WESTERN UNION
Technical Review

Switching System 35

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Electronic Signal Translator

•

Letterfax Flexibility

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Telex in Canada

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Patching in PCH Offices

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JANUARY 1958

WESTERN UNION

Technical Review

VOLUME 12
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CONTENTS

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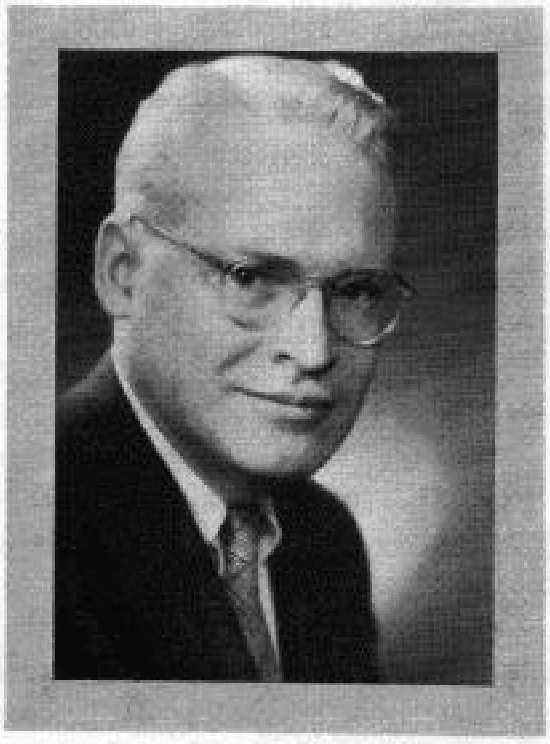
To Western Union's family, friends and readers of TECHNICAL REVIEW all around the world I send most cordial greetings.



Western Union is proud indeed of the prestige that has come to its fine name through the leadership established by this magazine, not only in the United States but overseas as well.

With a readership in forty-five countries of Europe, Africa, Asia and Latin America, TECHNICAL REVIEW has become an important instrument for greater understanding and exchange of technical information between telecommunications engineers both here and overseas.

Western Union has been honored by having certain important technical articles translated and reprinted in their entirety in official publications of foreign Posts and Telegraphs; additional articles have been excerpted for use in other technological magazines. It is indeed gratifying to know that TECHNICAL REVIEW is held in the highest regard by its world-wide readership and maintains such an enviable position of international influence in the field of technological progress.

I wish to take this opportunity, in behalf of the International Department, to express sincerest congratulations to the splendid staff of the TECHNICAL REVIEW for their publication guidance and to Western Union authors for their many outstanding contributions to international technology.

K. Bruce Mitchell

VICE PRESIDENT —
INTERNATIONAL COMMUNICATIONS

January 1, 1958.

R. V. MORGENSTERN, Assistant Electronics Applications Engineer
HERBERT BUCHWALD, Engineer, Electronics Applications

Switching System 35 for Larger Tributary Offices

Installation of over 50,000 telegraph machines in the offices of Western Union customers has provided a large measure of automation for the collection and distribution of telegrams locally. And efficient operation of the customer tie lines—a subject continuously studied—has required development of a variety of special equipment such as Switching Systems 31 and 35.

SWITCHING SYSTEM 35 is another forward step in Western Union's continuing program of automating telegraph message handling. The primary purpose of this program is to give better record telecommunication service at lower cost.

Switching System 35 is intended for use in the larger tributary offices working into principal reperforation centers. It eliminates manual retransmission at those centers of messages originating with customers having teleprinter tie lines to the tributary offices. Switching System 35 is the logical outgrowth of the very successful operation of Switching System 31,[1] installed at Chicago in 1951 and at New York in 1953. Those systems are used to eliminate manual relaying of messages from Western Union branch offices to reperforation centers beyond Chicago and New York.

At present the 35 system is designed to handle 24 customers over two trunks to a reperforation center, with up to ten automatic operating positions intermediate between the customers and the trunks. In contrast, the 31 system required a trunk for every two operating positions. It is estimated that, used efficiently, the 35 system can handle approximately 200 messages per hour. The message number record sheets for the customers must be kept at the receiving positions in which the trunk connections terminate at the reperforation center. Twenty-four such sheets are considered the maximum which it is practical for a receiving operator to handle under the circumstances.

Figure 1 shows a block diagram of Switching System 35 starting with the customer and ending at a receiving position in the reperforator office. Only principal components are shown.

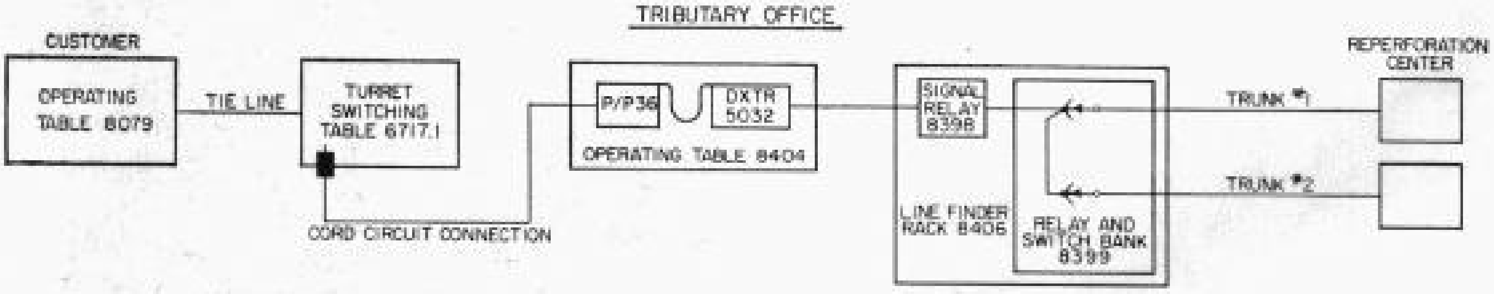


Figure 1. Block diagram of Switching System 35

Operating Equipment

Figure 1 shows an Operating Table 8079 in the customer's office but other equipment, for example a single page teleprinter, can be used. Operating Table 8079 may be arranged in a number of ways but essentially consists of a perforator for punching coded paper tape, and a distributor-transmitter for sending the teleprinter signals from the customer to the tributary office over a tie-line conductor. A monitor printer or other means is also generally provided to furnish the customer with a "hard copy" of the message transmitted. Figure 2 shows one version of the customer's Operating Table 8079. It is equipped with a perforator, distributor-transmitter, and a page printer for monitoring purposes.

The tie-line conductor terminates at the Western Union tributary office on a jack in Concentrator 9040 which is a variation of the familiar Plan 8 concentrator turret[2] so widely used in small and medium sized Western Union offices. Figure 3(A) shows the turret on Turret Switching Table 6717.1. Associated with each jack is a "call received" lamp and in the apron of the table is a series of lamps associated with the cord circuits of the Operating Table 8404 shown in Figure 3(B).

Each Operating Table 8404 accommodates two printer-perforator distributor-transmitter combinations and associated equipment, relay banks, line relays, message-waiting indicator, and so forth. The printer-perforators are part of the cord circuit shown on Figure 1 while the distributor of the distributor-transmitter is cross-connected to the Line Finder Rack 8406, shown in Figure 4, where it is selectively connected to a trunk to the reperforation center.

Line Finder Rack 8406 is equipped with signal relays used for registering and storing calls for trunk connections, and with rotary switch and relay banks for interconnecting the trunks and distributor-transmitters. Also included on the line finder rack are two monitor printers associated with the trunk circuits. Copies of all messages sent to the reperforator office are thus available.

The receiving position at the reperforation center will vary with the type of center but in all cases manual switching from the receiving position must be employed as the customers' operators are not expected to insert selective switching characters in the tape. They are, however, expected to give each message a sequence number and to end each message with a double carriage-return.

A brief description of the operation of Switching System 35 follows.

System Operation

The customer's operator perforates the message in coded tape form starting with the proper sequence number and ending with a double carriage-return. The operator inserts the tape in the transmitter and presses a button located in front of the distributor-transmitter (see Figure 2). This inserts an open in the tie line and causes the signal relay in the concentrator turret at the Western Union office to release, short itself out of the circuit and bring up a call received lamp associated with the jack which terminates the tie-line conductor. As soon as a cord circuit becomes idle the Western Union operator

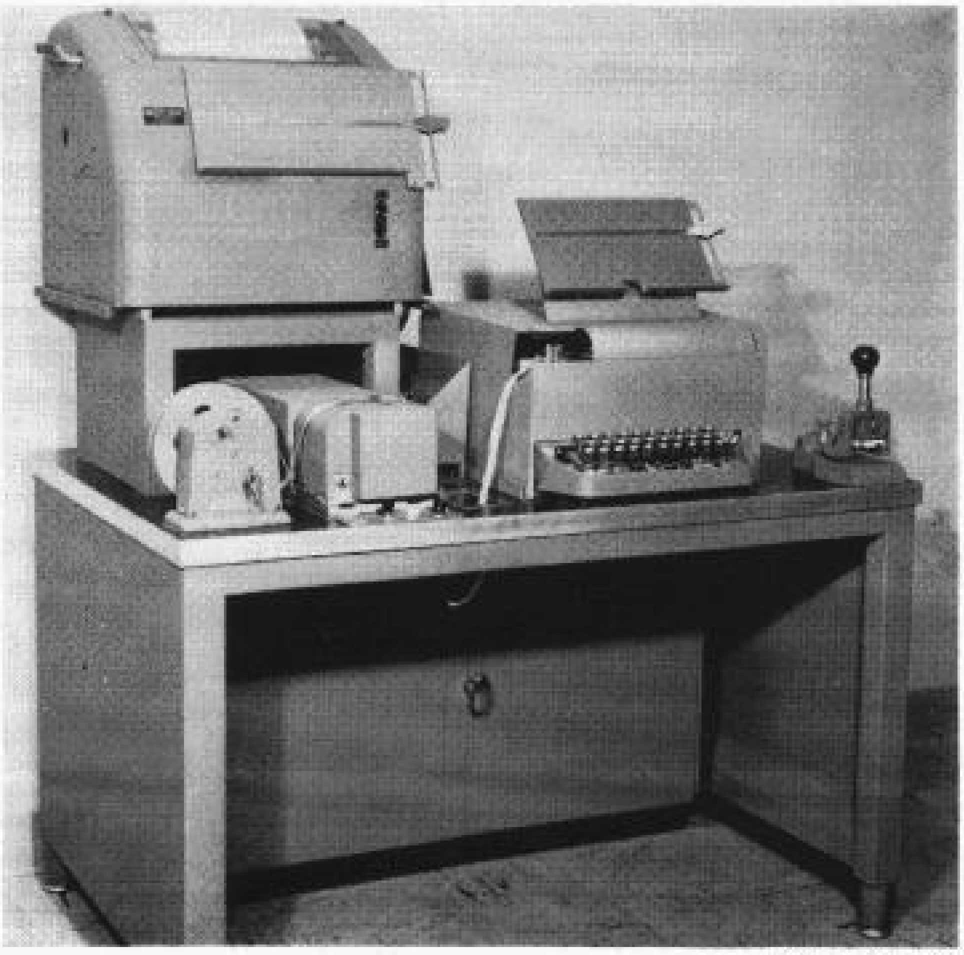


Photo R-10,453

Figure 2. Operating Table 8079

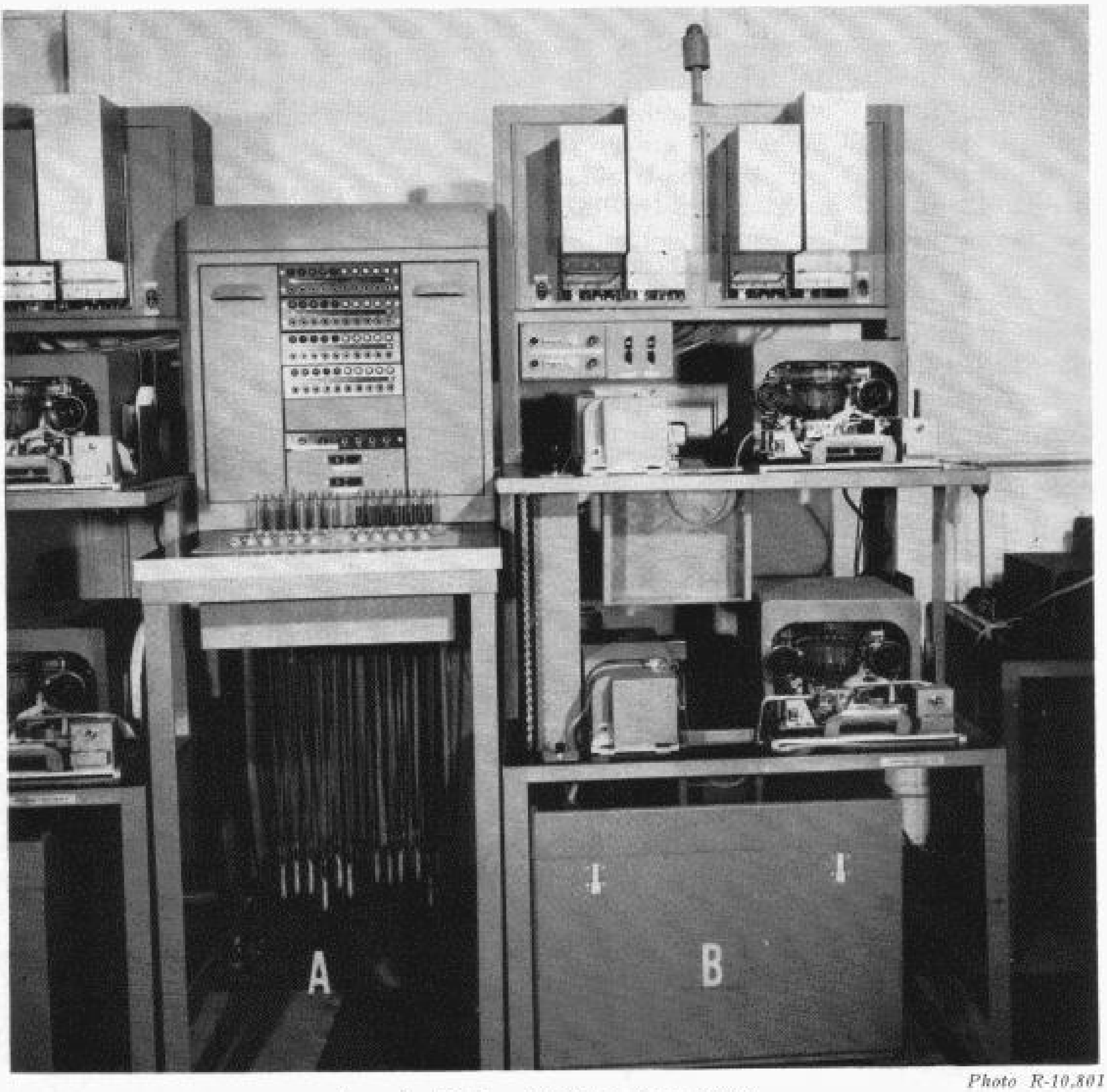


Photo R-10,801

Figure 3. (A) Turret Switching Table 6717.1
(B) Operating Table 8404

plugs a printer-perforator up to the jack and tie line. This reverses the potential applied to the tie line and operates a polar control which closes the clutch magnet circuit on the distributor-transmitter in the customer's office. Transmission over the tie line is at 65 words per minute.

When the double carriage-return at the end of the message is received at the Western Union printer-perforator, sufficient blank tape is automatically metered out to allow the last character in the tape to pass through the associated transmitter. At the end of the metering period a white lamp in the shelf of the turret switching table lights to indicate that the operator may pull down the cord circuit. If there is a second message in the tape at the customer's office the metering of the tape will start but the metering circuit will be disabled on receipt of the start pulse of the first character (other than a blank) in the second message. This character will be properly received on the printer-perforator.

In addition to starting the tape metering, the reading of the double carriage-return steps forward a message-waiting indicator and prepares a call circuit.

In order to save trunk time to the reperforation center, the blanks inserted in the tape between messages to bridge the physical gap between the printer-perforator and the distributor-transmitter are idled through the transmitter.

When the first intelligence character is over the pins of the transmitter, the distributor-transmitter stops. If one or more complete messages have been received on the associated printer-perforator subsequent to the time the distributor-transmitter last had a trunk connection, the message-waiting indicator will have prepared a path to the call circuit.

At the time the distributor-transmitter stops at the first message character a request for a trunk to the reperforation center will be placed with the line finder. If both trunks are busy the call will be stored by Signal Relay 8398 until there is a trunk available.

When the trunk connection has been completed by the rotary switch on the line finder stepping to a point associated with the distributor-transmitter making the call, the direction of the current in the interconnecting circuit between the distributor-transmitter and the line finder rack reverses and operates a polar relay which closes the clutch magnet circuit and starts the transmission of the message to the reperforator office at 76 words per minute. At the end of the message the two carriage-returns are read and the distributor-transmitter is stopped. The connection to the line finder is knocked down and the message-waiting indicator stepped back one step.

If there are messages waiting at all of the other distributor-transmitters associated with the system they will all get a trunk connection consecutively, before the distributor-transmitter which has just completed a message will again have a chance to send to the reperforation center.

The operator can watch the progress of a message through the system by observing the lights in the shelf (Figure 3(A) associated with the turret switching table. There are five lamps for each cord circuit. The first in the row from back to front tells the operator that the tie-line customer has completed sending the message to the printer-perforator and that the cord circuit may be pulled down. The other four lights are associated with the distributor-transmitter or trunk sending side of the cord circuit.

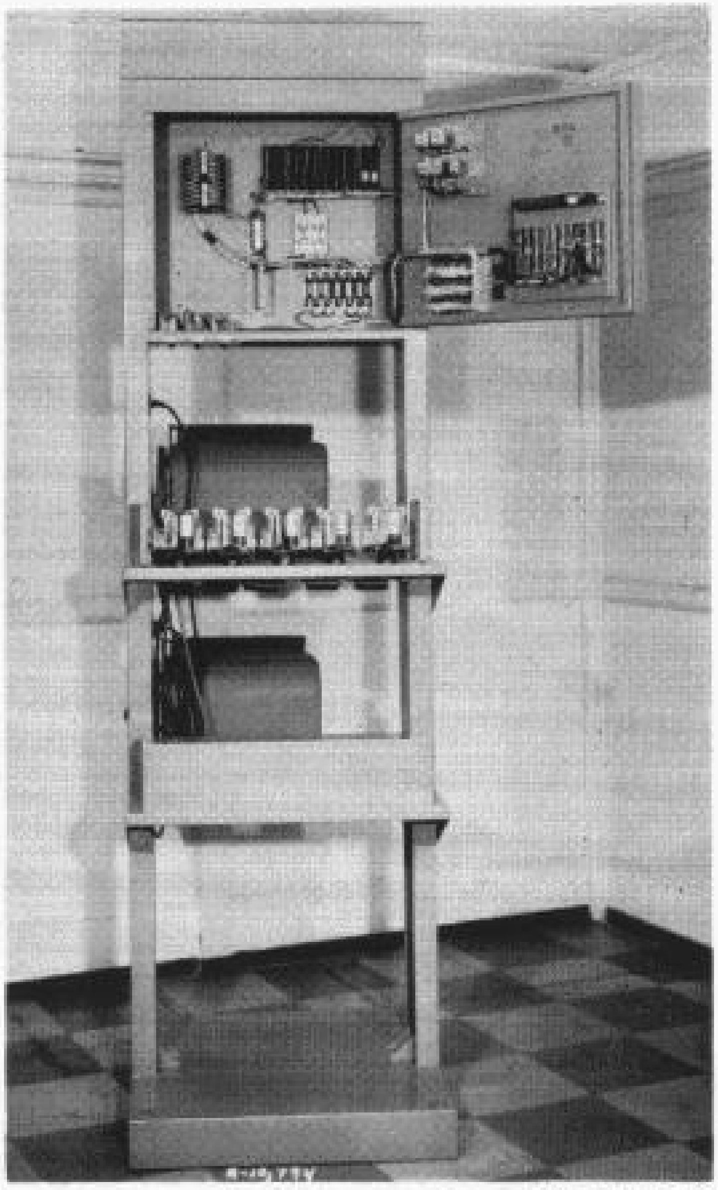


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Figure 4. Line Finder Rack 8406

When a distributor-transmitter puts in a call for a trunk connection a green message-waiting lamp lights and remains lit until the trunk connection is completed. It then goes out and the transmitting lamp, which is a neon, blinks on and off until the transmission is completed. If the distributor stops before the end of the message the amber tight-tape lamp will light up. Finally if it becomes necessary for any reason to disconnect the 8404 Table from its normal path to the line finder rack the red sending stop lamp will be lighted.

The question is sometimes asked, Why a manually operated turret? Why not use a line finder between the customers and Operating Tables 8404 as well as between the tables and Line Finder Rack 8406? From a technical standpoint it is, of course, feasible to do so or even to switch the customer direct to the trunk without any intermediate operating tables. However, there are several reasons for the system as designed. The advantages of tape reperforation between the customer and the trunk are well known and do not require discussion here.

The principal reason for using a manual turret rather than automatic means between the customer and Operating Tables 8404 is that some operator supervision of the traffic is required and it is easier to provide this supervision with a manual connect and disconnect of the printer-perforator cord circuits than with an automatic system. Since operator attention is required at the switching center there is no need to incur the initial expense and higher maintenance charges of an automatic device.

Switching Systems 35 installed to date have proved highly successful and no doubt their use will be expanded.

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1. Telegraph Switching for Remote Branch Offices, R. L. PARCELS and F. A LUCK, *Western Union Technical Review,* Vol. 6, No. 3, July 1952.
2. A Small Office Teleprinter Concentrator–Plan 8, R. V. MORGENSTERN and H. BUCHWALD, *Western Union Technical Review,* Vol. 8, No. 2, April 1954.

R. V. Morgenstern graduated from Ohio State University in 1921 with a B.E.E. degree. While at Ohio State he was a member of the honor societies of Sigma Xi and Eta Kappa Nu. Coming directly to Western Union upon graduation, he is best known for his work in connection with direct-current telegraph repeaters, teleprinter concentrators and outstation operating tables; he has also had charge of many other projects ranging from experimental light beam transmission to the design of circuits for small switching systems. Mr. Morgenstern holds a Professional Engineer's license and is at present Assistant Electronics Applications Engineer.

Herbert Buchwald entered Postal Telegraph service in 1929 as a student in the teleprinter school. Shortly thereafter he was made supervisor of outside teleprinter maintenance in the New York City area. Upon graduating from Newark Technical School in 1938 with a degree of Associate Engineer in E.E., he became Shop Foreman, and during Postal's semiautomatic program was transferred to the inspection department. Following merger of Postal and Western Union, Mr. Buchwald entered the D. & R. Department as senior engineering assistant, working on light beam transmission. Later he was transferred to Applied Engineering and subsequently made an engineer. He is presently engaged in work on teleprinter concentrators, repeaters, operating tables and wiring cabinets. Mr. Buchwald is an associate member of AIEE.

GUY FONTAINE, Station Electrician, St. Pierre

An Electronic Multiplex to Teleprinter Signal Translator

The time-division multiplex method, by which a number of telegraph channels are operated over a single circuit facility, is employed on Western Union ocean cables. Although conventional start and rest impulses are required on land lines connected to the cables, cable signalling is limited for efficient circuit utilization to the five intelligence impulses per character. An electronic method of restoring the characteristics of original teleprinter signals with start and rest impulses again included is in service between Key West and Havana.

THE WIDE frequency spectrum of telegraph circuit facilities within the United States has directed the domestic telegraph system towards the use of the frequency-division method of channel multiplexing. In this method of operation, one voice-band having a nominal spread of 0 to 3000 cycles carries simultaneously a number of channels, a narrow frequency band being assigned to each channel within the frequency range of the carrier system, and the channels being isolated by frequency selective filter techniques. With this method it is more advantageous to send to the line the complete signal describing a character; that is, the five intelligence impulses and the associated start and rest impulses. Transmitting the start and the rest impulses simplifies the repeating equipment and adds to the flexibility of interconnection of the circuit.

The problem is quite different when the line is a transoceanic cable. The frequency band there available is indeed very narrow: zero to 150 cycles at the most. This limitation is due to the very rapid increase in signal attenuation as the frequency of signalling increases; for instance, with a sending voltage of the order of 100 volts the received signal level at 75 cycles per second would be less than one-tenth of one millivolt when transmitting on a transatlantic cable. Another factor limiting the signalling speed is the comparatively low value of the received signal-to-noise ratio, the noise being a combination of electromagnetic or atmospheric disturbances and crossfire interference due to the proximity of other cables or lines.

With the limitations imposed by the narrow band the first thought is to restrict the transmission to the information absolutely necessary to identify a character, the start and the rest impulses of which are of a predetermined and constant polarity and can therefore be deleted at the sending end. The five intelligence impulses are of course indispensable and are sufficient for the recognition of a character; these alone are consequently transmitted exclusively to the line.

To provide the numerous channels required for international communications, and to use efficiently the narrow frequency band available, the time-division system of multiplexing or combining several individual channels is used throughout the Western Union cable system. In this type of multiplexing the cable is connected successively to a number of channels, this number being limited by the signalling capacity of the cable and the individual channel speed. For practical purposes the channel speed has been made uniform at 50 words per minute on international facilities and any increase in signalling speed of a cable brought about by improvement of the terminal equipment or of the received signal quality is utilized by connecting more channels to the cable. The duration of each cable signal impulse nevertheless remains a function of the signalling speed of the cable and is unrelated to the 22-millisecond duration of the teleprinter signal impulses.

At the receiving cable station the signal is patched to the land-line system and at this point translation must take place to restore the characteristics of the original teleprinter signal; the start and rest impulses must be added at the beginning and at the end of each character, respectively, and all impulses delivered to the leg at fixed intervals of 22 milliseconds.

This article describes electronic translation from a 5- to a 7-unit code but the principle can be applied to other types of coded signals.

Previous methods of translation used electromechanical devices such as signal relay chains, start-stop distributors, tape reperforators or a combination of these. The new translator is mostly electronic except for the timing which is controlled by brush commutation; this teleprinter timing was supplied in the first application of the translator by an extra ring added to the multiplex distributor faceplate.

After regeneration in the multiplex set the five intelligence impulses are stored in a bank of five capacitors (Figure 1). Positive and negative charges are kept on two extra capacitors to generate the start and the rest impulses.

When all five impulses from the multiplex have been stored, the seven capacitors are discharged to ground in proper sequence, each through a primary winding of a transformer and the timing ring. The transformer is polarized so that a spacing impulse is induced in the secondary with the grid of VT1-A positive. A spacing impulse therefore turns on VT1-A and the voltage at its plate drops to a point where the neon lamp cuts off, making the control grid of VT2 negative; VT2 cuts off and the increase of its plate voltage is reflected to the grid of VT3 making it more positive. VT3 conducts and its plate current drives the line relay to spacing through one of its windings.

Conversely, a marking impulse cuts off VT1-A, the corresponding plate voltage on the trigger tube increases, the neon lamp fires, making the grid of VT2 more positive, and VT2 conducts; the voltage at its plate drops and the change is reflected at the control grid of VT3 making it more negative, VT3 cuts off, and the plate current of VT2 "marks" the line relay through its second winding.

The 5-element polar signal from the multiplex is in this way translated into a 7-unit teleprinter signal and transmitted to the leg by the line relay which can be set for either polar or make-break output according to the mode of operation of the extended leg. However, the systemic blanks used by the multiplex equipment during the idle intervals to maintain syn-

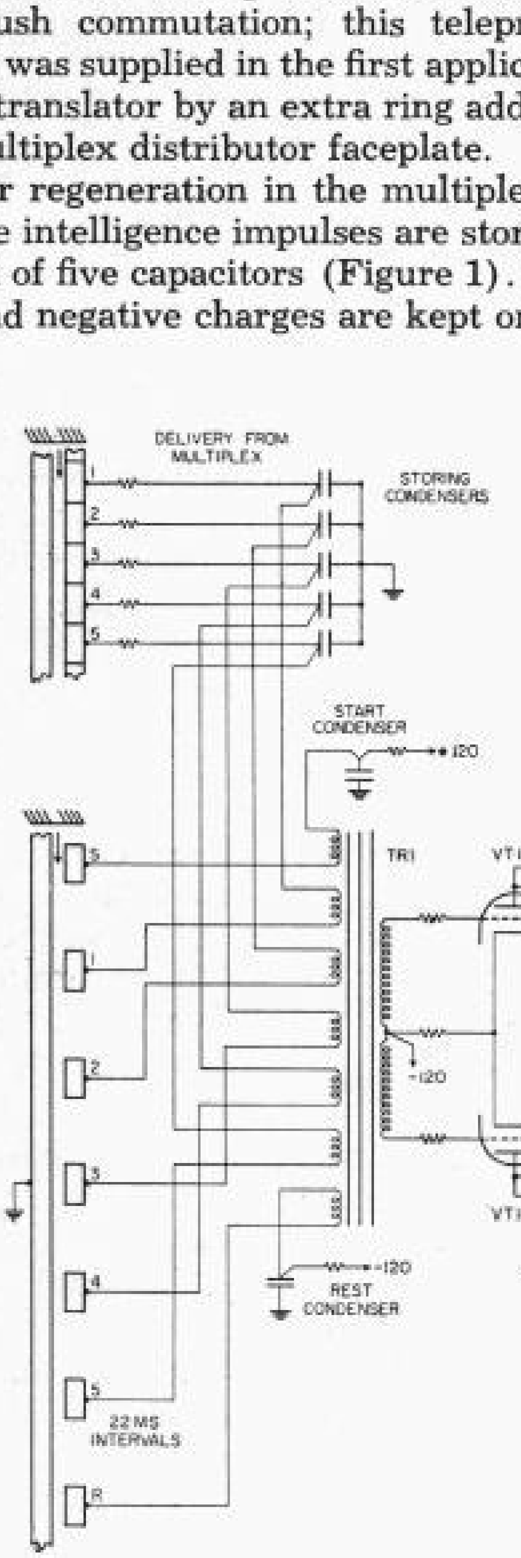
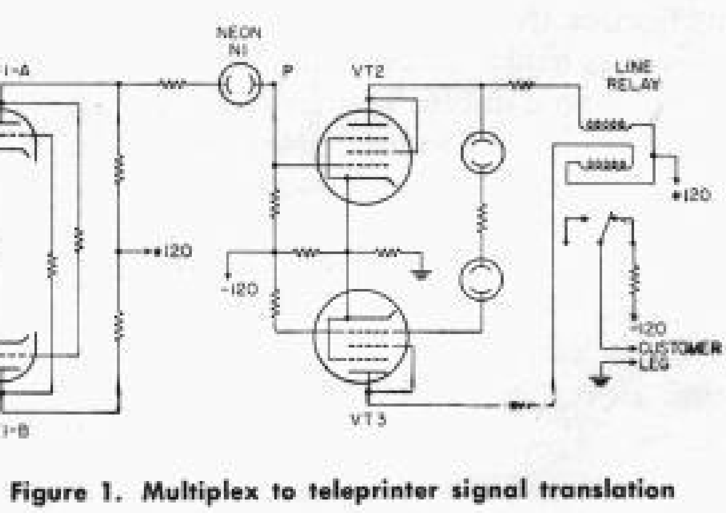



Figure 1. Multiplex to teleprinter signal translation

chronism between the sending and receiving distributors would be translated and repeated to the leg by the circuit just described unless these blanks are differentiated from other characters and the line relay is locked to its marking contact for the duration of one character each time a blank is received.

The reception of blank characters is sensed by the blank control circuit (shown in Figure 2) which, as a whole, will apply a positive bias to the grid of VT2 (at "P" on Figure 1), through a neon lamp N2, as long as blanks are received and will remove this bias when any other character is stored for translation.

Five resistors (Figure 2) in series with the storing condensers are coupled through the five primary windings of a transformer to the grid of a trigger tube VT4. Each of these resistors passes current with either spacing or marking polarity as the brushes wipe over their respective segments, and the wiring to the coupling transformer is so arranged that spacing or positive signal impulses induce in the secondary winding an impulse making its lower terminal positive with respect to its upper terminal.

Because of the shorting effect of the diode connected across the secondary of the transformer, the five spacing impulses of a blank have no effect on the trigger tube and VT4 therefore remains in the state initiated by the preceding Reset 1; that is, the lower section of the trigger tube or VT4-B conducting and VT4-A cut off. Under these conditions the plate voltage of VT4-B is comparatively low and the grid of VT5 is kept highly negative so that, shortly after the storing of the five intelligence impulses has been completed, the scan impulse making the cathode of VT5 more negative will not be sufficient to turn on VT5. Consequently, no voltage variation is passed by the coupling condenser CC to VT6 and this trigger tube will stay as positioned by the preceding Reset 2, namely, VT6-A conducting and VT6-B cut off. The neon lamp N2 remains conductive applying a positive bias to the grid of VT2 (Figure 1). The keying of the

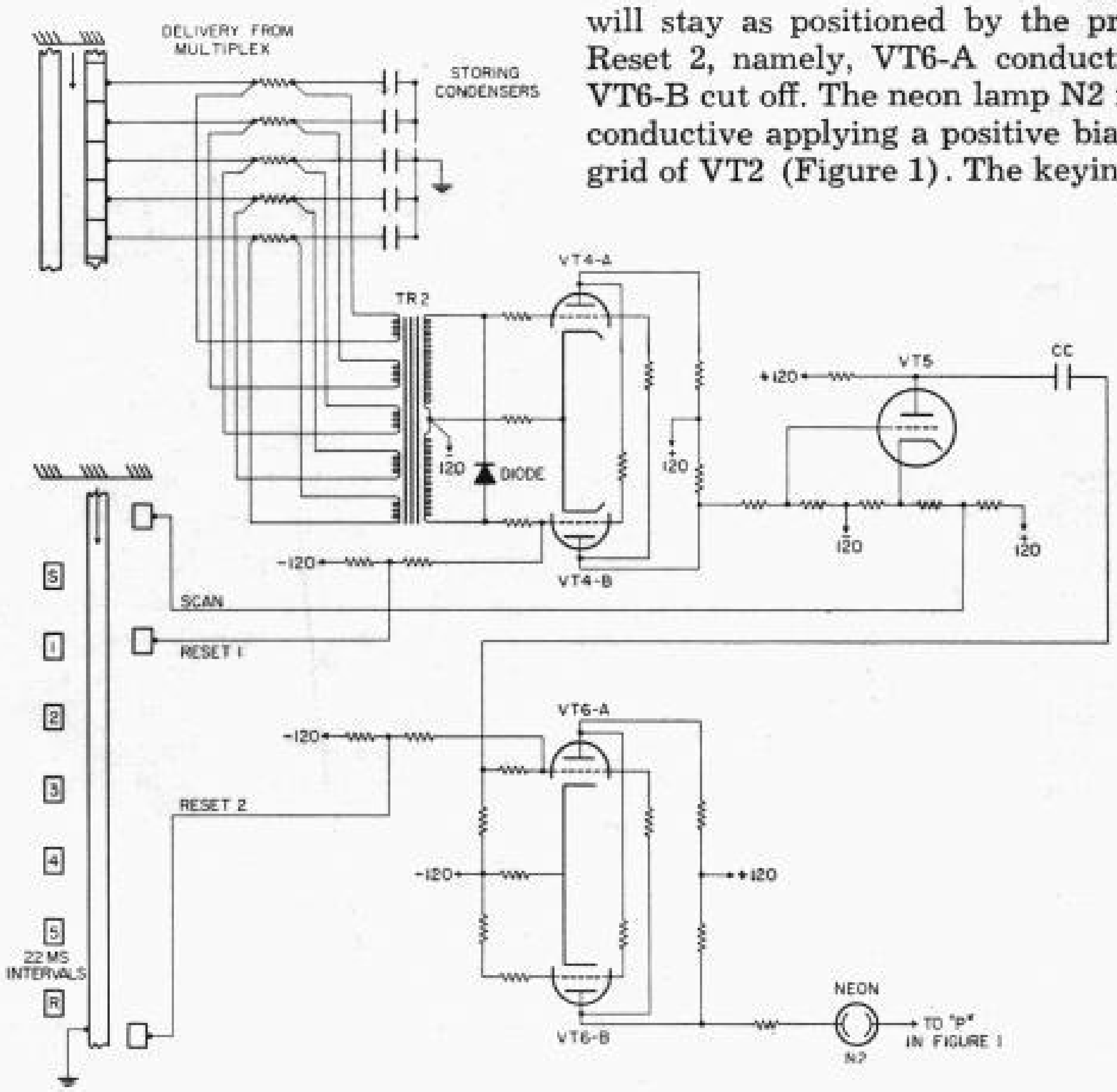


Figure 2. Blank deletion circuit

neon lamp N1 by the seven teleprinter impulses will consequently have no effect on VT2 which will keep conducting, holding the line relay to marking.

Should a character different from a blank be stored, it would have in its combination at least one marking impulse which will trigger VT4-B to cutoff; the corresponding plate voltage increase is reflected to the grid of VT5 by a more positive bias although not sufficient to make VT5 conduct. The scan impulse following the storing of the five intelligence impulses will this time make VT5 conducting because of the higher positive bias on the grid. The condenser on the plate discharges partially and triggers VT6, the upper half VT6-A being cut off. The lower half VT6-B is then conductive, its plate voltage drops and the neon lamp N2 is extinguished. The control of the relay drive is therefore passed over to N1 and transmission of the teleprinter signal can be initiated with the start impulse.

Figure 3 illustrates the translation of a specific character, letter N, and that of a blank, showing the sequential operation of a few key points.

For the letter N the first marking impulse being stored, in this case the third impulse of the multiplex, triggers VT4 and makes the grid voltage of VT5 more positive; although the fifth impulse of the combination is a spacing impulse, it will not alter this condition because the diode across the secondary of TR2 renders all spacing impulses ineffective.

The scan impulse biases the grid of VT5 positively and as a consequence N2 extinguishes, making the grid of VT2 more negative. The start impulse will make the grid of VT2 further negative by extinguishing the neon lamp N1 and the line relay will operate to spacing. Marking impulses will turn N1 back ON, making the grid of VT2 more positive and throwing the armature of the line relay back to the marking contact.

Reset 2 will confirm the rest impulse, restoring the positive bias on the grid of VT2 by firing N2 and, some time during the translation, Reset 1 positions VT4 to its original state in readiness for the storing of the next character.

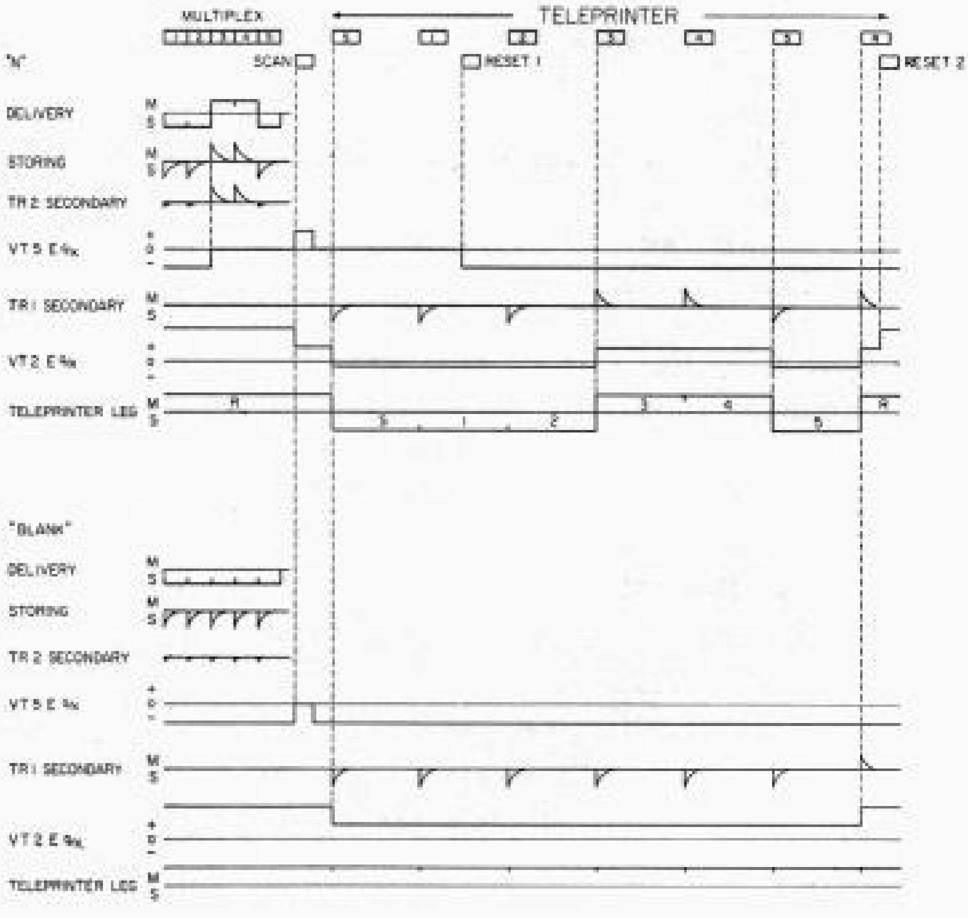
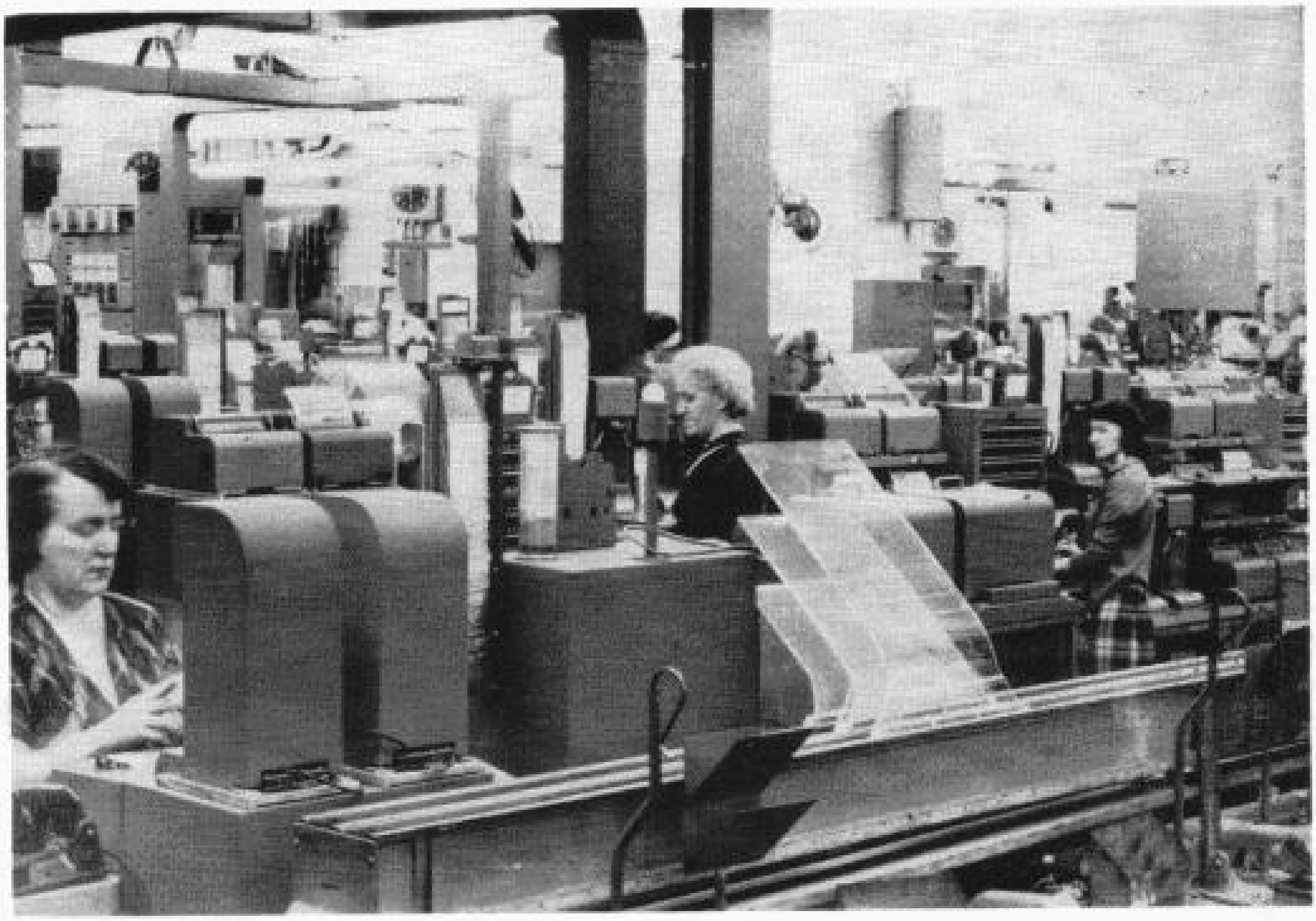


Figure 3. Timing chart

When a blank is stored, the five spacing impulses have no effect on VT4 and the grid of VT5 remains highly negative so that the change brought about by the scan impulse is not sufficient to fire VT5. The neon lamp N2 stays ignited applying a positive bias on the grid of VT2, the spacing impulses of the teleprinter signal keying N1 do not bias the grid of VT2 to cutoff, and the line relay is kept to marking.

This method of translating from multiplex signals to teleprinter signals has been used in the 6-channel multiplex racks recently installed at Key West and Havana and has proved to be very satisfactory. The multiplex equipment will be described in a later issue of TECHNICAL REVIEW.

Guy Fontaine, after attending l'Ecole Polytechnique in Montreal, joined Western Union in 1948 as a student at the cable repeater station on the island of St. Pierre. He became Station Electrician in 1955. During the initial phases of the ocean cable submerged repeater program he was assigned to the Development and Research Department where he assisted in the laboratory and field installation. Since 1955 he has been temporarily transferred to the Plant and Engineering Department where his work is connected with the design and installation of terminal equipment for cable stations. Now a citizen of France, Mr. Fontaine has taken the first steps to become a citizen of the United States.



Facsimile circuit concentrator units in Telefax section of New York main office operating room serve some 1350 tie-line customers. Direct wires provide prompt "pickup" and delivery. Shown in foreground is rear of one 100-line unit with vertical Telefax transmitters, jack turret including customer card index and supervisory lamp, plastic message chutes, belt message conveyors, and Telefax recorders.

Two Medalists Given 1957 d'Humy Award

J. EDWIN BOUGHTWOOD and F. BEAUMONT BRAMHALL have received the Telegraph Company's F. E. d'Humy Memorial Award for 1957 for one of the most important telecommunications inventions of the 20th Century — frequency-modulated carrier telegraphy.

Presentation of the three-inch bronze medallion, accompanied by a certificate and honorarium, was made to each man by Western Union President Walter P. Marshall, at a special ceremony in the company's auditorium, 60 Hudson Street, New York, on November 1, 1957.

Commenting on the achievement upon which the Award was based, Mr. Marshall said: "The development of FM carrier, which brought new stability and speed to telegraph transmission, was a monumental forward step in the progress of record communications. Carrier equipment creates a large number of separate telegraph channels of superior dependability from a trunking facility such as a radio beam, and this makes it unnecessary to construct millions of miles of additional wire plant.

"For example, three out of every four miles of Western Union's circuit capacity, or a total of 3,370,346 miles of circuits, are now carrier operated. This is enough to cross and recross our continent more than 1,300 times, linking our nationwide network of high-speed message centers and also serving to meet the rapidly expanding needs of our private wire business."

Dr. Ivan S. Coggeshall, Director, International Communications, talked on "Innovation — Technology's Priceless Ingredient." "All industries should pause, from time to time, to assess their debt to invention," he said. "The communication industry is a case in point. It does not derive its basic sustenance from the size and complexity of its visible organizational structure, but from resources hidden far below the surface—from the sum-total of all the new ideas which its members are continually producing. Just as the foliage of a tree is sustained from below ground by the root system which feeds it, so a business institution is nurtured — indeed is kept alive — by an endless succession of discoveries, inventions, improvements, and technical developments."

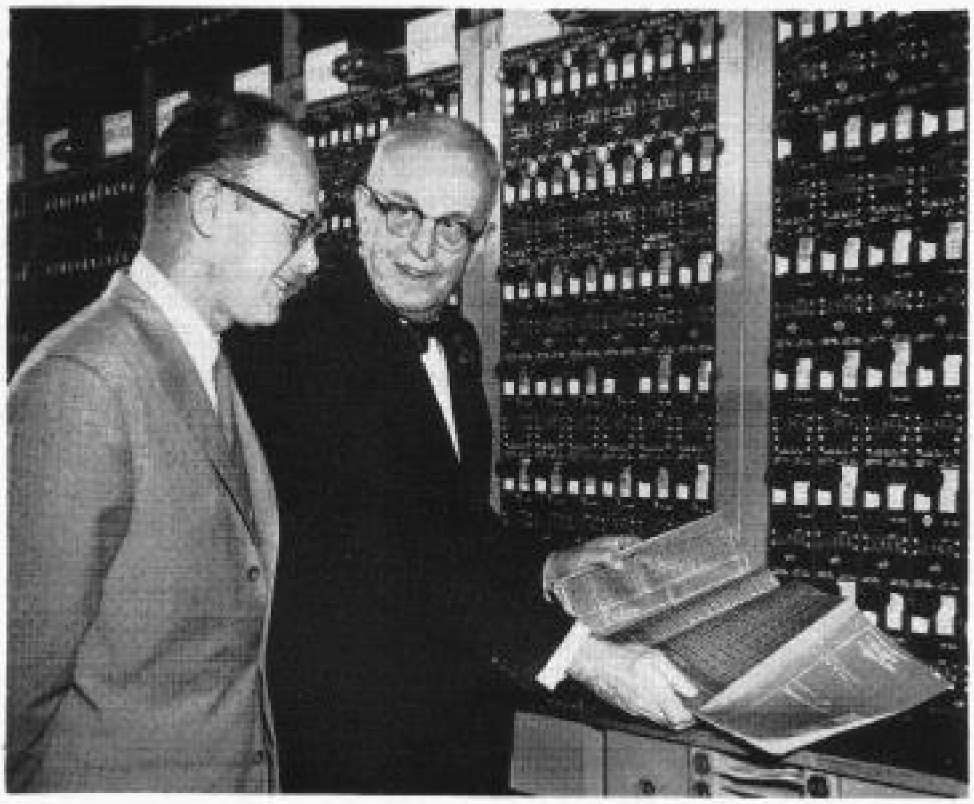
William H. Francis, Assistant Vice President, Plant and Engineering, addressed the audience on "Fernand E. d'Humy — Man and Engineer." Among Mr. d'Humy's many accomplishments, said Mr. Francis, were engineering and construction of central offices, leadership for design and installation of initial carrier systems for the Telegraph Company, and leadership in its mechanization program starting with Fort Worth, Richmond, and Atlanta through the automatic offices, as well as sponsorship of radio beam developments and of Telefax devices for commercial telegraphy.

The d'Humy Medal was established by The Western Union Telegraph Company in recognition and commemoration of the accomplishments of the late Fernand E. d'Humy, Vice President and Director of the company, whose inspired leadership and able guidance in telegraph research and engineering laid a firm foundation for the company's technical achievement. The award to Mr. Boughtwood was "For fundamental scientific explorations and basic inventions in the field of frequency-modulated carrier telegraph systems." Mr. Bramhall received his award "For contributions to the art of frequency-modulated carrier telecommunication and for technical direction leading to its wide adoption."

A native of Massachusetts, Mr. Boughtwood has been employed in engineering and research activities with Western Union since his graduation from Northeastern University. His acceptance remarks sketched briefly the company's scientific advances and took a look at future developments in carrier transmission. "The basic principle of carrier was recognized long before the tools to make it practical were invented," he said. "In Western Union, experiments were conducted and a circuit installed between New York and Patterson, N.J., in 1920. The equipment of necessity was crude, tuning forks were used as transmitters and ear phones as receivers. Attempts to do business on this basis proved futile primarily because it was not possible to extend circuits by means of repeaters, and because head-phone reception was decidedly unpopular. It was not until tools such as vacuum tubes and filter networks came into being that the possibility of designing a practical carrier system became a reality.

"Evolution continued. Systems were developed capable of deriving up to 160 independent two-way telegraph channels from a single pair of line wires. When microwave radio-relay circuits became a reality in 1944, carrier channelizing equipment was built to derive 690 circuits from a single radio facility. Changes occurred also in the physical size and appearance of the equipment. Early carrier equipment was extremely bulky so that only two channels could be mounted on a carrier bay. By 1946 an all-electronic terminal, mounting eight to a bay, had been developed. This unit comprises the vast bulk of our carrier plant today. The next few months will complete the development and prototype phases of a transistorized unit mounting 20 channels to a bay and complete with power supply and monitoring facilities."

Mr. Bramhall, born in Pennsylvania, was graduated from Pennsylvania State College and joined Western Union's engineering organization in 1920. Speaking of telegraphy's future, he said, "Computers and automated business machines will be the feeding and the recording mechanisms, the producers and the consumers of telegraphic information. The volumes of digital information moved and the rates of handling it for these devices will be much higher. A large part of the present telegraphic load will gradually move over into the field of automation. Emphasis will be on accuracy of information. Editing and recopying by humans will no longer be possible. The automated mechanism must be able to detect and correct its errors and those of the transporting medium. The redundancy introduced by mechanized error recognition increases the volume of "bits" which must be handled. This in turn increases the speed again, and so puts more exacting requirements on transmission. But it isn't a hopeless spiral. FM at higher speed will solve this one, too."



J. Edwin Boughtwood (left) and F. Beaumont Bramhall who received the 1957 d'Humy Award given by Western Union for outstanding contributions to the telegraph art

ARCHIE S. HILL, Assistant to Project Analysis Engineer

Letterfax Equipments for Service Flexibility

A feature in equipment design more often sought than successfully achieved is a full measure of flexibility in service application. When the impracticability of much apparatus supposedly capable of "all things for all people" so often has been demonstrated, a report outlining some practical accomplishment in this direction is of interest.

HARDLY had Western Union's accelerated facsimile program for the improvement of its customer tie-line service gotten under way, when some business organizations being served by it became interested in applying facsimile to their own private communications needs. Because of this interest equipments were developed specifically for private systems applications. In this category the Letterfax transmitters, recorders and auxiliary equipments were designed to meet as many as possible of the most common requirements, both as to types of subject copy to be handled and patterns of transmission or distribution. This group of equipments constitutes building blocks with which a variety of systems can be fabricated.

The purpose of this paper is to describe the important units of the group and some of their systems arrangements.

All of the equipments are powered by 117-volt 60-cycle a-c power. Transmitters and recorders are driven by synchronous motors. Connected facsimile machines must operate at precisely identical speeds throughout any unit of transmission. In systems involving limited distances, frequently machines at all locations can be powered by continuously connected commercial power supplies, thereby assuring synchronous operation of connected machines. In systems involving longer distances, however, mutually synchronous commercial power supplies usually are not available at all machine locations. In such cases the machines are driven by one or more synchronous amplifiers controlled by the output of a standard frequency generator at the same location or at a remote location. When the standard frequency generator and synchronous amplifiers are remotely located they are connected by separate communication-type line facilities.

By design the transmitters and recorders can be provided to operate at either 180 or 360 scanning strokes per minute by an easily accomplished change of gears.

Transmitters and Recorders

The transmitter is of the horizontal rotating drum type. In addition to the necessary mechanisms and optical scanning

Photo H-1979

Federal Reserve Bank Letterfax central station elements, the transmitter unit includes a preamplifier. All other electronic and operational control units required for any of several operating arrangements are located within the supporting console.

Subject copy is held in position on the transmitter drum by a transparent wrapper. One end of the wrapper is permanently attached to the drum. Copy is laid face down on the extended wrapper. Wrap-up is accomplished by turning the drum and securing the free end of the wrapper with hooks actuated by a lever on a hand wheel on one end of the drum.

Subject matter of any size and shape up to the maximum of 8½ by 11 inches can be accommodated by the drum. The maximum area that can be scanned is 7⅞ by 10 inches.

By positioning either or both of two sliding knobs at the front of the transmitter, transmission can be caused to start and stop at selected points on the subject copy in the plane parallel to the drum axis. This feature serves two important purposes. It saves transmission time by eliminating blank areas at the top and bottom of the copy and permits limiting transmission to a selected area of the copy such as a particular paragraph of a letter.

By positioning a radially adjustable lever on the left-hand end of the drum, transmission of a portion of each line of scanning can be blanked out. This feature

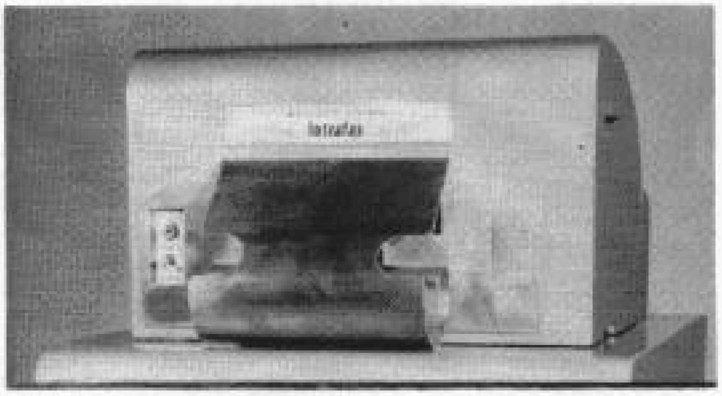


Photo R-10,132

Letterfax recorder

also serves two important purposes: it blanks out areas of the drum not covered by the subject copy, preventing the unsightly recording of unmatched background; and it permits the deletion of material along what would normally be the right-hand margin of the subject copy, such as the prices on an invoice. Normally subject copy is scanned from top to bottom but it can be placed on the transmitter to scan from bottom to top just as readily. The blanking feature, therefore, can be employed to delete material along either margin of the subject copy.

A selector switch permits a choice of three different methods of treating the signals generated by scanning copy: (a) positive linear, which is used when the intelligence to be transmitted contrasts appreciably with the sheet on which it is impressed or when the copy contains a variety of shades of gray and black; (b) positive nonlinear for use when the impressed intelligence is in limited contrast to the sheet; and (c) negative linear when the imprinted intelligence is of lighter color than the sheet as in a photostatic negative and, as is usually the case, it is desirable that a positive black on white copy be produced by the recorder.

The recorder unit is an electromechanical device. The recording amplifier and all other electronic and operational control units required for any arrangement are located in the supporting consoles.

The recorder is of the belt-mounted multiple-stylus type. It employs 8½-inch wide "Teledeltos"* recording paper in a continuous roll. It is completely automatic in operation, starting, phasing and stopping on signals from the transmitter. After a message has been recorded and upon receipt of an end-of-message signal, the rate of paper feed is greatly increased until a predetermined length of paper has been fed out. The paper with the recorded message is then sheared off and deposited in an accumulator on the front of the machine. A dial within the recorder provides a choice of two methods of controlling the length of received message sheets. By one setting of the dial, all messages will be on sheets of uniform length as may be desirable because of certain filing or processing requirements. By the other setting, messages will be at random length determined by the vertical dimension of the subject copy which was scanned by the

*Registered Trademark of The Western Union Telegraph Co.

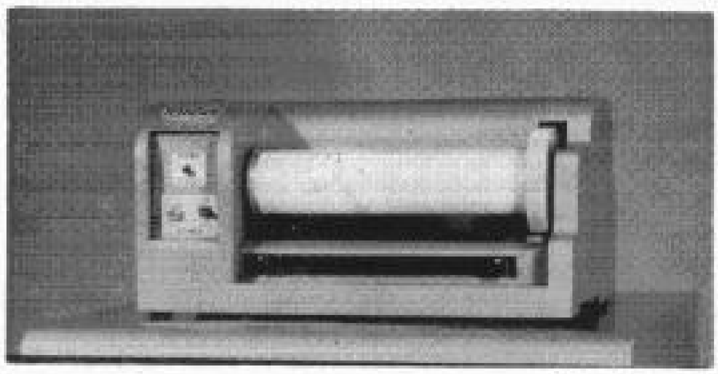


Photo R-10,131

Letterfax transmitter

transmitter, and a minimum of recording paper will be used.

A lamp on the recorder will glow when only sufficient "Teledeltos" paper remains on the roll for 25 or 30 messages. When the roll of paper is exhausted to a point where no further messages can be received safely the recorder automatically is conditioned to be irresponsive to succeeding calls until the paper supply is replenished. This conditioning of the recorder will not interfere with the complete reception of a message in progress at the time it is initiated. As an additional indication of a low paper supply condition a strip of red dye appears along the margin of the last ten feet of paper on the roll.

A variety of consoles provides for accommodating transmitters or recorders singly or in pairs by double-decking. The double-decked pairs may be either two transmitters, two recorders, or one transmitter and one recorder.

Circuits

Letterfax equipments may be operated over physical line pairs for local and intracity service and over carrier voicebands for longer distances between cities. For the present, operation over carrier voicebands is limited to 180 scanning strokes per minute. By an improved transmission method, however, there are prospects that speeds of 300 or more scanning lines per minute will be obtained in the near future.

The transmitters and recorders and their control units were designed for operation over physical line circuits, primarily. In such operation the line pair is "simplexed" to provide a d-c path for phasing and for an automatic indication as to whether or not the line is intact and the distant recorder is in readiness to receive. If it is indicated that the line is intact and the distant recorder is in readiness to receive, transmission will proceed, otherwise the transmitter will run idle but will not scan its copy.

The distance over which the equipment can be operated over physical line pairs depends upon the gauge of the conductors of the pair, the type of cable, and whether operation is at 180 or 360 rpm. The limit of distance can be stated in signal attenuation which should not exceed 25 db at the facsimile carrier frequency. The distance of operation over physical line pairs can be increased by the insertion of intermediate repeaters at suitable locations.

With a carrier voiceband channel which is ordinarily employed for longer circuits there is no path for d-c signals. Carrier control units are inserted between the transmitter and the carrier channel at the sending end and between the carrier channel and the recorder at the receiving end. By these carrier control units the d-c control signals are converted to trains of tone for transmission over the carrier section of the circuit and converted back to d-c signals into the recorder. With this arrange-

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Letterfax transmitter and recorder double-decked ment the automatic indication of the condition of the line and the readiness of the recorder to receive is not provided. However, operating routines such as sequence numbering can adequately safeguard transmissions in both directions.

Systems

The following paragraphs describe briefly some of the circuit arrangements possible with the building blocks available.

1. *One-Way Operation Over a Physical Line Pair.* The simplest arrangement is for operation from a transmitter to a recorder over a physical line pair.

2. *Two-Way Operation Over Two Physical Line Pairs.* Two-way operation over two physical line pairs is, of course, merely two one-way circuits in opposite directions between the same two points.

3. *Two-Way Operation Over One Physical Line Pair.* Two-way operation over one line pair (Figure 1) is offered when (a) operation is required in both directions, (b) the cost of facilities is considerable because of distance, or (c) the total two-way load does not exceed the capacity of one line. For this arrangement no equipment is required other than is normally included with the transmitter and recorder consoles.

When neither transmitter is running the line is automatically terminated in the recorders at both ends of the circuit. When a transmitter at one end of the circuit is started, the line is automatically transferred from the recorder to that transmitter, and transmission takes place automatically.

Two-way operation is conducted without confusion. Assume a condition when, with the circuit idle, both stations desire to send. Station A loads his transmitter

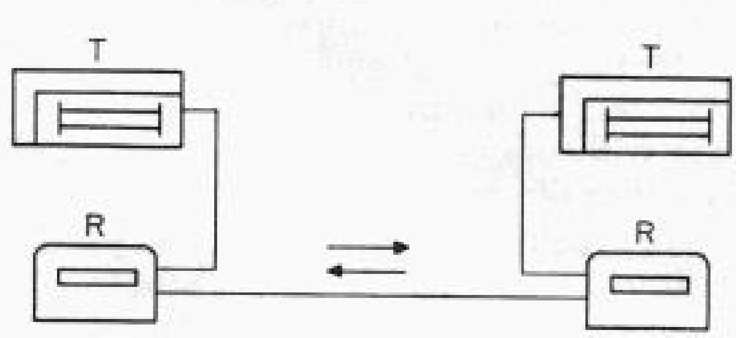

Figure 1. Alternate two-way operation over one circuit

and presses the start button. A moment later Station B loads his transmitter and presses the start button, ignoring the fact that his recorder has started to run in response to the operation of the transmitter at Station A.

When Station A started his transmitter his terminal of the line was automatically transferred from his recorder to his transmitter and at the same time the line was automatically locked to the recorder at Station B.

When the Station A to Station B transmission is completed, the line will be automatically reconnected to the recorder, at Station A. At Station B the lock-up of the line to recorder will be released. The line will then be automatically transferred to the running transmitter at Station B and transmission will proceed to Station A.

4. *One-Way Operation to Three Points One at a Time.* A central point has need to pass information or instructions to three

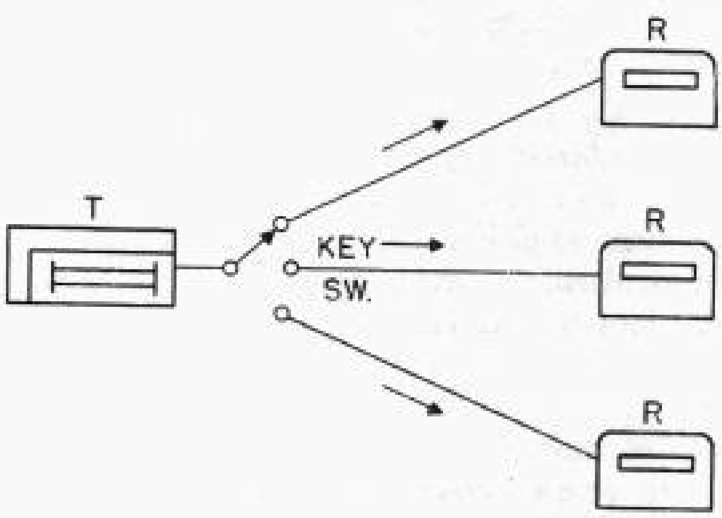

Figure 2. One transmitter to three recorders selectively

stations, for example the Production Manager's office to three departments in the factory. The transmitter at the central point is equipped with a three-position key switch by which it can be connected to the line to the desired department. The departmental recorders will automatically start and receive transmissions directed to them. (See Figure 2.)

5. *One-Way Transmission from Two Transmitters Alternately to One Recorder.* A dual transmitter control provides for operation from two transmitters alter-

nately to one recorder (Figure 3). The two transmitters may be at different locations such as in two departments of a factory connected to the Production Manager's office. Either transmitter can be loaded and started without regard to whether or not the other is in operation. When the line is idle a started transmitter seizes it and transmits to the recorder. When one transmitter has seized the line and the second transmitter is started, the second transmitter will rotate but not scan until the first transmitter has completed its transmission and shut down. The second transmitter will then seize the line and transmission will proceed.

6. *One-Way Transmission to Two Recorders Simultaneously.* A bridged recorder chassis provides for transmitting from one transmitter to two recorders simultaneously (Figure 4). With the bridging unit located with the transmitter, the two recording stations may be in any two directions from the transmitting station. With the bridging unit located with one of the recorders, the second recorder may be located some distance from the first recorder.

7. *Concentrator Arrangements.* In many larger business organizations, the flow of formal information incident to operation and control is mostly between a central office and stations in the various clerical, accounting, production, shipping and other departments. Units of equipment have been designed whereby a variety of arrangements can be provided to meet probable requirements for such organizations.

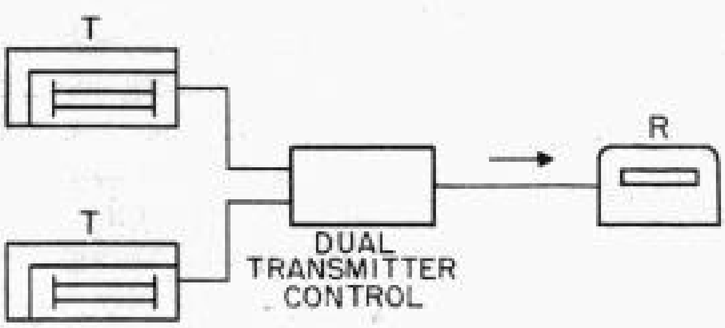

Figure 3. Two transmitters alternately to one recorder

Each of the departmental stations is equipped with transmitters and/or recorders as needed. Lines connecting all of the departmental station machines are terminated in jacks in one or more concentrator consoles in the central office. One concentrator console can terminate up to 30 lines in jack strips of 10 jacks each.

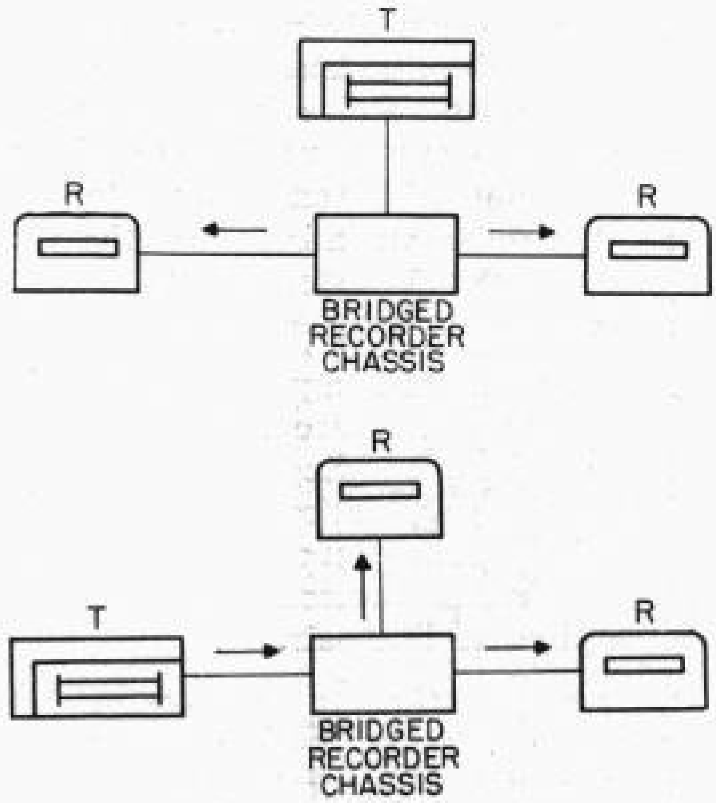

Figure 4. One transmitter to two recorders
(Top) Recorders in different directions from transmitters
(Bottom) Recorders connected serially on one line from transmitter

The central office is provided with the number of transmitters and recorders necessary to handle satisfactorily the total flow of messages to and from the departmental stations. These transmitters and recorders, to a maximum of ten per concentrator console, are connected to flexible cords and plugs in a shelf of the concentrator console below the line jacks. Any central office machine may be connected to any departmental station line by the insertion of the proper cord plug into the proper line jack.

Lines connecting the central office and departmental stations will vary in length and may differ in other physical respects. They are adjusted to be equal electrically so that any central office machine can be operated with any departmental station line with uniform recorded copy density in either direction.

For requirements which include the ability to broadcast subject matter to all or selected groups of departmental stations a console has been designed which, in addition to the concentrator features already described, will provide for (1) single master sending; that is, simultaneous transmission from one transmitter to selected groups of departmental stations to a maximum of 30, or (2) double master sending; that is, simultaneous transmission from each of two transmitters concurrently or separately to two selected groups of departmental stations ordinarily to a total maximum of 20. By special arrangement this double master sending total can be expanded to 30. The input of a master send unit is terminated in a jack on the console. Any central office transmitter can be connected to a master send by inserting its cord plug into the master send jack. Selected lines to which the transmission is to be directed are connected to the master send unit by the proper positioning of the three-position key switches of which there is one associated with each line connected to the console. Lamps are included which indicate when each of the selected group of departmental stations has answered. A station which does not answer in a reasonable time can be dropped from the group by setting its associated key switch in its neutral position thus permitting transmission to proceed to the rest of the group. In this console line circuits are routed through the assemblage so that when a line is connected to a master send unit it cannot be interfered with by an inadvertent connection to its normal console jack.

Photo R-10,416

Letterfax concentrator without master send feature

While master sending is ordinarily from a central office transmitter it can also be from a departmental station by connecting that station's sending line into the master send unit at the central office.

In addition to the line jacks and master send jacks already mentioned there are jacks on the console by which two special operating features can be provided as follows:

1. Permanently connected between two of the jacks there is a dummy line electrically similar to the departmental lines. By plugging a transmitter into one of the jacks and a recorder into the other a local circuit is established for reproducing letters or other documents.
2. Permanently connected between the jacks of each pair of two pairs of jacks is a one-way facsimile repeater. By connecting the proper line jacks and repeater jacks with double-ended patching cords, one-way or two-way transmission can be provided between two departmental stations. A supervisory lamp associated with the jacks of each repeater indicates the status of the circuit and when the connection can be pulled down. Such interdepartmental circuit connections are set up by the central office on telephone or message request by the departmental station requiring it.

One or more of most of the features which can be provided by the Letterfax equipments described have been included in the many installations in operation. Results to date indicate that there will be a continuing steady demand for systems which can be fabricated from the building block units described.

In all cases and regardless of the types of equipments furnished, Western Union facsimile equipments in private installations, including the Letterfax equipments described above, are labelled "Western Union Intrafax."

Archie S. Hill, Assistant to the Project Analysis Engineer, entered Western Union service in the Testing and Regulating Department in Buffalo, N. Y., in July 1916, after six years with the Postal Telegraph Company. After service in World War I with the Signal Corps, he was for many years Assistant General Traffic Dispatcher in New York City. He transferred to the Engineering Department after the beginning of World War II and was closely associated with the accelerated Telefax program launched after the close of the war. Mr. Hill actively participated in the planning and successful field trial of a Desk-Fax installation at Newark, N. J., and with many of the installations which followed. Recently he has contributed materially to the successful application of Western Union's Telefax to business needs in Private Wire Service. Mr. Hill is a Pratt Institute graduate in Industrial Electricity and an Associate Member of AIEE.

One section of Western Union data transmission equipment furnished to Sylvania Electric Products, Inc., at Camillus, N. Y., center for rapidly processing as many as 50 different kinds of business data such as payroll, costs, inventory and sales, collected telegraphically from some 70 locations nationwide over a 20,000-mile wire network supplied by Western Union.

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Telex in Canada

Arrangements are being made to provide Western Union teleprinter customers in New York with direct connections into the Canadian automatic teleprinter exchange system called Telex. This Canadian system, patterned after European methods, is operated by the telegraph divisions of the Canadian Pacific and Canadian National companies. Installation of the Western Union exchange will permit interchange of teleprinter traffic directly with customers of "Telex in Canada," but not overseas.

THE Canadian Pacific and Canadian National telegraph systems introduced a Canadawide automatic teleprinter exchange service which was placed in operation in July 1957. This service supplements the international Telex connecting service which commenced operation in November 1956 and through which subscriber interconnections can be made to some 19 European countries, in addition to some 18 Latin-American, African and trans-Pacific countries. Canadian subscribers to this service have access to something in excess of 30,000 separate subscribers over international communications.

Basic considerations for service performance and operations were studied and these salient points were established as requirements:

1. The tariff rates to be applied must be as low as practical and be simple to apply.
2. The maximum simplification and ease of operation must be provided for subscriber operations.
3. Full-time service, 24 hours per day, must be provided and interconnections between subscribers must be established with minimum delay.
4. Positive identification of each connection must be established so that messages can go forward even though the receiving subscriber's position is unattended.

To provide a full-time service with minimum switching delays it was obvious that automatic operation was a requirement. The public's familiarity with dial operation, together with the ease of maintenance and familiarity of operating personnel with step-by-step switching, were important considerations leading to the selection of a dial step-by-step switching system.

However, a requirement for an automatic switching system dictated a requirement for automatic registration of charges for connections established. In this connection, recently the telephone companies have developed and are in the process of placing into operation an automatic ticketing arrangement, but the cost and complications of their system precluded consideration of it to meet Telex requirements. In general, dial systems in operation have been used to provide local services and depend on manual operation for toll switching and ticketing. Since the application of teleprinter switching is almost exclusively for toll connections, it was evident that systems available outside of Canada and the United States of America would have to be reviewed.

Fortunately, European systems have been developed and used which in the main provide all the basic requirements previously enumerated. Since certain of these features are new to this continent, it is proposed to confine this discussion, insofar as practical, to these particular items. In particular, these new items are the answer-back, 4-bank keyboard and time-zone metering. The answer-back is a

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relatively simple device which is fitted to the subscriber's teleprinter. It consists of a coding drum associated with the transmitter-distributor unit of the printer and so arranged that it can be released either by the transmission of a special character or manually. The coding drum can be set to transmit a shortened form of the subscriber's name and location, consisting of some 15 characters. The answer-back unit is shown in Figure 1.

The method of use is extremely simple. When the subscriber dials and completes a connection he operates the WHO key on his printer and this character trips the answer-back drum which automatically reproduces the subscriber's identification on both printers. The operation of the HERE IS key by the originating subscriber releases his answer-back code which in turn is reproduced again on both printers. Positive identification is thus completely assured by the originating subscriber and information can be transmitted with complete assurance even though the receiving subscriber's machine is unattended. The ability for positive identification is an attractive feature and especially so where automatic switching is used.

Teleprinters supplied on private wire service have employed a 3-bank keyboard. Since only 32 separate characters are available in the 5-unit code, numbers and special characters must be provided as upper-case shift characters. Since FIGURES shift and LETTERS shift characters must be transmitted at appropriate positions in the transmission of text, a certain degree of confusion exists until the typist has become familiar with the keyboard arrangement and operating procedure. The 4-bank keyboard avoids this confusion by providing separate keys for each character, including numbers. The shift and unshift characters are locked, depending on which shift character was last transmitted. The 4-bank keyboard closely approximates the standard keyboard of a typewriter and the interlocking arrangement eliminates difficulties of transmitting characters in the wrong shift. The advantage of being able to use regular typists without a special training period is obvious. The teleprinter and console used in the Telex service are shown in Figure 2.

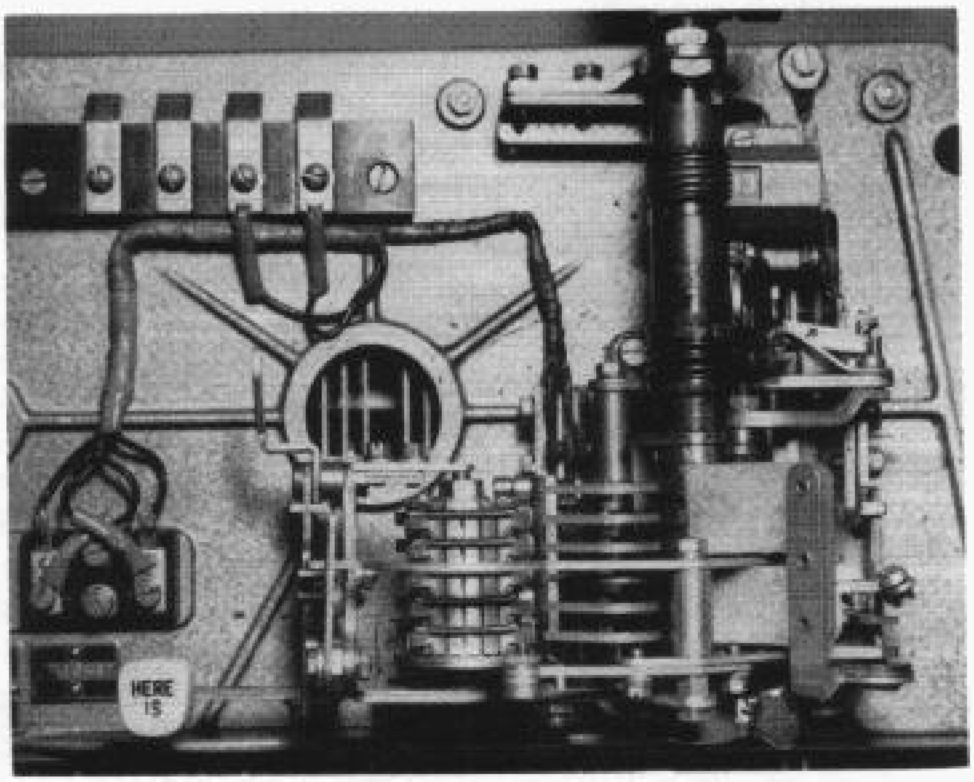


Figure 1. Answer-back unit fitted to subscriber's teleprinter

The third item which will be dealt with concerns time-zone metering. This arrangement has been extensively used in European Telex networks and is now being applied to their automatic telephone services. The arrangement is relatively simple, reasonable in cost and provides very considerable simplification in accounting and billing. These various factors providing for simplification of administration and accounting make it possible to provide service at a lower rate than would otherwise be the case.

This unit consists of a counter associated with each subscriber and to which can be connected pulses, the rate of which is determined by the distance of the connection. Due to this simplification it does not become necessary to penalize the subscriber for each connection by imposing a minimum charge for a specified period. It is, therefore, practical to make the charges on a straightforward basis of time the connection is held and the distance concerned.

As previously mentioned, a pulse rate corresponding to distance is connected to a meter counter and the rate concerned is determined by the number dialed. In the Telex system 4-digit discrimination is provided.

It is apparent that the application of such an arrangement requires careful system designing, especially with respect to the numbering scheme employed, since the entire determination of the rates must be decided from each location to each of the other locations through examination of the number system.

The present Canadian system consists of three main switching areas which are designated by the numbers 01, 02, and 03. From each of these main switching areas district switching offices are extended which bear the main switching number followed by a third digit which implicitly designates the office concerned. From the district exchange office subdistrict offices are extended and the subdistrict office bears the district exchange number followed by another digit which designates the subdistrict concerned. It will be noted that four digits precisely determine any exchange centre and that with this system no duplication of numbers occurs. In consequence, four digits precisely locate the geographical position of a subscriber and, of course, the distance involved from the originating point to this subscriber is likewise known. It will, therefore, be apparent that if one examines these four digits for each originating call, and connects the pulse rate corresponding to these digits on a meter associated with the customer, one can obtain a meter charge corresponding to the time the connection is held and the distance from which the call is transmitted. (See Figure 3.)

Figure 2. Teleprinter and console used in Telex service

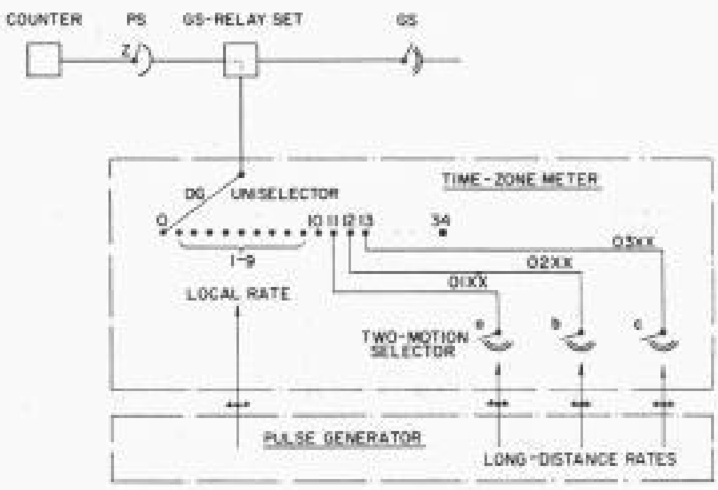


Figure 3. Time-zone meter

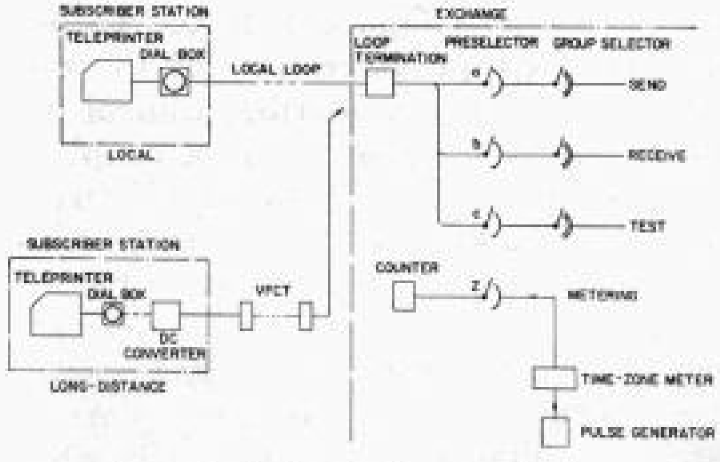


Figure 4. Customer's loop termination

It will be noted that this arrangement is relatively simple in theory and no difficulty is involved in a practical application. It will be seen from Figure 4 that each customer's loop is terminated in a counter and a preselector. The preselector consists

zone meter discriminating unit consisting of a 34-position uniselector and a group of two-motion 100-position switches. The time-zone meter arrangement is driven by the dial pulses used to establish the required connection and thus position themselves to conform to the dialed number. The discriminating portion of this network is shown on Figure 3. Referring to this figure, it will be noted that when the number 0 is dialed the uniselector advances to the position 10, the next digit dialed determines the main switching center concerned and if this were 3 the uniselector would operate to position 13. When the main switching centre has been selected the dialing pulses are transferred by apparatus not shown in this diagram to the two-motion switches which are designated

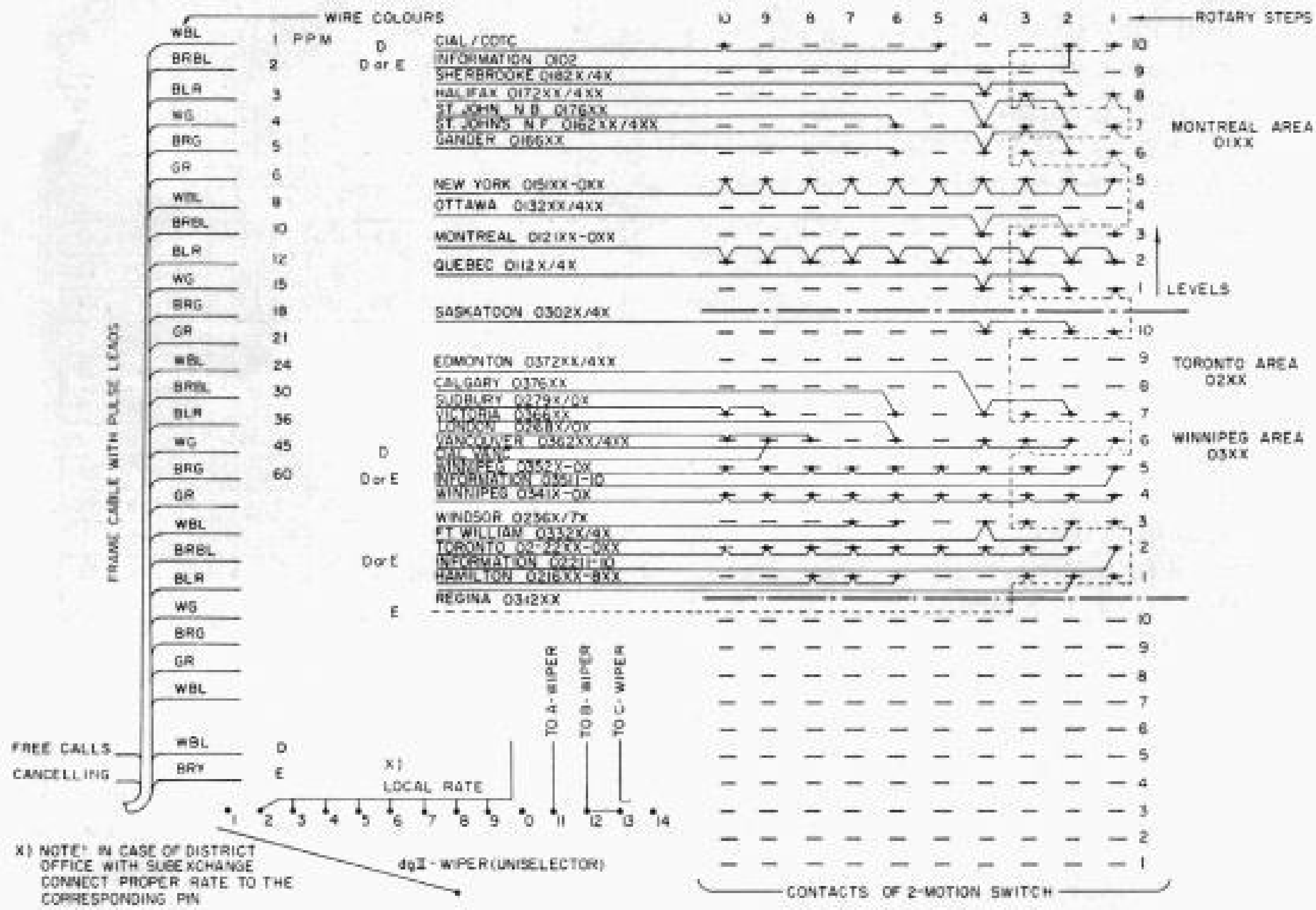


Figure 5. Time-zone meter strappings

of a 4-bank 10-position uniselector, one level of which is associated with the meter counter. This preselector has access to a common group of first group selectors, each of which is associated with a time-

as a, b, c. The next two digits cause the two-motion switch to advance vertically to a level which corresponds to the digit dialed, and the fourth digit causes it to cut into a position corresponding to the digit dialed. This position has associated with it a pulse rate which has been determined by tariff requirements and this pulse rate is connected through a level of the time-zone meter to the preselector and thence to the counter. Referring to Figure 5, it will be noted that the various pin positions on the two-motion switch have been designated to various exchange areas corresponding to their actual numbers as developed from a numbering plan. Figure 6 shows the pulse rates from each of the exchange areas to each of the other exchange areas. At each switching centre a pulse generator containing all of these pulse rates is provided and connected to the pin positions which are shown in Figure 6 to conform to the tariff rates which were established from that switching centre to the corresponding number.

LOCAL RATE 1

	SHERBROOKE	HALIFAX	ST. JOHN N.B.	ST. JOHN'S NF	GANDER	OTTAWA	MONTREAL	QUEBEC	SASKATOON	EDMONTON	CALGARY	SUDBURY	VICTORIA	LONDON	VANCOUVER	WINNIPEG	TORONTO	WINDSOR	FT. WILLIAM	HAMILTON	REGINA
SHERBROOKE		12	10	18	18	8	5	6	24	30	30	12	36	12	36	21	12	15	18	12	24
HALIFAX	12		6	15	15	15	12	12	30	30	36	18	36	18	36	24	15	18	21	18	30
ST. JOHN N.B.	10	6		15	15	12	12	10	30	30	30	15	36	15	36	24	15	18	21	15	24
ST. JOHN'S NF	18	15	15		6	21	18	18	36	36	36	21	45	24	45	30	21	24	24	21	30
GANDER	18	15	15	6		18	18	15	30	36	36	21	45	21	45	30	21	24	24	21	30
OTTAWA	8	15	12	21	18		6	10	24	24	24	10	30	12	30	18	10	12	15	10	21
MONTREAL	5	12	12	18	18	6		6	24	30	30	12	30	12	30	21	12	15	15	12	24
QUEBEC	6	12	10	18	15	10	6		24	30	30	12	36	15	36	21	12	15	18	12	24
SASKATOON	24	30	30	36	30	24	24	24		10	12	21	15	21	15	12	21	21	15	21	6
EDMONTON	30	30	30	36	36	24	30	30	10		8	24	15	24	15	15	24	24	18	24	12
CALGARY	30	36	30	36	36	24	30	30	12	8		24	12	24	12	15	24	24	21	24	12
SUDBURY	12	18	15	21	21	10	12	12	21	24	24		30	10	30	15	10	12	12	10	21
VICTORIA	36	36	36	45	45	30	30	36	15	15	12	30		30	4	21	30	30	24	30	18
LONDON	12	18	15	24	21	12	12	15	21	24	24	10	30		30	18	6	6	15	4	21
VANCOUVER	36	36	36	45	45	30	30	36	15	15	12	30	4	30		21	30	30	24	30	18
WINNIPEG	21	24	24	30	30	18	21	21	12	15	15	15	21	18	21		18	18	12	18	12
TORONTO	12	15	15	21	21	10	12	12	21	24	24	10	30	6	30	18		10	15	3	21
WINDSOR	15	18	18	24	24	12	15	15	21	24	24	12	30	6	30	18	10		15	8	21
FT. WILLIAM	18	21	21	24	24	15	15	18	15	18	21	12	24	15	24	12	15	15		15	15
HAMILTON	12	18	15	21	21	10	12	12	21	24	24	10	30	4	30	18	3	8	15		21
REGINA	24	30	24	30	30	21	24	24	6	12	12	21	18	21	18	12	21	21	15	21	

Figure 6. Pulse rates between Telex exchanges (figures denote pulses per minute)

Now that the special features incorporated in this system have been briefly outlined, it may be of interest to outline briefly the method of operation and to trace through a call.

The equipment at a subscriber's terminal is shown in Figure 2. It will be seen that on the right-hand side of the teleprinter there is a subscriber control unit consisting of a signal lamp, a couple of switches and a dial. When the subscriber desires to initiate a call, he presses the START button. The operation of this button causes his preselector to seize one of the first group selectors in readiness for dial operation and at the same time releases the dial on his control unit which during the inert stages was locked. The unlocking of the dial is indicated by the appearance of a white shutter on the control unit. The customer now dials the number required. This dialing operates the step-by-step switches in the various exchanges and the dial pulses also operate the time-zone meter discriminating equipment for the first four digits concerned. When the connection has been completed to the dialed subscriber a permanent positive pulse will be transmitted from the distant end. This is recognized at the originating end and performs two functions:

1. It turns on the customer's machine

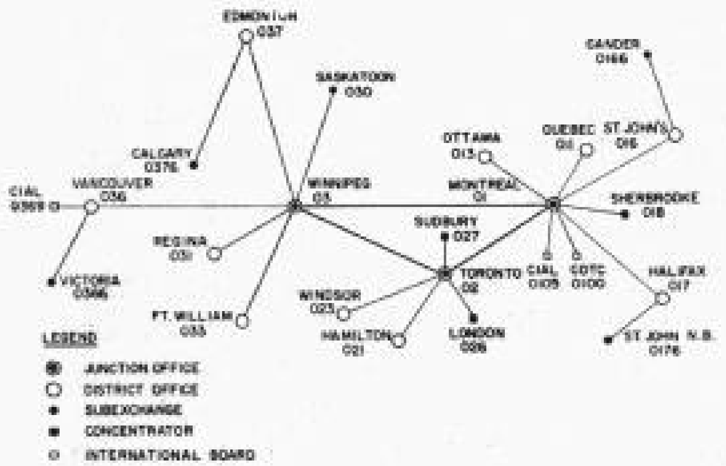


Figure 7. Exchange areas—Canadian Telex system

which had been previously inactive, lighting the signal lamp on the control unit.

2. It completes a circuit from the pulse generator through the time-zone meters to the counter connected to the subscriber's loop termination. The completion of the connection to the called subscriber automatically starts his teleprinter.

The completion of the connection above is identified when the originating subscriber operates his WHO key. Immediately, the called subscriber's identification is reproduced on his machine as well as on the receiving machine. He then operates his HERE IS key which automatically transmits his identification code and reproduces it on both machines. When the interchange of traffic is complete either party may release the connection by the operation of the STOP key. The operation of this key knocks down the switching train and both parties are immediately disconnected and the machines come to rest. If it happens that the called subscriber is engaged at the time the call is initiated, a busy signal is transmitted to the calling subscriber which causes his signal lamp and teleprinter to be connected momentarily, followed immediately by a clearing out signal which restores his machine to the inactive condition.

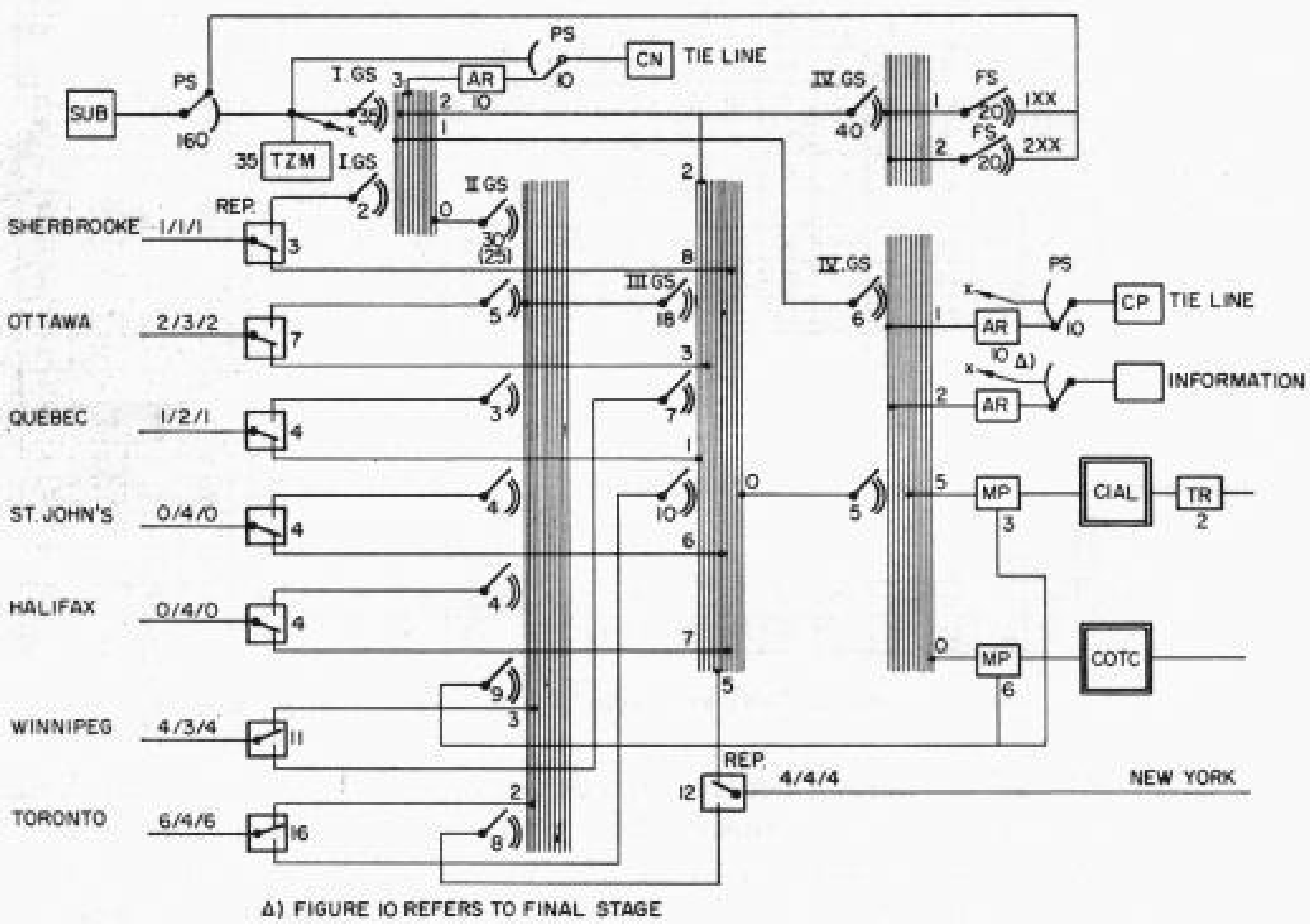


Figure 8. Schematic of Montreal switching area

Certain free conditions are provided for tie-line connections, trouble reporting, information, and so forth. Time-zone meters are so arranged that no charges are applied for these calls. Since these same numbers are used at various points, it would be possible for a customer to complete a connection through several exchanges to the common number at another exchange, except that certain strapping arrangements are made on the time-zone meter which gives a constant BUSY signal. Therefore, no connection can be established, except as provided for meeting the required service needs.

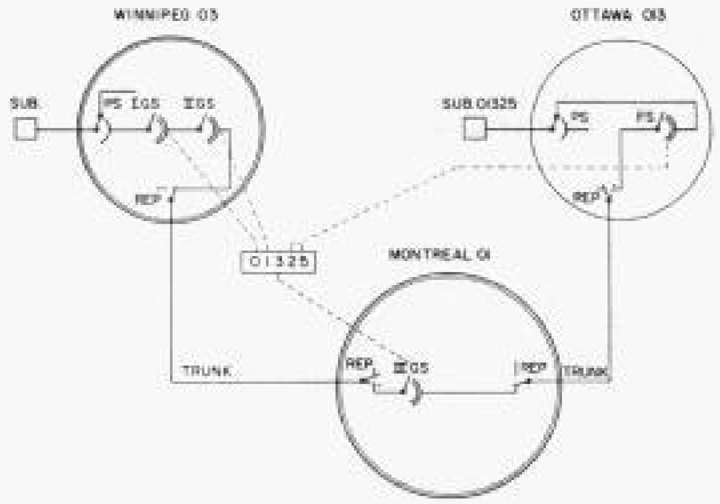


Figure 9. Interconnection from a Winnipeg to an Ottawa subscriber

Figure 7, showing the exchange areas of the Canadian Telex system; Figure 8, showing in schematic form preselectors, group selectors and final selectors for the Montreal switching area; and Figure 9, showing an interconnection from a Winnipeg subscriber to an Ottawa subscriber through the Montreal switching centre, will be helpful in visualizing the method of operation of the Canadian Telex system.

C. J. Colombo graduated from the University of Toronto with B.A. Sc. in E.E. in 1929, after which he joined the Bell Telephone Company, working in the Transmission and Foreign Wire Relations Engineering groups in the Toronto and Hamilton divisions. Later he transferred to the electrical staff of Hollinger Mines then, in 1937, to Canadian Pacific Communications in the capacity of General Transmission Engineer, later expanded to include Foreign Wire Relations. In 1955 Mr. Colombo was chosen to head up the newly formed Planning and Methods group as Assistant to the General Manager Communications.

W. LEE ELKINS, General Operations Supervisor, Maintenance and Operations

Leg Patching in Polar Centralized Circuit Handling Offices

Uniform employment of double current (polar) operation for local telegraph circuits at certain important offices has proved advantageous in improving transmission and reducing circuit testing and regulating. With this method of operation, a variety of circuit rearrangements may be accommodated readily by patching procedures.

CONTINUATION of a successful competitive position in an industry, such as the telegraph industry, is largely dependent on the continual development of equipment and systems which provide easier and quicker means of doing necessary work better. The history of the telegraph industry is filled with examples of such developments. For instance, reperforator switching replaced manual teleprinter relay of traffic which had formerly replaced Morse traffic handling methods. More recently, delivery of telegrams to many customers over facsimile tie lines has replaced manual delivery.

Another fairly recent development which now aids greatly in keeping established circuits operating and in establishing new circuits or extensions to old circuits is the Polar Centralized Circuit Handling System[1,2] for main office wire and repeater rooms, hereafter abbreviated PCH system. In the wire and repeater rooms are terminated the carrier channels, physical lines and leg conductors to drops. Circuits may be repeatered through, hubbed (have several stems radiating from the city), or terminated in a city. The PCH system permits technicians in the wire and repeater rooms to handle more circuits in an easier and more orderly manner than the non-PCH system. It was first proposed in 1950 and a field trial installation was made at Buffalo in 1953. This proved so successful that it led to further conversion of offices to this type of operation.

It is axiomatic that there can be no systematic circuit handling plan in any office until the leg terminations and patching procedures are standardized. For example, such a plan cannot be realized in a non-PCH office where repeaters, carrier channels and drops are worked 2-leg and 1-leg and leg circuits operate on 60, 70, 120 milliamperes and in some cases as much current as the facility will permit. There are other reasons why an orderly arrangement cannot be set up in a non-PCH office but the reasons just given should be sufficient to show that a real problem in circuit handling exists in such offices. Due to the various leg arrangements and leg currents used in non-PCH offices it is obvious that considerable checking and analyzing by a highly qualified technician should precede the making of any patch, throwing of any leg switch, adjusting of any current, turning of any bias control or taking any action likely to cause the leg circuits not to fit together properly or the transmission margins to be impaired.

In the PCH system the legs are standardized by making all the leg terminations in the office polar. See Figure 1 for polar terminations which include most of the PCH terminations currently in use. The term "terminations" includes the terminations of the legs of local city drops as well as the terminations of the legs of traffic tables, carrier channels and repeaters. Tie-line terminations are normally excluded from the system for they are seldom connected to repeaters or carrier channels. However, means are provided for connecting any tie line into the system when it is necessary or desirable.

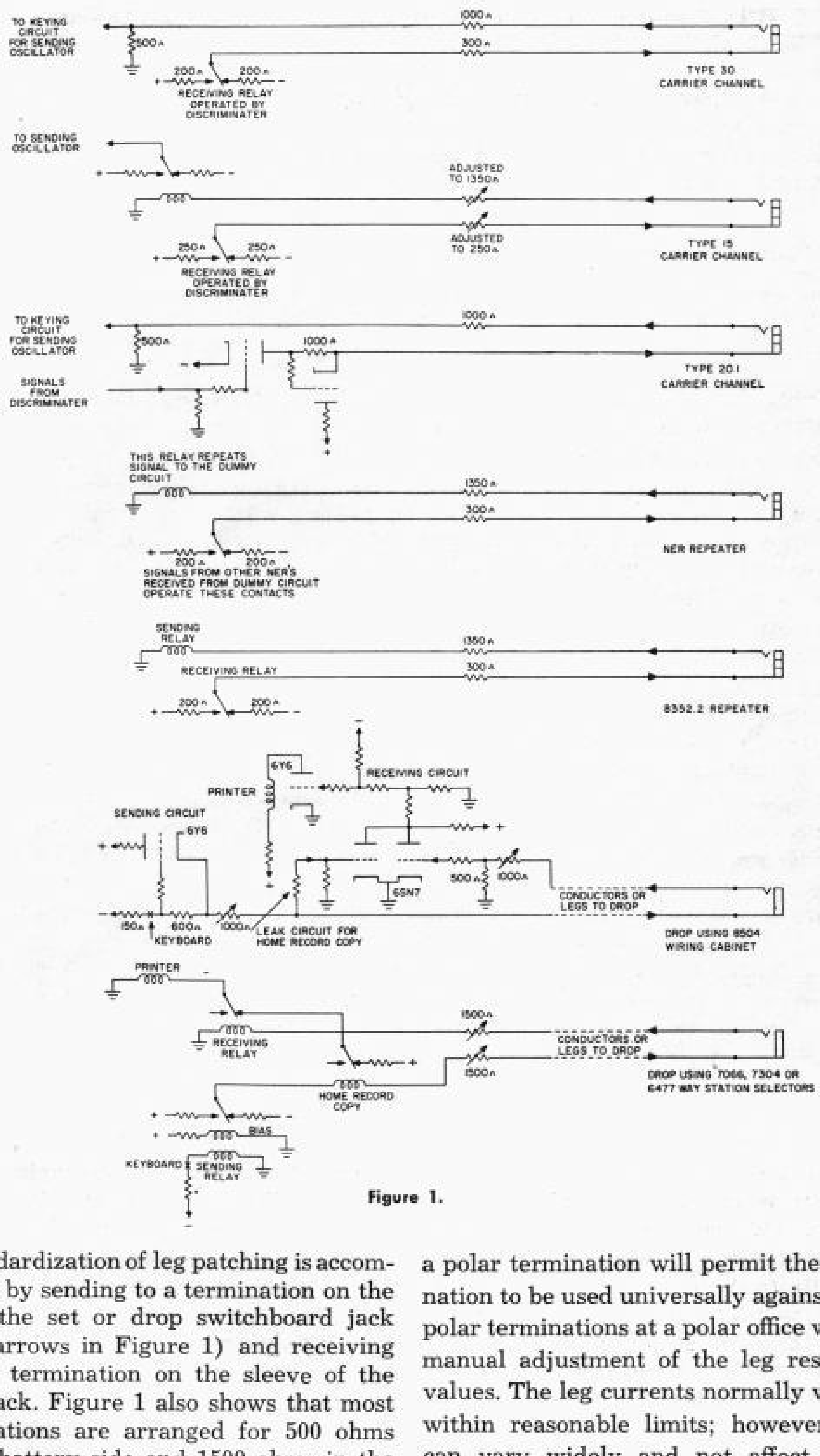
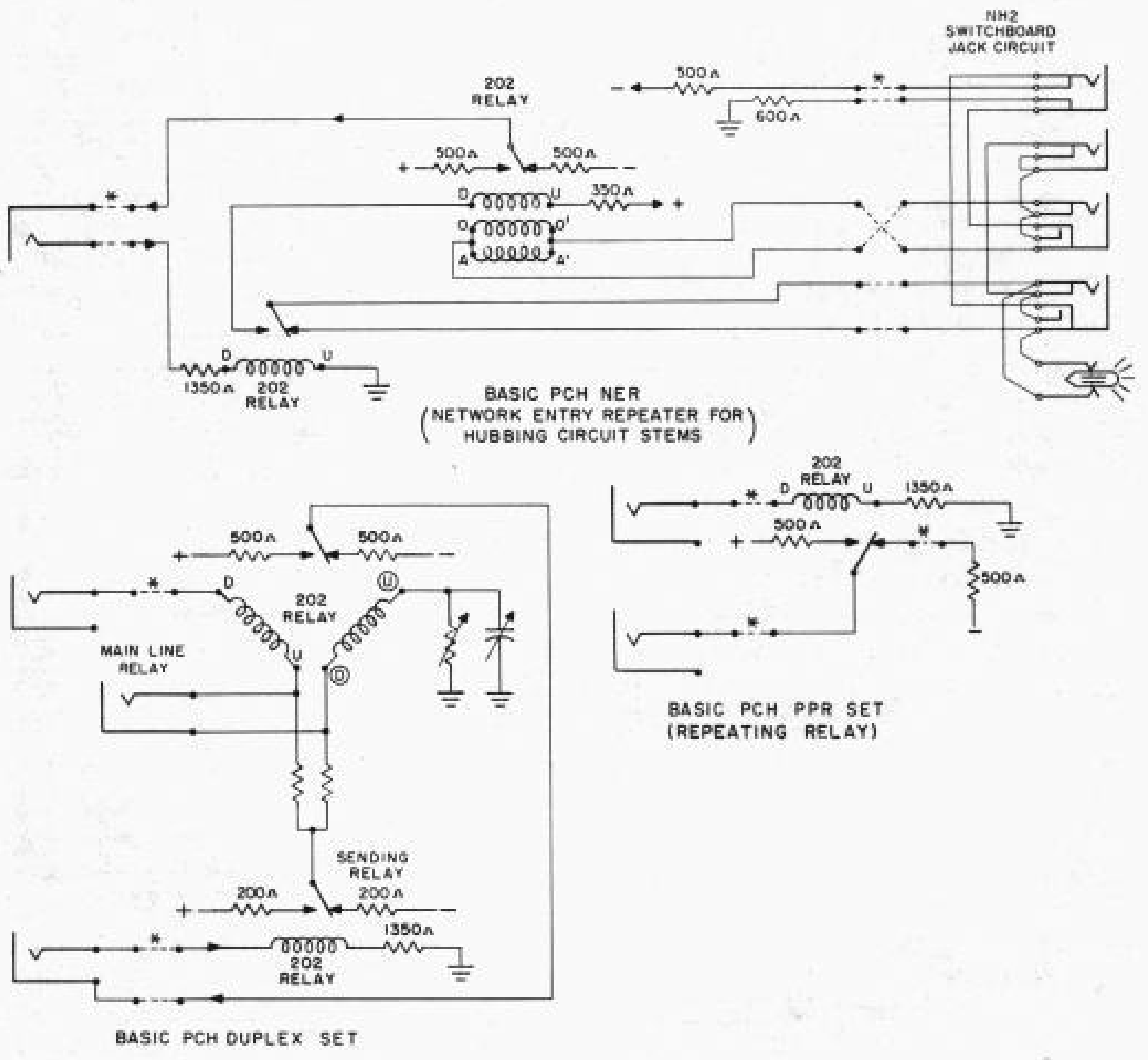


Figure 1.

Standardization of leg patching is accomplished by sending to a termination on the tip of the set or drop switchboard jack (note arrows in Figure 1) and receiving from a termination on the sleeve of the same jack. Figure 1 also shows that most terminations are arranged for 500 ohms in the battery side and 1500 ohms in the ground side. These values of resistance in a polar termination will permit the termination to be used universally against other polar terminations at a polar office without manual adjustment of the leg resistance values. The leg currents normally will fall within reasonable limits; however, they can vary widely and not affect circuit operation. Some polar circuits have been operating satisfactorily on as low as 20 milliamperes. The standardization of leg terminations and leg patching procedures with the use of polar leg operation results in the simplification of leg patching and elimination of leg current and bias adjustments for all practical purposes.

Compatible repeater equipment presently being used at PCH offices includes the 7086D carrier drop repeater for hubbing; the 8352.2 duplex repeater for terminating physical lines; the 7352 polar press repeater for single relay repeating purposes; and the 7500 duplex-duplex half



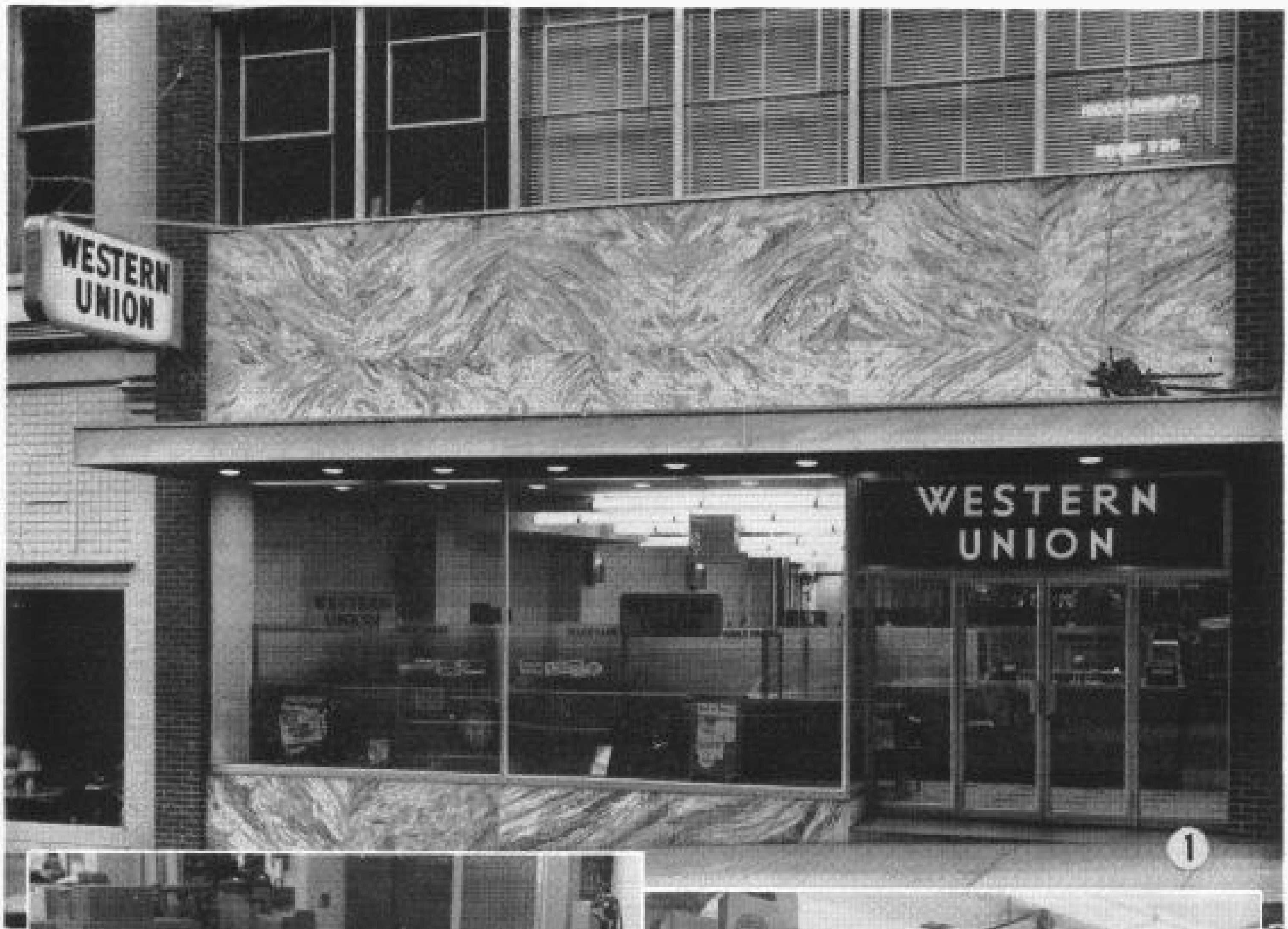
* CROSS CONNECTIONS

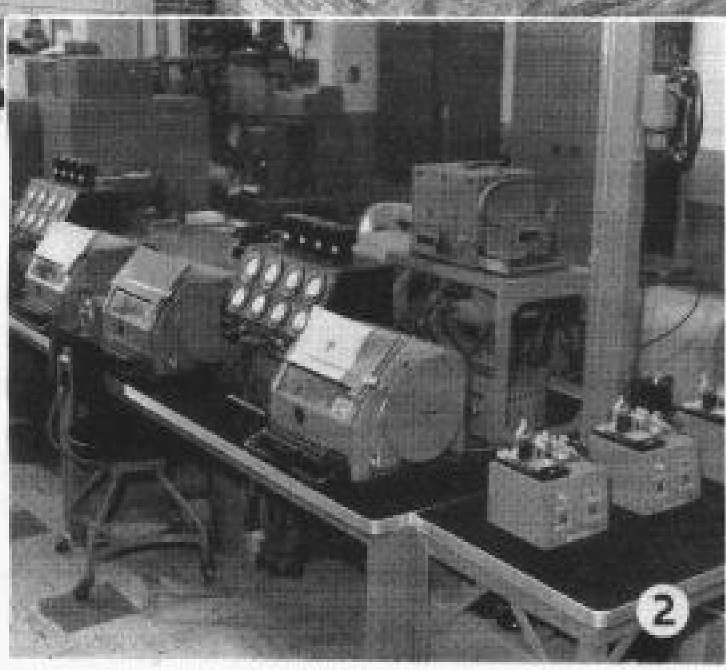
Figure 2.

Figure 2 shows theory sketches of the minimum essential repeater equipment needed at PCH offices except for a screening repeater used in certain special cases. Currently compatible repeater equipment (useful in either PCH or non-PCH offices) is being installed at the PCH offices. It is hoped that in the near future repeaters for PCH offices can be stripped of the extra units (jacks, switches, lights, etc.) now required on compatible equipment for use at non-PCH offices.

repeater for screening drops having patron owned equipment where it is impractical to arrange for a drop conversion to polar operation. Such patron drops are essentially converted to polar operation in the main office through the use of 7500 duplex-duplex half repeaters. At the latest PCH offices the types of repeaters are being limited to these four.

Compatible drop or semicompatible drop equipment used at cities having PCH central offices includes the 7066, 7304 and





Nashville, Tenn.

1. Front of main office

2. Monitor center

3. Main switchboard

7336 way-station selectors and the 8504 electronic wiring cabinet.

Accompanying illustrations show typical scenes in the Nashville and Miami offices which were recently converted to PCH operation — Nashville in 1956 and Miami in 1957. New Haven has just been converted and other offices scheduled to be converted soon include Amarillo, Utica and Cleveland.

Figure 3 shows three hypothetical PCH offices (A, B and C) and some of the carrier channels and repeaters which would be used to set up circuits. Two circuits are shown (Circuit 1 and Circuit 2). Circuit 1 is a direct circuit between Office A and Office C while Circuit 2 is hubbed at Office C and has drops at all three offices. If the physical wire, Wire 201NYC, fails between Office A and Office

Miami, Fla.

1. Front of main office
2. Monitor center
3. Main switchboard
4. Repeaters

C, causing Circuit 1 to fail, Circuit 1 may be quickly restored by moving the end of the red cord patched in jack 5 to jack 4, and the end of the red cord in jack 12 to jack 13. Notice that only patch changes are required and that there is no indecision as to what type of patching cord to use, no currents to adjust, no biases to adjust or switches to position.

1. At Office A: Move the end of the red cord patched into jack 3 to jack 4.
2. At Office B: Remove the patching cord between jacks 6 and 7.

   Remove the patching cord between jacks 8 and 11.

   Move the end of the red cord patched in jack 9 to jack 11.

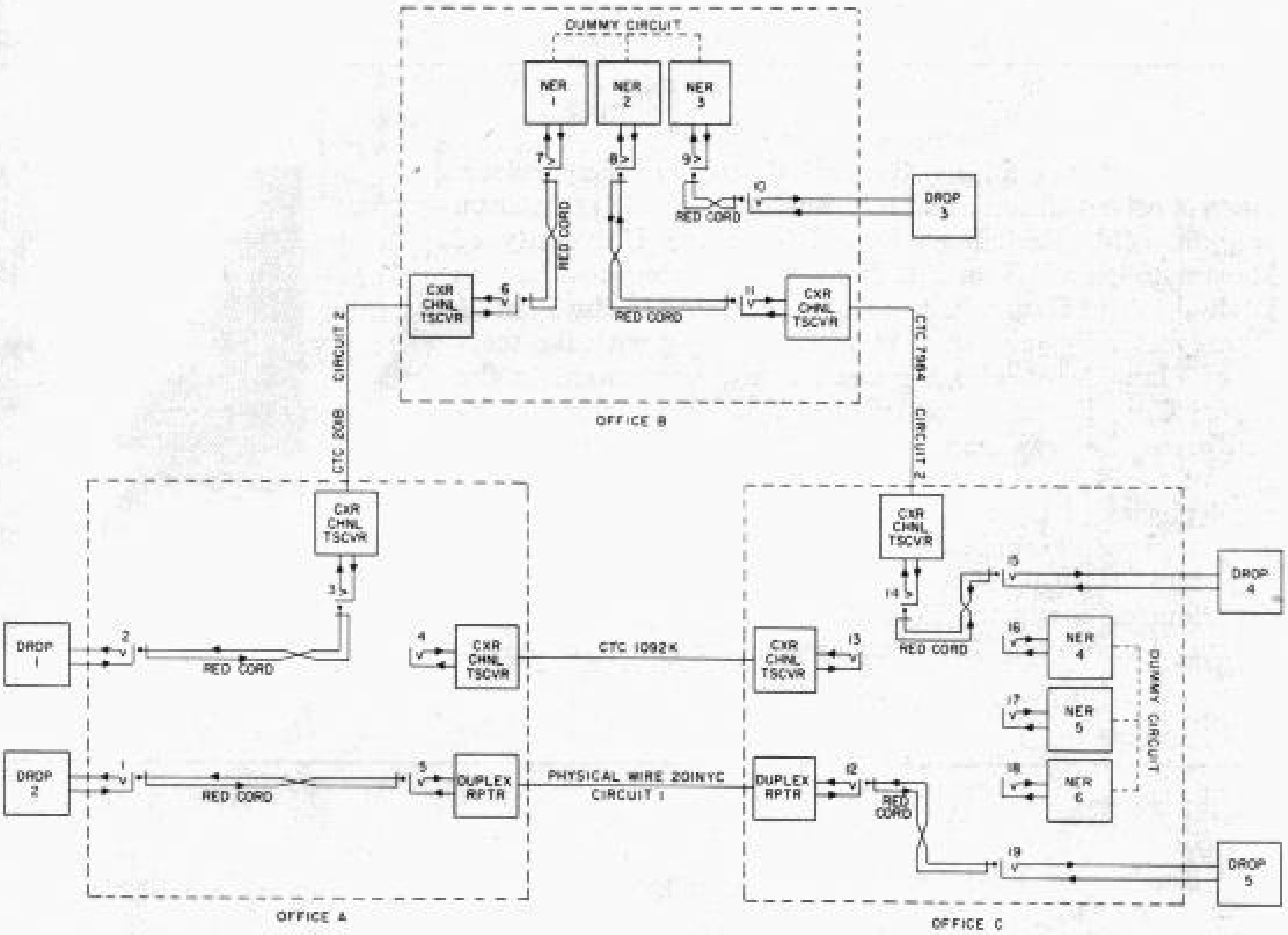


Figure 3.

In order to show the flexibility of the PCH system to even greater advantage, Circuit 2 is given. It is assumed that there are no spare carrier channels or physical facilities between Office A and Office B, none between Office B and Office C, and only one (CTC 1092K) between Office A and Office C. Now assume CTC 201B between Office A and Office B fails. Since there are no spare channels between Office A and Office B, the A Office drop is off the circuit until other arrangements are made. The drop at A Office (Drop 1) may be added to the circuit via Office C with Office C doing the hubbing very easily and quickly. For this move the following patch changes are required:

3. At Office C: Patch the dummy circuits of NER (Network Entry Repeater) 4, 5 and 6 together to form one common dummy. (This is done in the same manner at all offices.)

   Move the end of the red cord patched into jack 14 to jack 16.

   Use a red cord patch between jacks 14 and 17.

   Use a red cord patch between jacks 13 and 18.

The patches made are not greater in number than at non-PCH offices to make this hubbing point change. However, as in the first example, it is not necessary to adjust any currents or biases, change any switches, use different color cords or run lengthy tests. When the patches mentioned have been made the circuit should immediately be ready for operation between the three offices.

Many other cases, of course, could be cited, but it is hoped that the two examples given are sufficient to show some of the more important advantages of the PCH system.

References

1. CENTRALIZED AND SIMPLIFIED CIRCUIT HANDLING USING POLAR LEG OPERATION, E. F. JAEGER, *Western Union Technical Review*, Vol. 8, No. 1, January 1954.
2. A COMPARISON OF MAKE-BREAK AND POLAR OPERATION, D. P. SHAFER, *Western Union Technical Review*, Vol. 8, No. 3, July 1954.

W. Lee Elkins, General Operations Supervisor, joined Western Union as a Field Engineer in 1948 at Atlanta, Georgia, after having graduated from the University of Alabama with a B.S. in E.E. Immediately afterward he was detailed to the Kansas City area for training in the Plan 21 Reperforator System. In 1949, after assisting with the testing of Plan 21 reperforator circuits and equipment in the Kansas City, Detroit, Los Angeles, New Orleans and Oakland areas, he was transferred to the New York General Operations P&E group. Since that time he has been active in all phases of Operations work. Projects he is presently associated with include the application of the Plan 34 and 35 Reperforator Systems to small offices and the conversion of various offices to the Polar Centralized Circuit handling system of operation. He is an associate member of AIEE.

Patents Recently Issued to Western Union

Facsimile Recording Amplifier

G. B. Worthen

2,794,913—June 4, 1957

A facsimile recording amplifier for use with the system of Patent No. 2,647,945 and designed to provide uniform level output signals from varying input levels, with noise rejection at zero and intermediate levels. Four stages, in order, are designed to perform more or less distinctive functions. The first stage is biased negatively for the duration of each revolution by the phasing pulse so that noise is suppressed in the absence of signals but signals are amplified with gain inversely proportional to level, the second stage is a limiter with short time constant, the third stage passes only the signals which exceed a certain level, and the fourth stage completes the limiting and shaping process.

Motor Stabilizer

F. T. Turner

2,803,792—August 20, 1957

A stabilizer for facsimile drive motor systems of the general type of Patent No. 2,715,202. A frequency standard provides motor-drive frequency (60 cycles) via a divider, and a regulating frequency (1440 cycles) via a multiplier, which latter is compared in a phase detector with a like frequency generated by a tone generator on the motor shaft. If the phases of the two frequencies differ, a d-c error signal is generated which controls a saturable reactor element in a phase changer located in the 60-cycle motor-drive circuit to thus vary the phase position of the motor shaft. Both synchronous and induction motors are illustrated.

Paper Feed Mechanism

A. S. Hill, D. S. Zabriskie

2,805,115—September 3, 1957

A paper feed mechanism for a facsimile page recorder in which the paper advances normally until approximate completion of message reception at which time a sector gear on the paper feed roller engages a rack bearing a lever and attached knob so as to propel the knob forward to indicate the approaching end of message. At end of message the operator then draws the knob forward to its end of travel to feed out a uniform length of paper for each message. This movement also restores the recorder to stand-by position for the next message.

Facsimile Scanner

G. H. Ridings, J. H. Hackenberg

2,806,081—September 10, 1957

Stylus carriage for a small portable type facsimile machine, which may be a transmitter adapted for scanning insulating marks on a conductive paper, in which the stylus pressure is determined by the weight of the mount, and the stylus carriage together with the associated mount may be lifted against spring pressure from the lead screw half nut and locked in retracted position for safety from damage during transport.