potentially available to the standby CDP from the on-line CDP.

Organization of the On-Line Program

The On-Line Program is organized into cycles, during which message segments are brought from various peripheral devices to the CDP, and after processing, sent to other peripheral devices, as shown in Figure 1. The On-Line Program, in this section, is discussed independently of the message protection features. The description relates to traffic exchanged between the CDP and the ADU; other traffic exchanges, e.g., between the CDP and certain magnetic tapes, are similarly processed.

During each cycle, the ADU tallies are read to determine which channels require servicing. The sequence of the following paragraphs does not correspond to the actual order of events within the program cycle; the actual order is shown in Figure 2. The transfer of incoming segments from the ADU to drum storage (via the CDP input buffer area) is scheduled. The program accounts for restrictions imposed by the drum system characteristics and the method of organizing message segments on the drum. Input scheduling updates bookkeeping tables in the HSM.

Once the incoming segments are scheduled and read into the input buffer in HSM, the program processes them, determines message destinations, and format validity, prepares Journal Records for certain types of segments (e.g. the first segment of a message), and updates various HSM bookkeeping tables.

There are three major sets of tables used by the program in the handling of messages. The *Drum Maps* locate the start of each message on drum, and link together the successive portions of each message stored in scattered locations on drum; unoccupied drum space is also identified by these tables. The *Destination and Queue Tables* establish the chronology of messages, according to priority, for each destination. Each occupied entry in these tables refers both to a next entry and, indirectly, to the start-of-message entry in the Drum Maps.

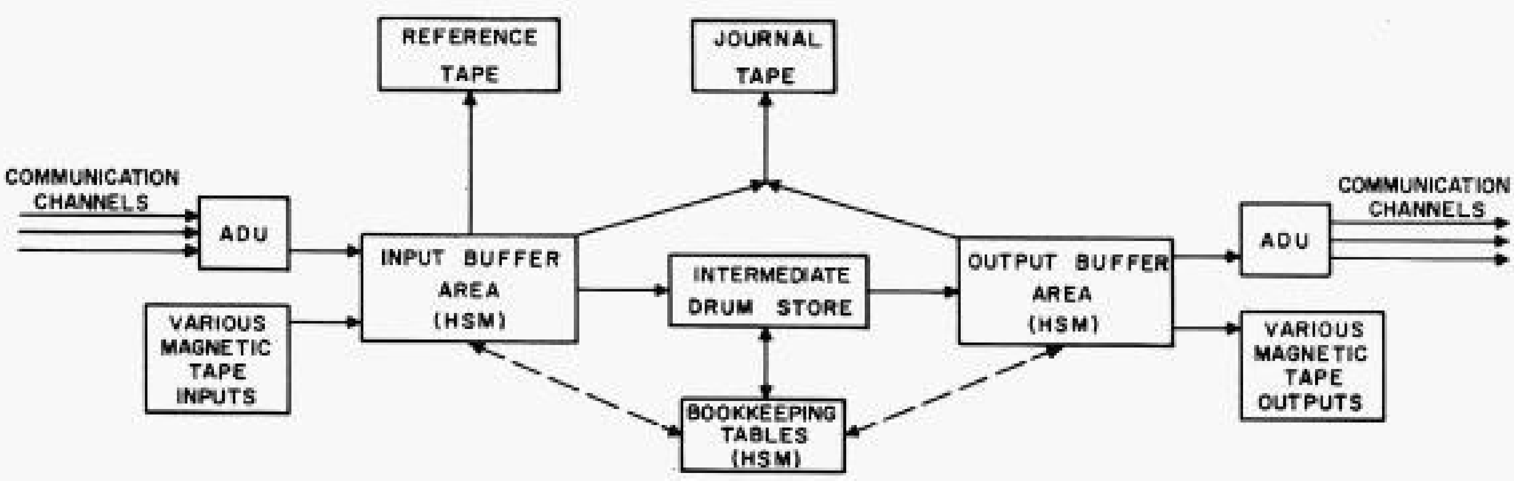


Figure 1. Dataflow Through a Message Switching Center

The *Input and Output Channel Control Parameters* tables contain status information used by the program to schedule and maintain traffic flow on each channel, as well as to record fixed and dynamic channel parameters. From the various indicators and switches in the entry for a particular channel it is possible to detemine whether a message is in process, and if so, what stage of processing has been reached. The identity of any message in process can also be determined, as well as the status of the ADU with respect to the current message.

When processing of the input data is completed, the contents of the input buffer area are recorded on magnetic tape as Reference Records and the message segments are stored in the scheduled locations on the drums.

The output function is initiated by scheduling the transfer of outbound message segments from the drums to the ADU via the CDP output buffer area. The outgoing segments are also processed in the output storage area. During this processing, Journal Records are prepared for certain segments. When processing is completed, the message segments are transferred to the ADU.

A new cycle is initiated when these functions have been accomplished.

Message Protection in the On-Line Program

The On-Line Program uses three mechanisms to prepare the system for rapid recovery from failures: (1) storage of control information in peripheral devices; (2) use of control information in the transfer of data between various system devices; (3) restrictions placed upon the sequencing of events within the program cycle.

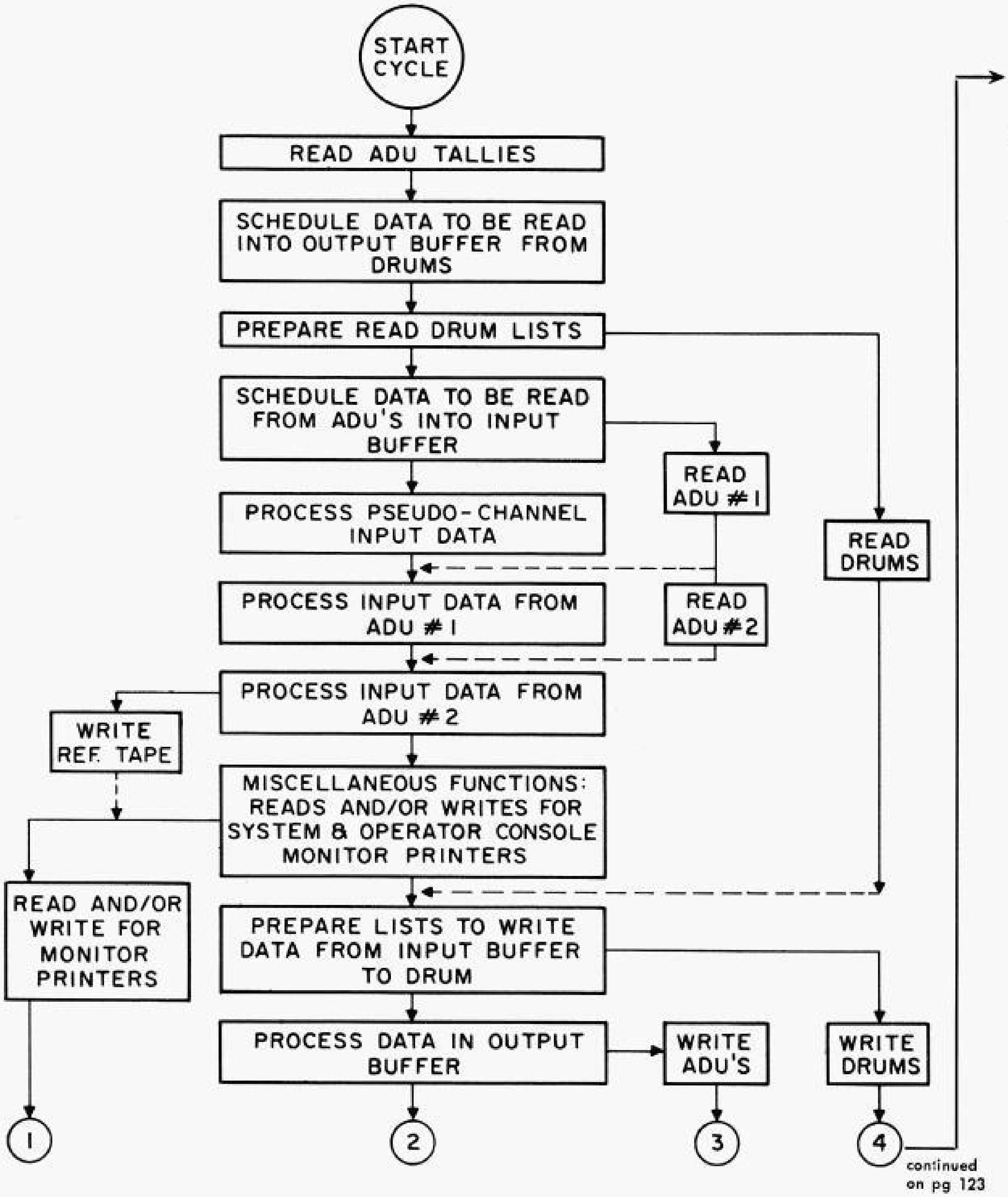
Control information consists of two primary types of data: (1) the Ledger Record, written every cycle on drum; (2) Reference and Journal Records, written on magnetic tape. The On-Line Recovery Program depends primarily upon the Ledger Record and the Off-Line Recovery Programs depend upon the Reference and Journal Records.

One section of each drum is reserved for the Ledger Record. This record contains all essential dynamic information needed by the On-Line Recovery Program. A Ledger Record contains the status of every input and output channel, the Drum Maps, the Destination and Queue Tables, and status information for each peripheral device of the CDP, along with the day of year, clock time, and the Cycle Number (CYN). Each program cycle is identified by a 24-bit CYN which is simply a cycle counter. The CYN serves to associate the Ledger, Journal and Reference records with the program cycle in which they were written. Note that although the Ledger Record is written every cycle, it is not overwritten on successive cycles, thereby providing at least one good record at all times. A CYN written at the start and end of the record allows verification of record integrity.

Two important types of control information used by system devices are the Channel Block Sequence number (CBS) and the acknowledgement signals. The CBS is a modulo 32 counter maintained both by the ADU and the On-Line Program for the line blocks transferred on each input and each output channel. A CBS character is added by the ADU to each line block received from a channel and is checked by the On-Line Program when the line block is read from the ADU. On output, CBS characters are generated by the program, inserted in outgoing line blocks sent from the CDP to the ADU and are checked in the ADU. The CBS of the last line block sent and received for each channel is written as part of the Ledger Record.

Acknowledgement signals are used between CDP and ADU and between ADU and the remote station terminal equipment. When the CDP reads message segments from the ADU, the segments are retained by the ADU until explicity and individually acknowledged by the CDP. On output, messages are not considered to have been delivered until acknowledgements from the receiver are returned to the ADU. Messages are wholly retained on drum until acknowledgements are received for all transmissions that are necessary.

Restrictions placed on the sequencing



Simplified sequencing diagram of On-Line Program cycle. Only two ADU's are shown here, although the program actually handles up to four ADU's. The pseudo-channel input data processed in Figure 2 (a) originates mainly from IC (Intercept), IM (Intermediate, or Overflow), and EDPE (direct industry-compatible) magnetic tape inputs which are scheduled one cycle in advance, as shown in the center of Figure 2(b). Because the length of all processing and in-put/out-put functions varies from cycle-to-cycle according to the amount and distribution of traffic loads, no attempt has been made in this figure to portray timing, except to indicate the general concurrency of processing and multiple input/output operations.

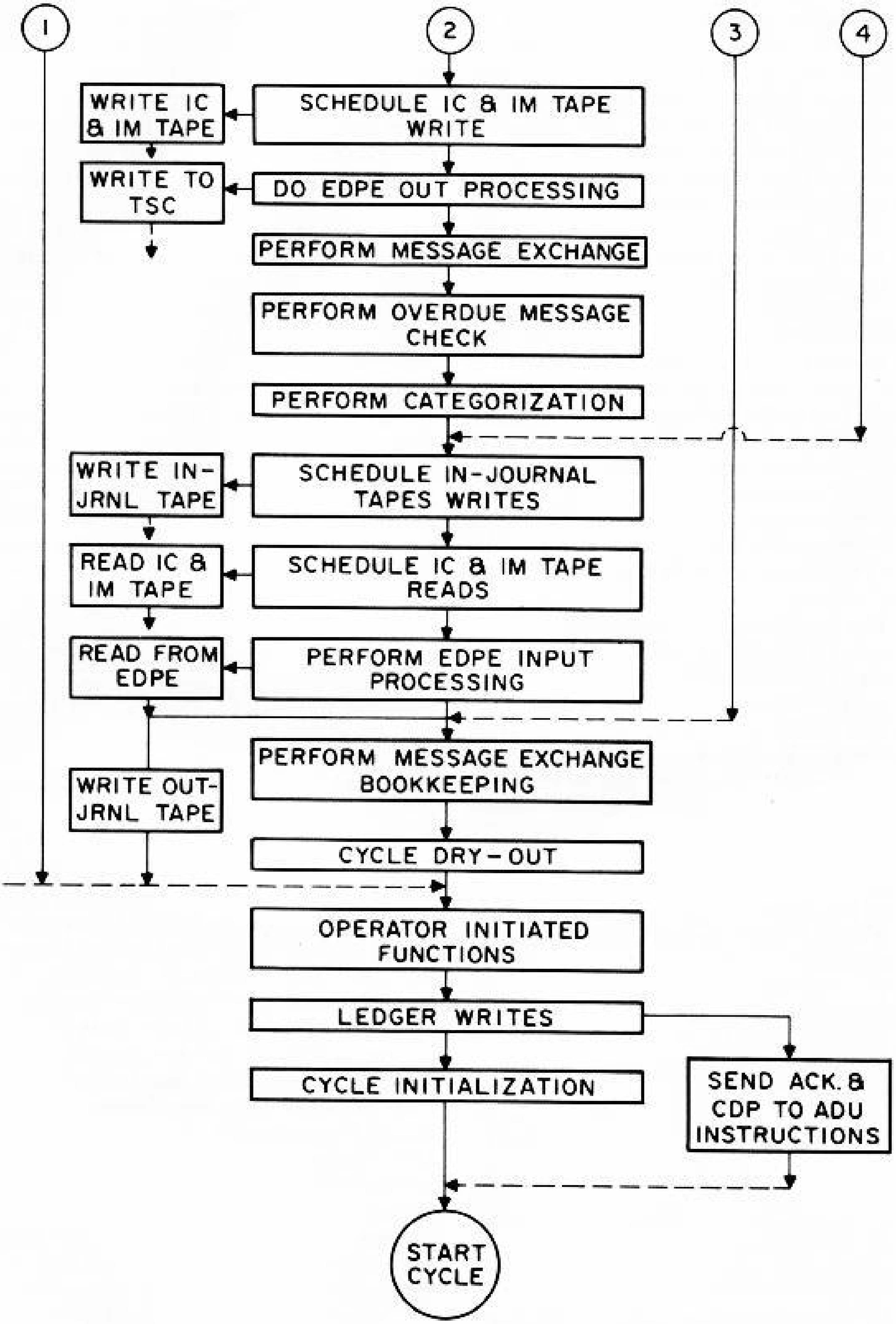


Figure 2. Program Cycle—Sequencing Diagram

of events in the cycle provide the framework for judging the acceptability of information found in peripheral devices subsequent to a CDP failure. This sequence of events, shown in Figure 2 provides the On Line Recovery Program with a basis for reconstructing a situation (in the HSM and in the peripheral devices) that allows the resumption of the On-Line Program.

The cycle is initiated by the reading of ADU tally information. Message segments are scheduled to be transferred from the drums to the output buffer and then to the ADU. At this point, transfer from the drums to the output buffer is initiated. Next, the transfer of message segments from the ADU to the input buffer is set up and started. When this transfer is completed, the input message segments are processed and the Reference write operation initiated. The transfer of the input message segments to the drums can now be set up.

The bookkeeping tables reflect the planned transfer of all data during the cycle. The "drum write" operation can begin subsequent to the completion of the "drum read" operations (when the drum transfer channel becomes available). The "drum write" operation places the message segments on the drums in appropriate locations.

Transfer of message segments from the output buffer to the ADU is initiated after the segments have been processed and the drum write operation completed.

The writing of Journal records is started after the Reference and ADU "writes" have been completed. The initiation of the Journal write operation signifies completion of all message segment transfers for the cycle, and at this point the Ledger Record may be written and acknowledgements sent from the CDP to the ADU for the inbound message segments that have been read and successfully processed.

Recovery Procedures

Recovery procedures provide for many types of failure: drums, tapes, ADU, CDP, and combinations of these as well as for total power failure. Message protection against a CDP failure and recovery procedures after it illustrate the outstanding features of the whole system.

Information stored in peripheral devices subsequent to a CDP failure varies considerably. Drums contain segments of active and obsolete messages intermixed in random fashion. Transmissions of messages stored on the drums may have started on one or more output channels. Some or all the transmissions of specific messages may have been completed. Beginnings of messages not yet fully received are scattered around the drums. A segment of any of these messages may be stored in both the ADU and on a drum. Reference Records may be absent, fragmentary, or complete for the last data transferred from ADU to CDP. The Journal Records may or may not reflect an up-to-date recording of essential transactions.

Rules to follow in recovering from a CDP failure are determined by the structure of the On-Line Program. Each message protection feature of the program is included because recovery would be difficult or impossible without it. It is neither practical nor necessary to attempt to pinpoint the program location where the failure occurred. The On-Line Recovery Program attempts to establish the state of its HSM which, with the data stored in peripheral devices, provides a consistent picture of a situation from which processing of traffic may proceed without loss or unknown duplication of messages. The reconstructed situation need not be a normal continuation of the state prior to failure, but must be meaningful to the system. The status of the data extracted from peripheral devices during recovery should be explainable in terms of the On-Line Program. If the data are found to be inconsistent (i.e., unexplainable in these terms), a clean reload of the system is needed and the message protection functions must be accomplished off-line. Assuming no such inconsistencies are found, the nature of recovery procedures may be clarified by the following example.

Assume that a "hard" failure has occurred, i.e., an internal CDP error condition or state is reached which does not allow the current program cycle to proceed. Depending upon the nature of the failure and the status of the standby CDP, one or the other of these two machines will automatically initiate the On-Line Recovery Program.

The On-Line Recovery Program must decide which of several Ledger Records corresponds to the last completed program cycle and using the data contained therein, provide the system with a logical restart point corresponding to the start of the cycle in which the failure occurred. For this example, assume that an inspection of the Ledger Record areas on the drums reveals the following data:

Drum #1 contains a Ledger Record having Cycle Number N-1; Drum #2 contains a Ledger Record being CYN N at the start and CYN N-2 at the end; Drum #3 contains a Ledger Record having CYN N; Drum #4 contains an empty Ledger Record. The empty Ledger Record on Drum #4 indicates that this drum was not being used for ledger purposes. The situation depicted by the contents of these drums is a double failure: a drum failure and an internal, uncorrectable CDP error occurred within less than two cycles. Prior to cycle N, Drums 1 and 2 were being used to store Ledger Records; the Ledger Record for cycle N-2 was written to Drum #2, and the Ledger Record for cycle N-1 to Drum #1. Drums 3 and 4 were not being used to store Ledger Records. A "hard" write error occurred during the Ledger Record write to Drum #2 during cycle N, causing the program to switch to Drum #3 and reissue the Ledger write. Thus, on Drum #2 the earlier Ledger Record for cycle N-2 was partially over-written by a fragment of the record for cycle N. The complete Ledger Record for cycle N was successfully written to Drum #3 but sometime between this point and the start of the Ledger Record write in cycle N+1 (which would have been written to Drum #1), an internal CDP failure occurred and the On-Line Recovery Program was automatically initiated.

The state of the system at the boundary between cycle N and cycle N+1 is described by the contents of the Ledger Record on Drum #3. In addition to using this Ledger Record to reconstruct the dynamic information needed to resume traffic processing, the Recovery Program must also position the various system magnetic tapes to avoid duplication or inconsistency between any data that may have been written during the aborted cycle N and the re-executed cycle N that will take place after the recovery. A similar housekeeping task is performed for any supervisor typeouts that were in process during the failed cycle.

Because the CDP writes data to the ADU's during the later stages of the on-line program cycle (see Figure 2), most failures will occur before this point has been reached. Nevertheless, some fraction of failures will occur during or after the writes to the ADU's. In general, any message segment written to an ADU during an aborted cycle may be duplicated after the recovery unless specific preventive provisions exist. The Channel Block Sequence Number (CBS), described earlier, is the mechanism for preventing such duplication. Once the on-line program is restarted, any possible segment duplication, caused by scheduling the same line block(s) after the recovery that were written to the ADU in the failed cycle, is detected by the CBS check in the ADU. Whenever the ADU indicates that the CBS check has failed on some channel, any message transmission in process on that channel will be terminated and the entire message will be re-sent from the start by the program.

An inverse but more remote possibility of segment *loss* arises on input from the ADU. Although message segments that are read from the ADU are not acknowledged by the CDP until nearly the end of the program cycle, it is possible that failure might occur after this point. Note that the acknowledgement from the CDP to the ADU effectively erases these input segments from the ADU Data Memory; therefore, after the recovery, they are no longer available. In this case, however, once the on-line program is restarted the CBS maintained by the on-line program will not agree with the CBS character inserted by the ADU in the inbound line-blocks. Whenever the input CBS check fails, any message in process on the affected channel is rejected, and must be retransmitted.

In summary, if the on-line program cycle was aborted before the CDP wrote to the ADU's, or if no message data to the ADU's were scheduled during the failed cycle, the recovery process will not be detectable externally, since transmission continuity is preserved for all messages in process. If the failure occurred during or after writes to the ADU's, only those messages for which a segment was written *during the failed cycle* will be terminated and retransmitted. The number of messages affected by a typical failure is a small fraction of the total number of channels because: (a) only those failures occurring during the later stages of the program cycle can cause a discrepancy in the CBS check; (b) the peak traffic capacity of the CDP hardware/program system is seldom demanded by the actual traffic load and, therefore, in a typical cycle, the number of segments that are transferred is relatively small. In any event, all messages not in process of transmission, i.e., messages that have been completely received and are on queue, are fully and automatically protected by the On-Line Recovery Program, and no retransmission or other off-line procedures are needed.

Many other failure situations are, of course, possible, and a variety of other special provisions exist in the recovery programs. In certain cases, it may not be possible to determine, without obtaining information from a remote terminal station, whether a particular outbound or inbound transmission terminated normally. Whenever this doubt arises, the subject message is tagged "suspected duplicate", so that in the event the original transmission was indeed complete any retransmission that may occur will not result in an unidentified duplication. A considerable amount of analysis is performed by the program to minimize the occurrence of such situations.

Because not more than a segment of any one message can at any time be stored in the ADU for a data channel, ADU failure cannot compromise message protection. Those channels which do not have the protective features of the data channel depend upon sequential message numbering for message protection in such situations.

Off-line recovery procedures are provided for message protection in two essentially different situations: (1) As a result of total system failure, e.g., invalid, unreadable, or absent Ledger Records; (2) failure of message tape (overflow or intercept tape) or drum read failure. In the event of a drum read failure, off-line procedures are necessary to reintroduce the messages contained on its surface. However, since the segments of any message are not spread over more than one drum, all messages contained on the remaining drums of the system are unaffected and normal on-line processing continues. Note that despite the write failure of Drum #2 in the example given earlier, the program would have continued to read messages stored on Drum #2 if it were possible to do so.

The On-Line Program maintains, on magnetic tape, all data needed to recover messages off-line. First, Journal Records are written, recording all message transactions between the CDP and the remote terminal stations. A journal entry is written at the start and end of every inbound and outbound message transmission. Information is provided in these entries to correlate in-entries and out-entries for the same message. Multiple out-entries are written for messages sent to more than one channel, and the "last" transmission is explicitly designated. Second, Reference records are written of all inbound message segments, as they are received from the ADU; it is from these records that the Off-Line Recovery Program may actually retrieve messages.

The Off-Line Recovery Program reads and processes the Journal information to determine the identity and destinations of all messages that must be recovered. Depending upon the type of recovery, this may include all messages contained in the system at the time of total failure, only messages stored on a particular drum or tape, or messages transmitted earlier to some particular destination. The message segments are retrieved from Reference tape, sorted into complete messages, given special pre-headers specifying their destination(s), and written to a recovery tape for re-introduction to the on-line system.

References

1. Message Protection Features in the DATACOM (COMLOGNET) SYSTEM, A. E. Miller and A. B. Shafritz, Auerbach Corporation, Philadelphia, Pa.; and, John R. Smith, Radio Corporation of America, Camden, N. J. Published in Proceedings of IFIP Congress 62, and presented at the IFIP Congress, Munich, September 1962.
2. AUTODIN — System Description, Part I — Network and subscriber terminals—H. A. Jansson, Western Union TECHNICAL REVIEW, January 1964, Vol. 18 No. 1.
3. AUTODIN—System Description Part II—Circuit and Message Switching Centers—H. A. Jansson, Western Union TECHNICAL REVIEW, April 1964, Vol. 18 No. 2.

MR. ROBERT L. SNYDER, Systems Engineer, in the Planning Department, has been a key figure in the planning and development of the AUTODIN system since mid-1958, when the project began.

Mr. Snyder joined Western Union in 1953, entering the Switching Group of the Development and Research Department, where he participated in design of the Plan 55 switching system. In the Automation Group during 1956-57 he was engaged in a feasibility study of computer-controlled switching which resulted in the design of probably the first message switching system based upon these techniques; he is co-holder of a patent issued for this design. Mr. Snyder joined the Planning Department when it was formed in 1957.

He received his BEE from the Polytechnic Institute of Brooklyn and has attended the graduate school there as well as at Columbia University and the Stevens Institute of Technology. He is a member of IEEE and ACM.

The continuing development of the AUTODIN project comprises:

1) *The AUTODIN Enhancement Program, to be completed by Spring 1965, which will provide additional core memory capacity to the CDP—and a spare ADU at each switching center,*
2) *A series of Program Improvement Packages called PIP's, which are currently being installed in the system.*
3) *The AUTODIN Expansion Program, whereby the present five-center network will be expanded to nine centers, with a capacity to serve over 2500 stations.*

Western Union's Dial-a-Wire Service

Western Union's first public "dial-a-wire" Telex machine went into operation in New York in June 1964.

Customers who wish to "telex" their messages will use a dial-equipped teleprinter located in the office's front lobby area.

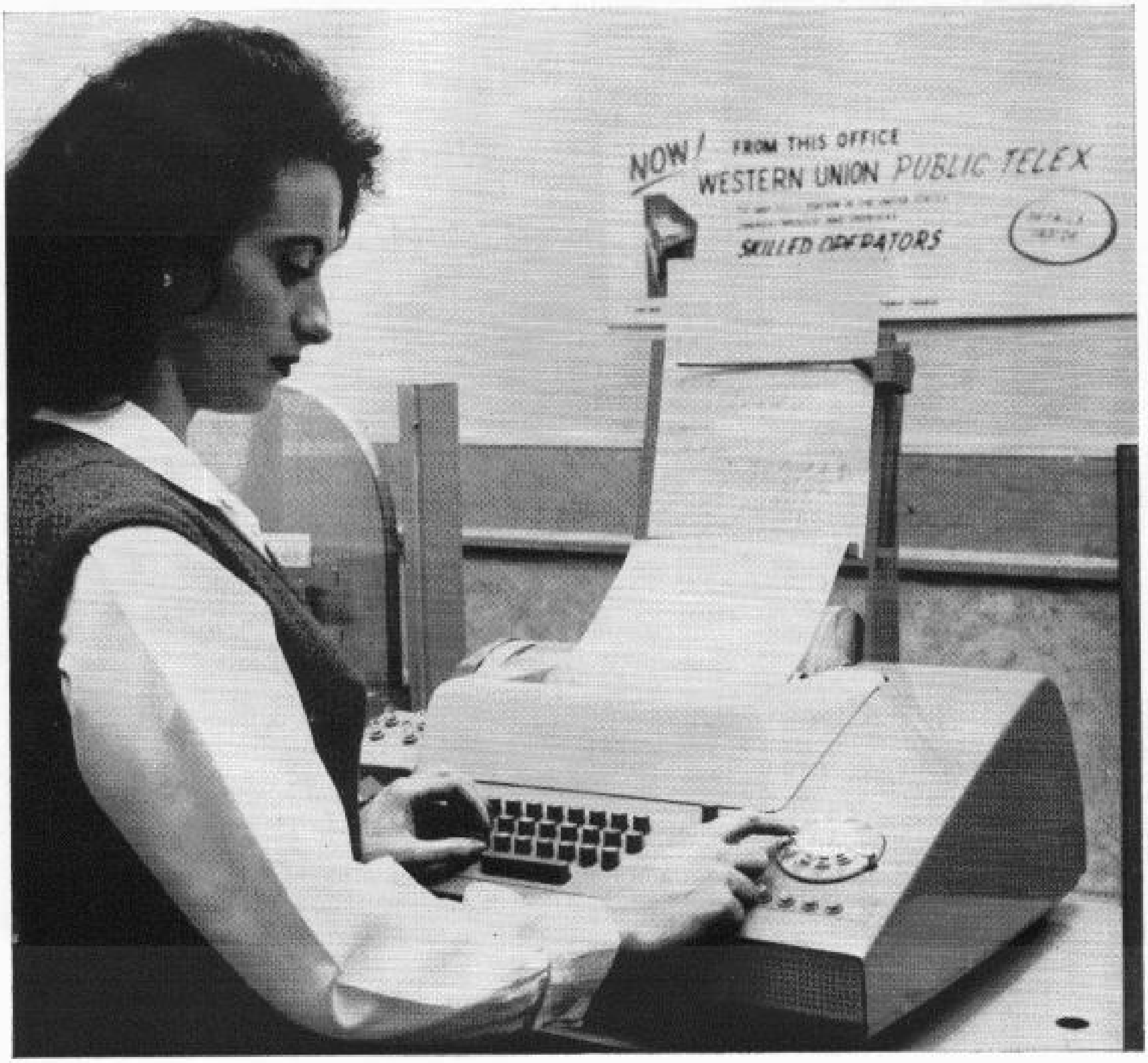
Telex, do-it-yourself telegraph service, connects Telex subscribers in the United States, Canada and Mexico for automatic, two-way telegraphic communication in a few seconds. A reply may also be obtained immediately on the same connection. Thus the customer and the called Telex subscriber may exchange communications on the one connection.

Calls to subscribers in overseas countries are arranged through connecting international carriers. Telex can be operated at speeds up to 65 words per minute.

The Public Telex machine is equipped with a tape perforating device which permits the preparation of the message before making the Telex call. Thus the message may be transmitted automatically in a minimum of time.

On Telex messages within the continental United States, and to Canada and Mexico, charges are based on time-distance units or "pulses", recorded on automatic metering devices. Each pulse is charged for at a fixed rate. Overseas calls are charged for on a time-usage basis. For example, the New York-London Telex rate is $3 a minute with a minimum charge for three minutes.

There are about 9,000 Telex subscribers in over 100 cities in the continental United States. The service is now being expanded to other cities.



Western Union's new Public Telex Service at Western Union's 1440 Broadway office in New York City. Public Telex "dial-a-wire" service permits users to talk back and forth in writing, at special time-distance rates, with over 100,000 Telex subscribers in the United States, Canada and Mexico, and with subscribers in 102 overseas countries via overseas carrier.

G. P. Oslin Retires from Western Union and the *TECHNICAL REVIEW*

George P. Oslin, Director of Public Relations, will retire from the Committee on Technical Publication, which is responsible for the Western Union TECHNICAL REVIEW, on August 30, 1964. After 35 years of dedicated service to Western Union and 17 years membership on the Committee, his retirement leaves a vacancy which will be difficult to fill.

He came to Western Union from the Newark Evening News, where he was a reporter, feature writer and editor. He was a director—founder of the Public Relations Society of America, and was president of the Public Relations Society of New York.

Mr. Oslin is well known for his cooperation, willingness and help in research regarding any publicity concerned with Western Union. He is universally respected in the communications field, and has earned the reputation of being the best informed man in America on the early days of the telegraph art.

He keeps up to date with the technology, and has done much research on the history of Western Union. However, his knowledge is not limited to Western Union. "George Oslin has long been recognized as one of the nation's top publicity men—and I know of no one who has done a better job or is more highly regarded in his field," says Mr. E. F. Sanger, Vice President of Public Relations and Advertising at Western Union.

His contribution to the success of the Western Union TECHNICAL REVIEW has been considerable and his memory of past publications is phenomenal. He has been instrumental in expanding the philosophy and improving the format of the magazine in the past two years. Every manuscript published in the past 17 years has been reviewed by him.

The Committee, authors and readers of this publication wish George Oslin many years of continued interest in public relations—and health and happiness to enjoy it.

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Private Wire Services
Transmission
Data Processing Transmission

Krantz, H. F.: Class "D" Service

Western Union TECHNICAL REVIEW, Vol. 18, No. 3 (July 1964) pp 94 to 107

Western Union's Class "D" Service offers the most efficient transmission facilities for operating with the new data processing system, at rates between 100 and 180 bands.

This article describes the various circuit arrangements provided to Private Wire Service customers. Some applications where this service has been installed are the New York Stock Exchange and the Advanced Record System for the General Services Administration.

Private Wire Service
High-Speed Ticker Service
Class "D" Service

Turner, C. and Straub, G. A.: Expanded Private Wire Service for the New York Stock Exchange

Western Union TECHNICAL REVIEW, Vol. 18, No. 3 (July 1964) pp 108 to 113

A new high-speed "900" Stock Ticker was introduced into Western Unions Private Wire Services in June 1964. This article describes the components of the two types of tickers used—and points out the advantages of the new high-speed ticker, which will upgrade the service and increase the volume of stock broker sales which were previously handled.

Private Automatic Telephone Systems
Telephone Switching Systems
Dial and Keyset Operation
Private Wire Service

Chong, G. R.: Interconnection of 3 PATS for Philadelphia Stock Exchange

Western Union TECHNICAL REVIEW, Vol. 18, No. 3 (July 1964) pp 114 to 117

This article describes the interconnection of 3 PATS systems, the terminal equipment and tie-line equipment. Special Wiring was used for this application.

Message Protection
AUTODIN
Traffic Maintenance
Switching Systems

Snyder, R. L.: Message Protection in the AUTODIN Message Switch

Western Union TECHNICAL REVIEW, Vol. 18, No. 3 (July 1964) pp 118 to 127

This article describes the AUTODIN message switch from the standpoint of its second function, namely, the protection of traffic and the maintenance of operation under conditions of extreme stress.

Message Protection requirements are enumerated and the basic aperational program are described. A Sequencing Diagram of the On-Line Program cycle is included.

EDAC Makes First Test

Laboratory Model of Western Union's EDAC (Error Detection and Correction) unit being unloaded from a barge off the East Coast of Africa for test on a long H.F. Radio Circuit.