WESTERN UNION Technical Review

Polar Leg Operation

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Book Message Equipment

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"A Lady of Quality"

•

Simplified Telefax Concentrator

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Synchronizing Systems

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Pole Yard Operations

VOL. 8 NO. 1
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WESTERN UNION

Technical Review

VOLUME 8
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Presenting Developments in Record Communications and Published Primarily for Western Union's Supervisory, Maintenance and Engineering Personnel.

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To the Readers of the Technical Review

As THE world's leading organization in the record communication field it is but to be expected that Western Union would pioneer new developments in this field. The present Western Union plant and operating methods clearly demonstrate the value and service inherent in the improved technology which has been made available.

Automatic reperforator switching improved the speed and accuracy of message relay handling at lower operating cost; microwave relay opened up a new horizon and a new means of providing trunk circuit facilities of higher quality than pole lines and wires; FM carrier afforded increased telegraph channel capacity with improved transmission margins; push-button switching techniques employed in handling message relay for large patron networks provided the required speed and volume of message interchange so essential to these industries; new facsimile equipment pioneered the road toward a mechanized terminal handling with the efficient Desk-Fax machine for patron tie-line use and opened up new areas for patron internal communications with the new Intrafax; new submerged repeaters have subsequently increased the capacity of the Company's transatlantic ocean cable plant. These and many other contributions to the art and science of record communications reflect the implementation of technological research into Western Union plant and facilities.

To keep our field forces apprised of current developments to be integrated into Western Union's plant and operations and to highlight future developments now in the research stage was, and is, the basic concept behind the TECHNICAL REVIEW.

We must look to the readers to evaluate the service to them afforded by the TECHNICAL REVIEW. I know that our technical and operating personnel in the field are keenly interested in the road ahead for Western Union, and I have every assurance that 1954 will find the TECHNICAL REVIEW continuing its fine performance in expanding our over-all knowledge of record communications.

J. M. Barr

VICE PRESIDENT—PLANT AND ENGINEERING

January 1, 1954.

Centralized and Simplified Circuit Handling Using Polar Leg Operation

E. F. JAEGER

IN THE MAIN telegraph office of every important city there is a room or section of a room from which radiate all telegraph circuits serving the city itself and the surrounding territory. This portion of the central office has, in the past, been referred to by various names such as Switchboard Room, Quad Room, T&R Room, and Wire and Repeater Room. In this article the term Wire and Repeater and the abbreviation "W&R" will be used.

Each W&R room serves as a center or hub of telegraph communication activities for its territory. It cooperates with other W&R centers and with smaller telegraph offices so as to establish and sustain satisfactory terminal to terminal operation of all wire services provided by the Company. When any of the wire services are interrupted, or when any service is found to be unsatisfactory, the W&R centers are required to clear or direct the clearance of equipment and facility troubles, rearrange circuits and facilities to best advantage under the resulting abnormal conditions, obtain and utilize emergency facilities, and use any other means at their disposal to insure prompt restoration of normal service as rapidly as possible.

This article describes a plan or system of circuit operation and W&R circuit handling methods for the purpose of greater standardization and simplification of the methods and practices used by the W&R centers. Application of the plan on a field trial basis will also be discussed. Although the system is intended for increasing the efficiency of W&R work methods, there are other collateral advantages some of which are as follows:

1. Since the basis of the plan involves the use of double current (polar) operation on the physical portion of practically all telegraph circuits, the excellent transmission characteristics, and self-regulating features of this method of operation become available for improvement of operating margins, increases in circuit speeds, and extension of the electrical length over which local circuits will operate satisfactorily.
2. Since only a few types of repeaters, terminal sets, and wiring cabinets are required, it is expected that the system will permit progress toward standardization of such units.
3. Since W&R work is simplified and concentrated at a circuit-handling switchboard and monitor table, it is no longer necessary for repeaters and carrier terminals to be located in the same room as the working technicians.
4. Since efficient operation of circuit terminating facilities no longer requires repeatering, current regulation, wave shaping and other complications, the development of new services and operating methods involving direct interconnection of high-speed circuits on either a manual or automatic basis, in either Western Union or customers' offices, becomes practical on a much broader scale than is possible with today's techniques.

Circuit Interconnections

Normally most of the circuits entering the W&R sections are connected through to other circuits. A trunk circuit may be connected to another trunk circuit, to a tributary circuit, or to a local circuit. A tributary circuit may connect to another tributary or to a local circuit, and so on. Also there are many circumstances which require that three or more circuits be interconnected with each other in one W&R center. This operation is popularly referred to as "hubbing". It is common practice to hub as many as ten circuits in regular assignments, and during facility failures or other emergencies, additional branches may be added to a hub to provide service to cities affected by the emergency. In this article, the network of circuit interpatches in the W&R centers will be called the "interconnection pattern".

In small telegraph offices the interconnection pattern may remain fixed for several days. In medium and larger offices, however, the frequency of disturbing factors requires more frequent circuit rearrangement and sometimes a large number of changes are necessary in a very short period of time. Some of the factors which affect circuit interconnections are given below:

1. When equipment or facility failures occur and it is desired to restore important services using spare facilities, emergency facilities, or those obtained by the temporary discontinuance of less important services.
2. When requests are received for the immediate establishment of additional circuits, for example, when special traffic handling circuits are required because of heavy traffic loads, or when leased service customers request temporary or additional circuits on short notice.
3. When it is necessary to rearrange equipment or circuits to perform routine tests, special maintenance, or to permit installations or removals without danger of interference with operating services.
4. When agency traffic circuits are terminated in different offices or different sections of the same offices during night hours and over week ends.
5. When temporary circuits are established on spare or idle facilities to transmit long press dispatches or other abnormally long traffic, in order to avoid the delay involved in manual or reperforator relaying.
6. When special events of considerable importance occur, a temporary telegraph office is often established and provided with a group of trunk circuits. It is not uncommon for an event of national importance to require 50 or more temporary circuits, the establishment and discontinuance of which may affect the interconnection patterns at W&R offices scattered over a large section of the country.

Except for the actual clearance of troubles, the work of adjusting circuit interconnections to conform to service requirements is the most important function of the W&R sections. A typical interconnection change and the work steps necessary to accomplish this change in one W&R office are given below. Assume it is desired to move a working service from one single section carrier circuit to another because of a channel or system failure. The W&R technician would proceed as follows:

1. Make the necessary circuit continuity patch at the loop or "NA" circuit switchboard.
2. Set the leg operation switch at the carrier channel terminal rack to correspond to the type of leg operation required by the failed service.
3. Adjust the leg current at the regulating switchboard to the correct value.
4. After confirming that the corresponding steps 1, 2 and 3 have been completed at the distant W&R office, obtain signals from the distant service drop (or equivalent signals from the distant W&R section) and adjust them to zero bias at the local regulating board.
5. Assist the distant terminal to obtain signals from the local service drop (or equivalent signals from the local W&R section) so they can be adjusted to zero bias at the distant terminal.

In some circumstances one or more of these steps may not be required; for example, if it is known in advance that the leg operation switch at the carrier channel terminal rack is already in the correct position, step 2 is not required. However, in other circumstances, all of the above steps and several additional may be necessary.

Trouble clearance and interconnection changes are closely related, — the greatest speed in making the largest number of interconnection changes is almost always required at the same time that trouble occurs; and, conversely, trouble can often be located or its effect alleviated by making interconnection changes. Therefore, if a system can be devised which permits making interconnection changes simply and speedily and without concurrent adjusting and regulating, improved efficiency in the performance of all W&R work is obtainable.

Conditions Required for Simple Standardized System of Interconnections

In some communication systems telegraph or telephone circuits are manually interconnected as part of a direct service furnished to patrons. Examples of these are manually operated TWX services furnished by the Bell System Companies, and the services furnished to large buildings or groups of buildings through manually-operated telephone (PBX) switchboards. For such services it has been the practice to standardize the circuits and terminations so that the interconnection switchboard can be made extremely simple to operate. It is not uncommon for a single PBX operator to average several hundred circuit changes per hour.

There are some operational differences between the type of interconnection work performed by W&R centers and that required for TWX and PBX purposes. For example, the latter services normally leave all circuits idle and terminated in switchboard jacks. The interconnections are made as required through cord circuits whenever service is requested. Most of the circuits passing through W&R offices, however, are normally interconnected and the interconnection pattern is changed only when the various services and other conditions require such changes. Therefore, when using the telephone or TWX boards for comparison purposes, the W&R switchboards should be considered as requiring large numbers of the telegraph equivalent of telephone cord circuits. An ideal arrangement for W&R switchboards would be to accomplish complete interconnection changes by merely rearranging physical connections between the electrical conductors on which the circuits route through the switchboards. This would permit permanent interconnections to be wired in through jack normals and temporary interconnections to be established with simple patch cords as is done at the present time at loop and NA boards for the continuity part of leg circuit interconnections. However, the desired simple, uniform and efficient interconnection system also requires that the following additional conditions be satisfied:

1. No regulation, switch throwing, testing or other changes should be required either before or after new interconnections are established at the switchboard.
2. Transmission losses should not be appreciably increased because of the interconnection methods.
3. Assuming that all individual circuits are free of bias, the interconnections should not affect over-all circuits in such a way as to create bias.
4. The interconnections should operate satisfactorily for either duplex or half duplex telegraph circuits without prohibitive complications.
5. The resulting system should not prevent a reasonably simple method of interconnecting three or more circuits together (hubbing) at or adjacent to the main switchboard.

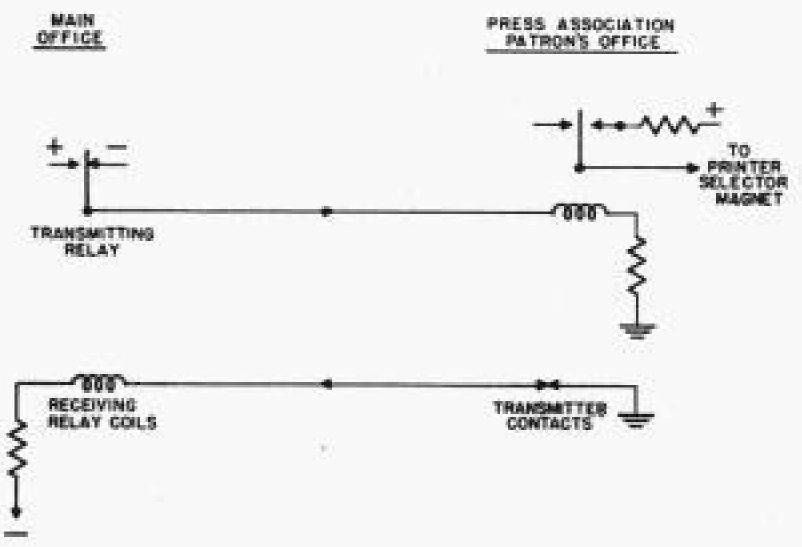

Figure 1. Method of local circuit operation used by the Associated Press

Theory of Polar Local Circuits for Simple Interconnections

Figure 1 shows a type of local or leg circuit operation presently employed by Press Associations which requires polar reception at the local drop on the main office sending leg, and make and break transmission from the local drop on the main office receiving leg. This method would obviously not satisfy the conditions for simplified W&R methods because local circuits could not be interconnected with other local circuits except through the use of cord circuit repeaters or other complications. However, if both legs are operated on a polar basis like the main office sending to the Press Associations, all conditions for the desired simplification can be satisfied.

The high efficiency and general superiority of the polar to ground type of telegraph transmission has been well known for over 50 years.[1] Technical developments during the last 20 years have greatly simplified the practical application of this type of transmission for local circuits. Physically small, inexpensive and dependable polar relays, an important factor in consideration of any modern polar telegraph system, have been developed.[2] Tremendous progress has been made in the field of small dependable ac-dc power conversion units and more improvements are expected.

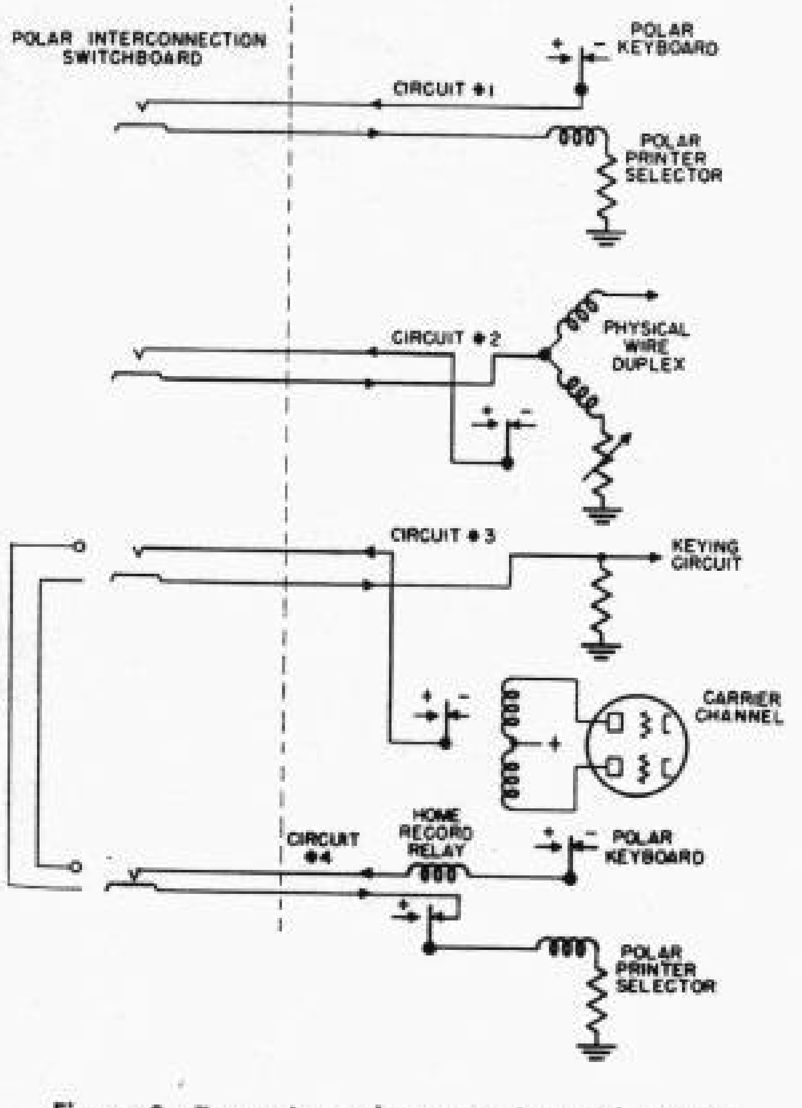

Figure 2. Two-wire polar operation with simple interconnection switchboard

Figure 2 shows four typical circuit terminations arranged for operation into a polar interconnection switchboard. Circuits 1 and 4 represent local duplex and half duplex operated terminations while circuits 2 and 3 represent a physical wire trunk and a carrier trunk, respectively. Any two of these circuits can be patched together to provide a complete interconnection. If circuit 3 is connected to circuit 4 as shown, the local half duplex drop is extended to a distant W&R office located where the carrier system on which circuit 3 operates is terminated. A similar interconnection at the distant carrier office establishes a complete circuit operated half duplex. No regulating or other adjustments are required.

Consideration of possible complications as well as additional advantages that might be encountered in the practical use of this type of interconnection system leads to the following observations:

1. Type 20 carrier terminals are not equipped for polar transmission but they are easily adapted for polar reception. However, polar transmission could be made available and at the same time the balanced transmission existing in the FM carrier system could be passed on to the leg and switchboard circuits by the use of a polar relay in place of the output tube.
2. Type 15 carrier terminals are already equipped for use with polar legs, and most repeater units and distributor tables are either already equipped or could easily be modified for polar leg operation.
3. Sending leg relays would not necessarily be required at local drops since some types of keyboards and other transmitting equipment could be modified to permit polar transmission directly from the sending contacts. Also, the development of high-power but physically small permanent magnets would permit the use of polar selector magnets which could be substituted for present magnets on printers and printer-perforators, in those cases where a receiving relay is not required for other purposes. High-speed tickers which are already equipped with polar selector units have performed satisfactorily in the field for many years. The latest 100-wpm printers are equipped for polar transmission at the time of manufacture.
4. Since the method shown in Figure 2 requires that all circuits which pass through the switchboard carry polar sig-

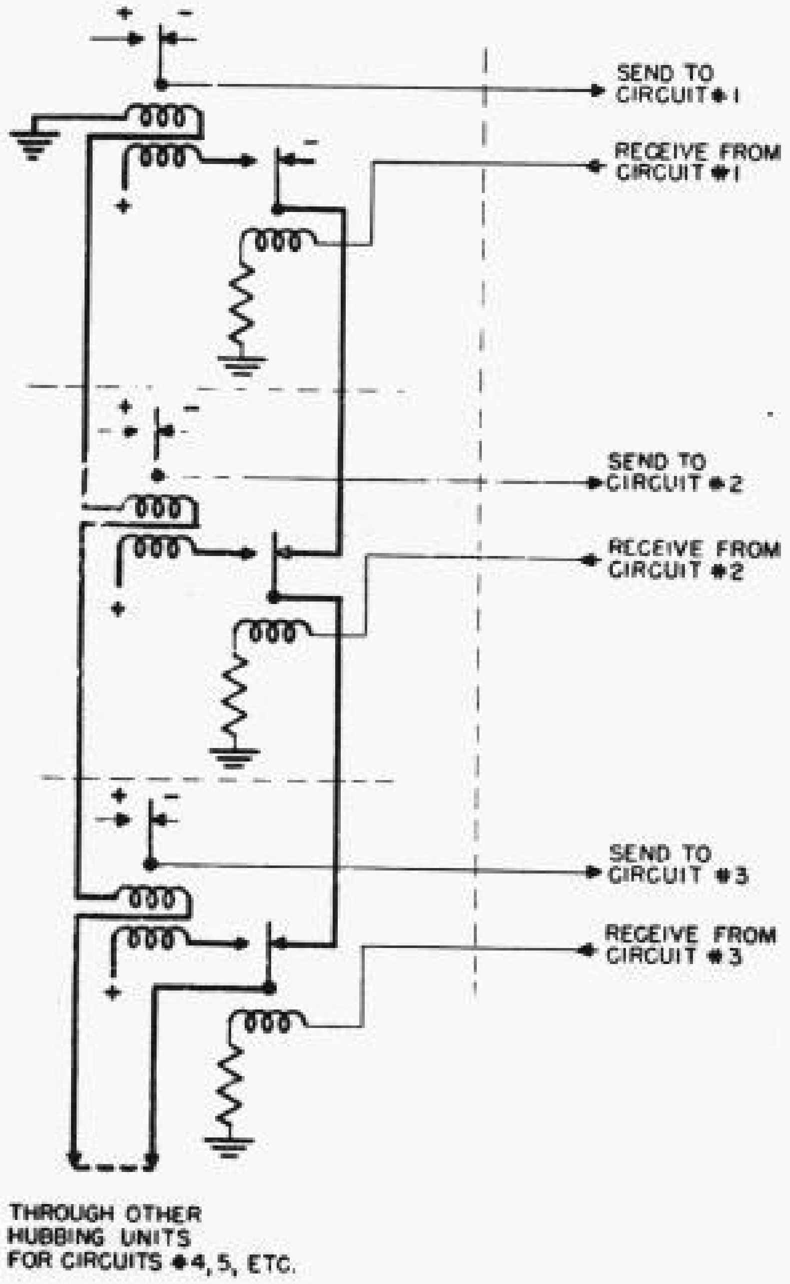

Figure 3. Multi-circuit hubbing using polar dummy method

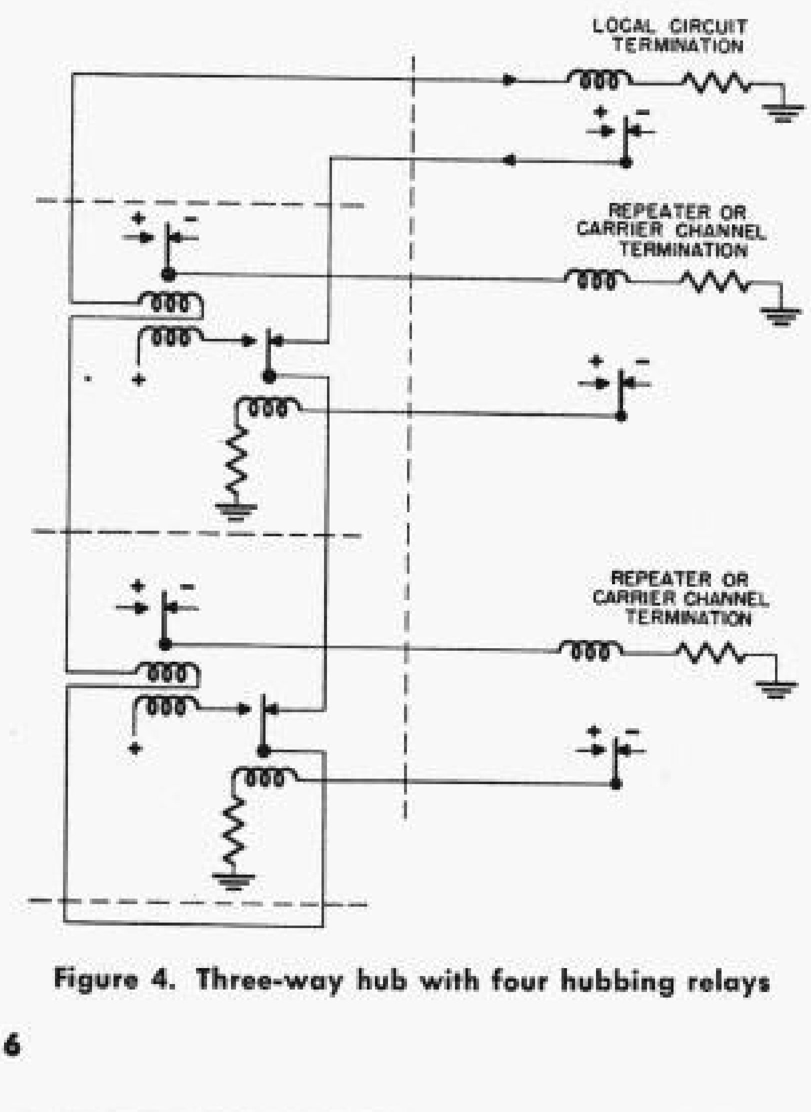

Figure 4. Three-way hub with four hubbing relays

nals, the need for pole changer relays or their equivalent on the transmitting side of trunk and tributary circuits disappears except where special conditions exist, for example, where high voltage transmission is required to operate an abnormally long physical wire repeater section.

5. Provision of the telegraph equivalent of talk, listen and circuit terminating facilities at or near the W&R switchboard is greatly simplified since all polar circuits of this type are essentially self-regulating and the insertion or removal of required values of resistive and reactive components in series or in shunt does not appreciably affect either transmission efficiency or bias.
6. The need for auxiliary handling facilities such as Type 71 carrier boards, loop boards, jack circuits and meters on repeaters and carrier terminals, is eliminated.
7. The present trend toward small-gauge cable conductors for local circuits and toward higher signalling speeds will not represent a limitation on the polar system since current values of as little as —0.015 ampere can operate a high-speed polar signalling circuit satisfactorily.

Polar Hubbing Circuits

Polar hubbing (interconnection of three or more half duplex telegraph circuits through the use of a polar dummy circuit) is already extensively used in the W&R sections. The basic circuit theory is shown in Figure 3.

If the simplified W&R switchboard is inserted in the hubbing arrangement at the vertical dotted line, the leg circuits (in both directions) are identical to those used in the circuit interconnections shown in Figure 2. The hubbing equipment consists of a number of 2-relay units interconnected with the polar dummy circuit shown in heavy lines. If the polar dummy connections are passed through a hubbing switchboard at the horizontally dotted lines, the switchboard circuits are also identical and all the simplified switchboard requirements are satisfied as applied to hubbing as well as to 2-circuit interconnections. This represents a high degree of standardization permitting major rearrangement of all the circuit interconnections with simple switchboard cord changes.

It is interesting to observe the effect on switchboard patches and equipment requirements if slight deviations from the system (along the lines commonly used at the present time) are permitted. Figure 4 shows a 3-way hub of one local circuit and two trunk or tributary circuits using only four relays in the hubbing equipment. The deviation involves a special patch between a hubbing circuit polar dummy and a local circuit at the switchboard. Also the local drop obtains his home record copy from the main office rather than from the usual home record relay.

If switches are added at the repeater and carrier terminals (similar to present practice) a workable hubbing arrangement is obtained which requires no special hubbing relays at all. (See Figure 5.) The

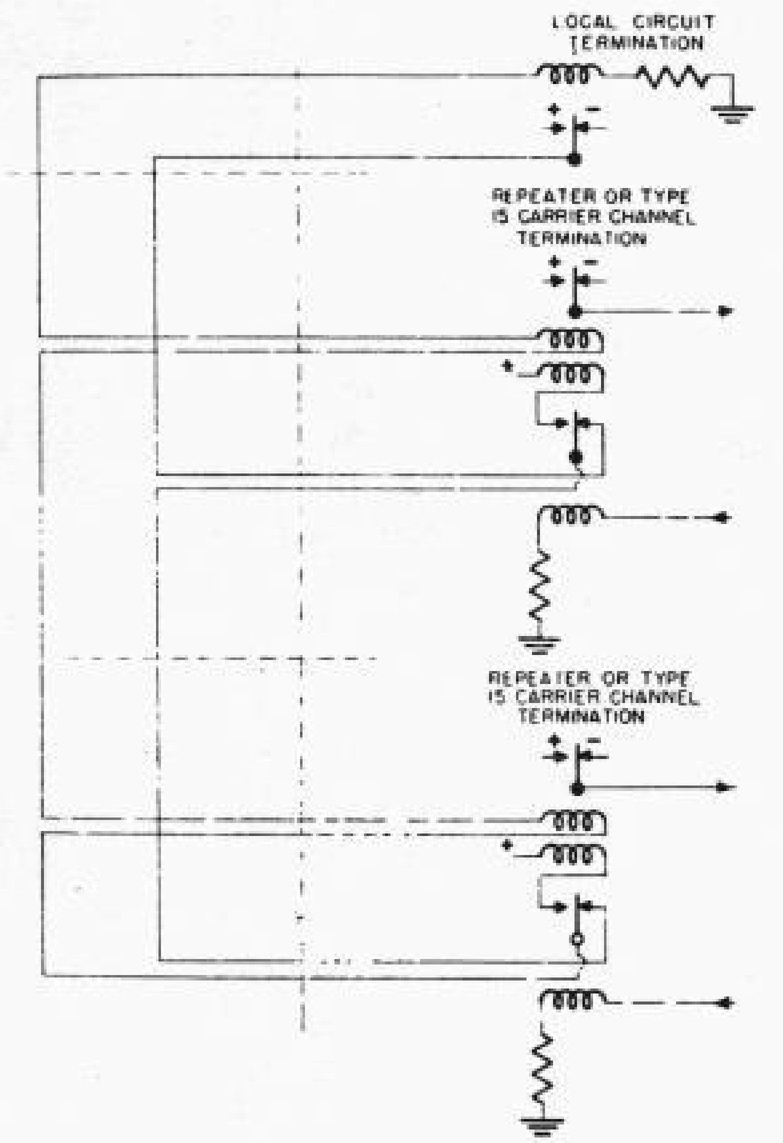

Figure 5. Hubbing arrangement using repeater and carrier channel relays in place of hubbing relays

hubbing functions are provided by the repeater and carrier channel relay circuits modified by what would properly be called a "hubbing switch". While this arrangement would defeat the standardization required in the W&R room and is therefore not desirable, it points the way to other practical applications where the hubbing facilities may remain permanently connected, as for example at patrons' offices.

Field Trial—Carrier and Repeater Equipment Changes

In order to confirm the practicability of this system under actual operating conditions, a field trial is being conducted at a representative medium sized test office. It was decided to replace a portion of the test office repeater sets with units designed specifically for the new system in order to demonstrate the obtainable simplification. The remaining repeaters were modified as described below to demonstrate adaptability of existing equipment.

Figures 6 and 7 show the electrical theory for converting existing equipment to operate into the new system, with representative types of operation indicated by numbers (1), (2), (3), and so forth. Type 15 carrier channels, example (1), Figure 6, are connected into the system by permanently placing the leg switches on position 2 and strapping out the send to carrier relay. One relay is therefore recovered from each channel.

Type 20 carrier channels, example (2), Figure 6, were connected into the system by permanently placing the leg switches on position 3, inserting polar relays in the receiving from carrier legs, and terminating the sending to carrier leg circuits to ground at the cathodes of the keying tubes. The associated Type 71 test boards are no longer required for W&R purposes since practically all W&R work is now concentrated at the switchboard positions and associated monitor table. When required elsewhere these Type 71 boards can be released by providing for bias setting and leg current limiting at or near the channel terminal racks.

Main-line physical wires were brought into the system using single relay duplex terminations as shown by example (3),

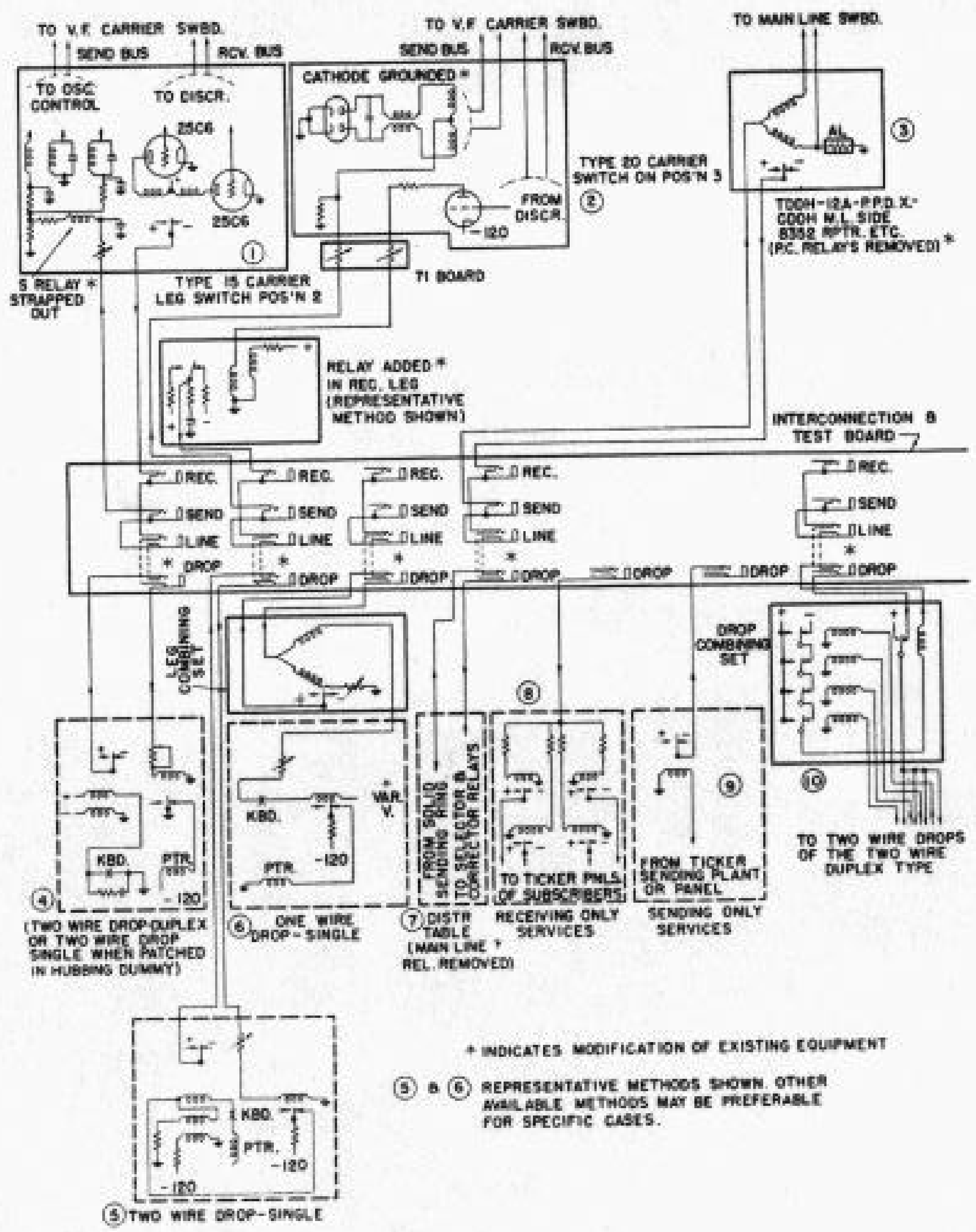

Figure 6. Theory of connecting existing equipment to simplified polar system — test board connections

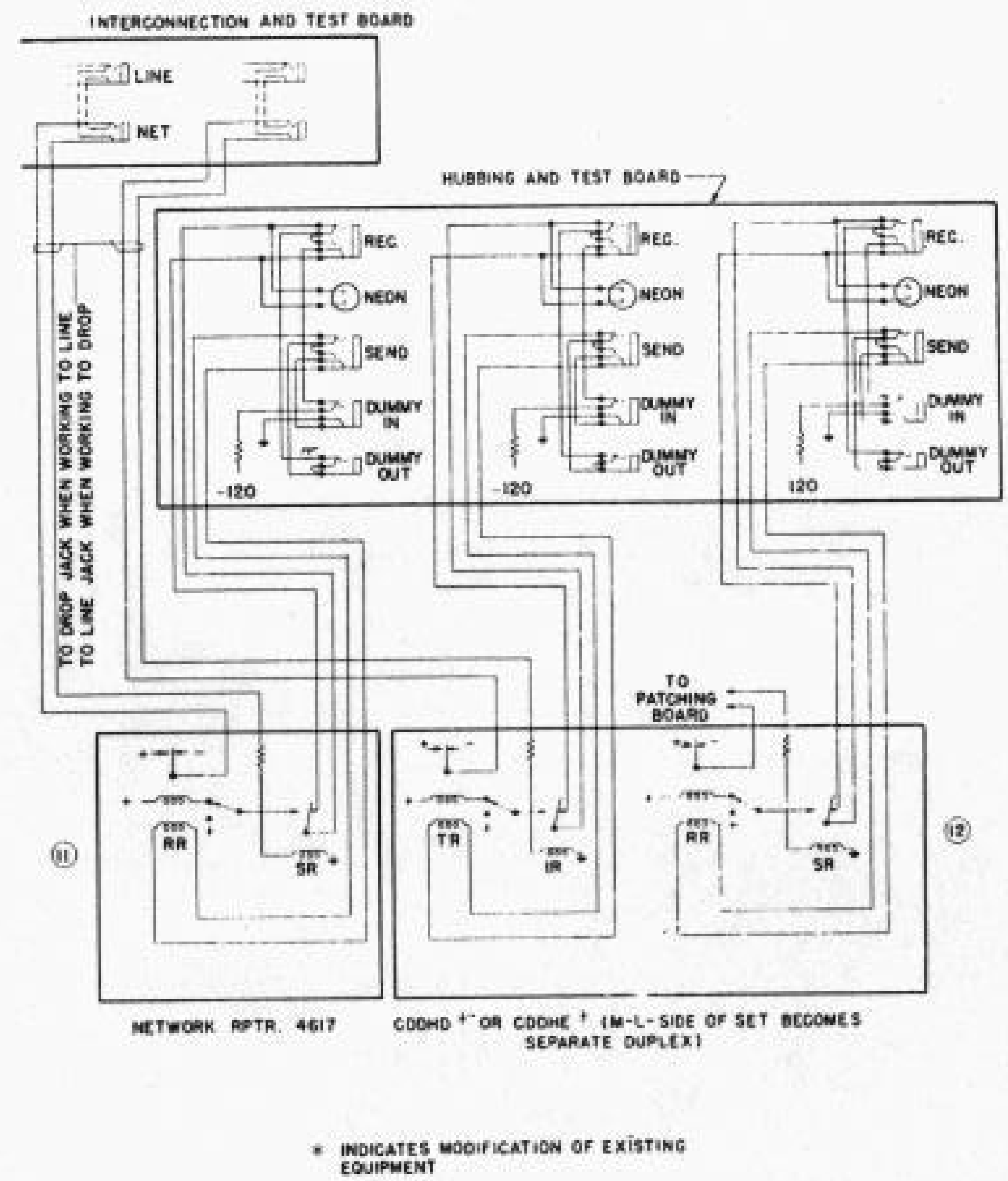

Figure 7. Theory of connecting existing equipment to simplified polar system — hubbing board connections

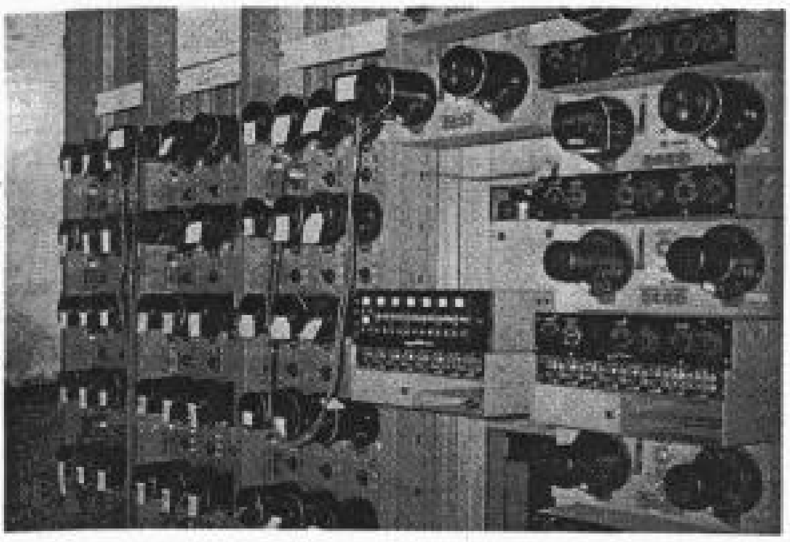

Figure 8. Simplified duplex terminations in background and 8353 duplex repeaters in foreground

Figure 6. As required for standardization, the relay terminations are permanently connected as part of the line facilities, interconnection patches being made on the leg side. Figure 8 is a photograph showing three racks of the new simplified type of duplex relay terminations in the background and some 8353 rack-mounted duplex sets, representative of rack-mounted types required by present methods, in the foreground. As the photograph shows, 15 of the new terminations are mounted on each rack leaving adequate room for future requirements in the higher locations.

Example (4), Figure 6, shows the method used for connecting duplex-operated local circuits into the system. The two relays can be eliminated if polar printers are made available.

Example (5), Figure 6, was not used in the field trial. The 2-wire half duplex circuits were connected into the system using the method shown in Figure 9. This can be simplified to the arrangement shown in Figure 10 if polar printers are made available. There were a few local circuits where two wires could not be obtained economically. They were brought into the system with the method given in example (6), Figure 6, with the main office relay arranged for "bust up" operation.

Examples (7), (8) and (9) were all used for the services shown and example (10) was used for the Bank Wire circuit.

Circuits which are hubbed at the test office were brought into the system as shown in example (11), Figure 7, to the extent that 4617 network repeaters were available. The CDDH repeaters, example (12) Figure 7, were replaced with simplified hubbing relay panels each mounting six relays and providing three hubbing terminations.

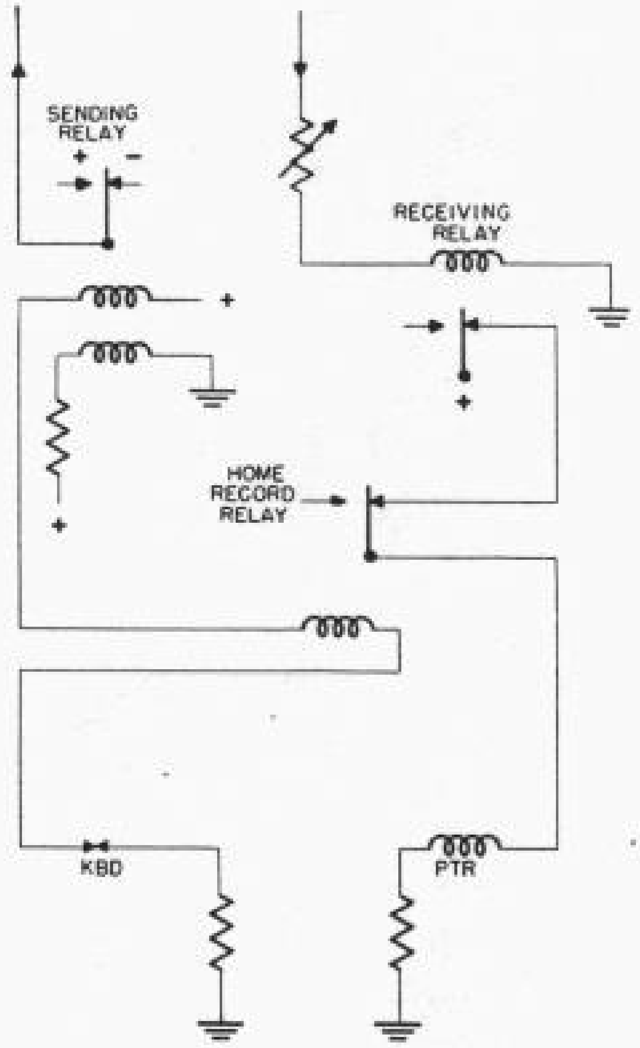

Figure 9. Two-wire single-circuit drop as used in field trial

Figure 11 is a photograph showing the test office installation of these panels in the foreground and some of the 4617 network repeaters in the background. As the

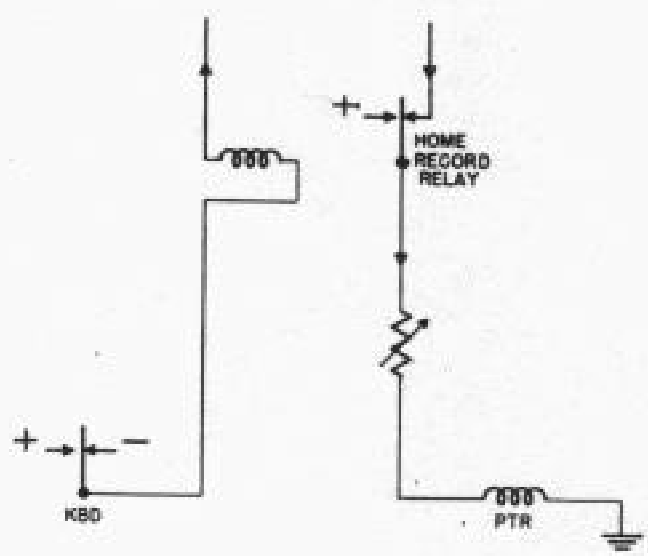

Figure 10. Two-wire single-circuit drop using polar printer

Figure 11. Simplified hubbing repeaters in foreground and 4617 hubbing repeaters in background

photograph shows, each rack of simplified relay panels accommodates 12 hubbing terminations with space available for future requirements in the higher locations on the racks.

Field Trial—Interconnection and Hubbing Switchboards

Figure 12 is a close-up photograph of part of one section of the interconnection switchboard. Jack strips containing two vertical rows of five jacks each were used. Circuits are wired vertically and require four jacks per circuit as shown in Figure 6 and on the handy reference diagram mounted on the switchboard framework. The fifth (bottom) jack is used for miscellaneous purposes — trunks to other sections of the switchboard, to the monitoring table, circuit blinding terminations, and so forth.

There are five horizontal rows of jack strips each accommodating 20 circuits so the present capacity of the board is 100 circuits per section. Further development of the system may eventually permit elimination of the first and second (looping) jacks thus increasing the capacity to 200 circuits per section.

Following is a practical example demonstrating the extreme simplicity with which an interconnection change (service restoration in this case) can be made:

Assume carrier group 206 (to Rochester) fails and it is desired to restore service at the local Red Cross on carrier channel 866J via Syracuse.The W&R technician picks up the local Red Cross service drop by inserting one end of a patch cord in the jack labeled "City 469-470 Red Cross" and patches it to the jack labeled "866J". No additional work of any kind

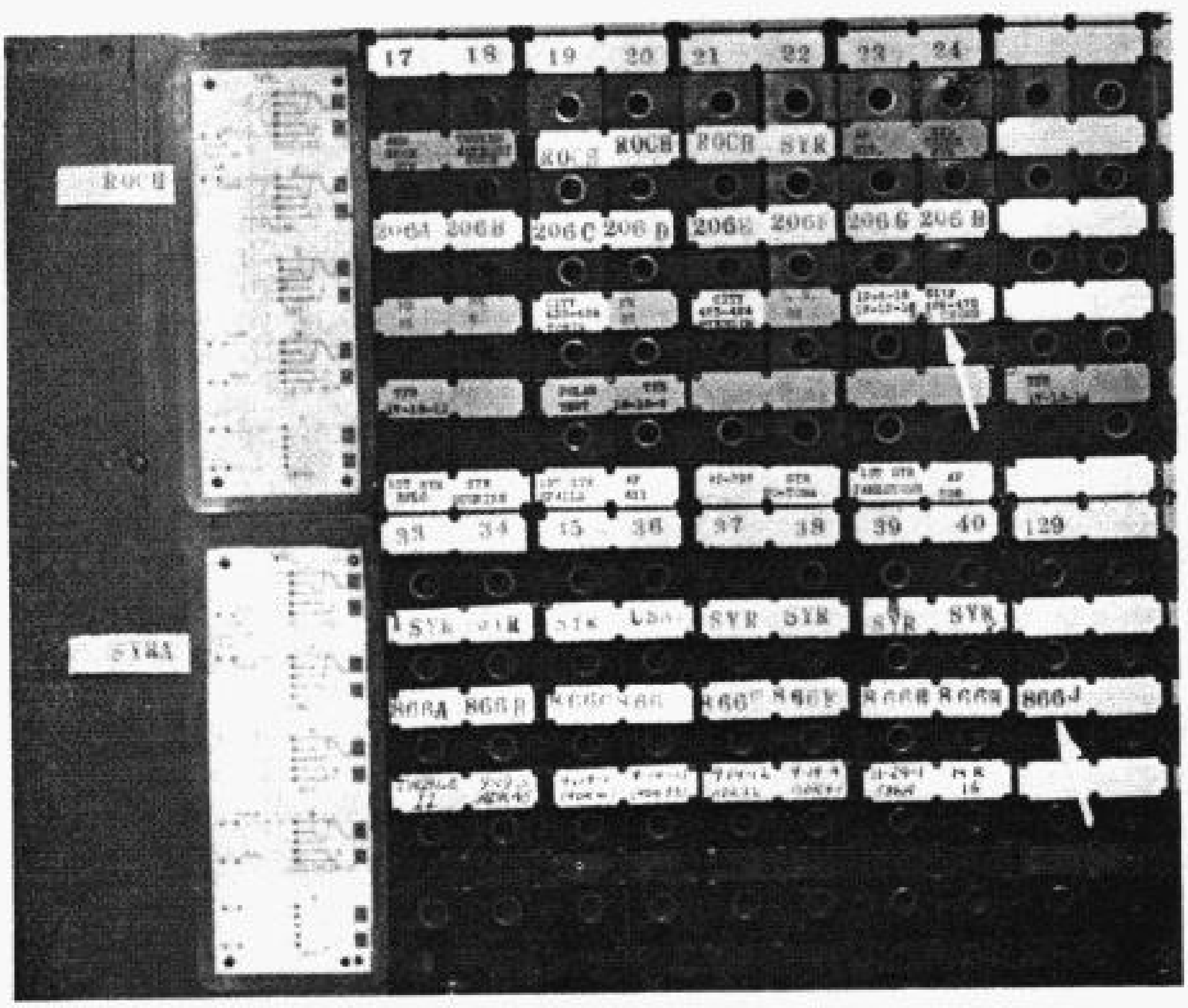

Figure 12. Part of one section of interconnection switchboard

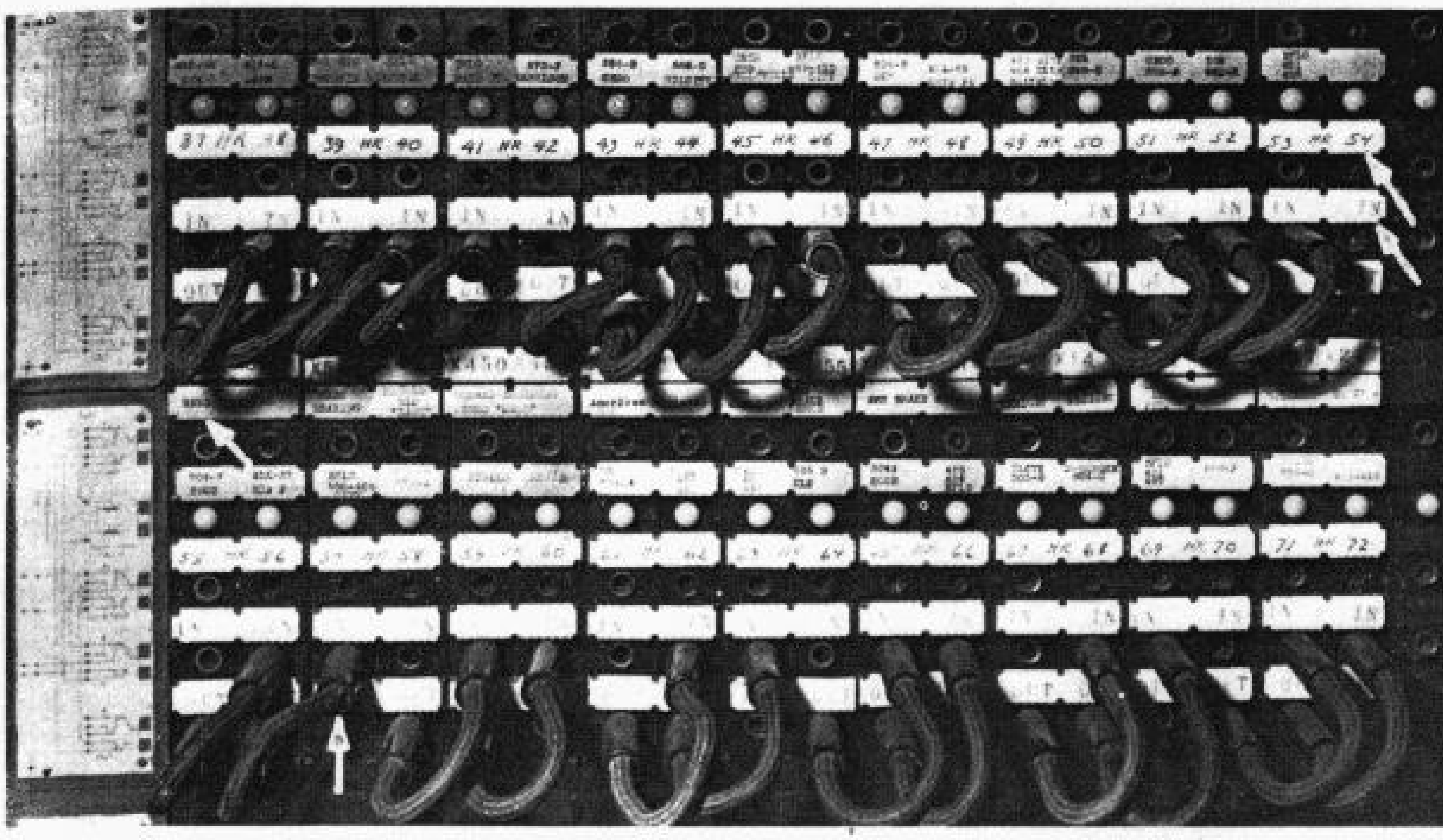

Figure 13. Part of hubbing switchboard

is required at the test office since bias, current, operating ranges, and so forth, find their proper values automatically.

Figure 13 is a close-up photograph of a portion of the hubbing switchboard at the test office as shown in Figure 7. The hubbing relays terminate in 4 jack circuits each of which is equipped with a neon lamp indicator (2nd jack position) for observation purposes. A section of switchboard can accommodate 100 sets of hubbing relays. The patch cords shown in the photograph interconnect the polar dummy circuits to establish the hubs. For example, at the left end of the top row of jack strips the Veterans Administration leased service is hubbed in five directions from the local W&R section. As the switchboard designations show, the first branch operates to Syracuse, the second to Bath, N. Y., the third to Batavia, N. Y. and the fourth and fifth to the local service drops.

The indicator lamps flash when the circuit branches with which they are associated are sending into the test office hub. When the circuit is idle, a flash on one of these lamps informs the W&R technician of failure and also tells him on which branch the failure occurred. A trained technician can also determine on which branch a failure occurs while the circuit is in operation by observing flashes on lamps associated with branches which are not sending at the moment.

A practical example of the hubbing board operation is as follows :

Assume it is desired to restore service to Niagara Falls, Rochester and the local service drop on the Rees Bearings lease (which has failed between Syracuse and Rochester) using spare channel 866J to Syracuse as a fourth branch in the hub. This lease is set up in the first hubbing group of the bottom row of jack strips shown in the photograph (Figure 13). The W&R technician picks up Syracuse by inserting one end of a patch cord in the jack labelled 866J and patches it to any spare set of hubbing relays, for example number 54, at the interconnection switchboard. The Syracuse extension is then added to the Rees Bearings lease by patching from the "IN" jack of hubbing relay set 54 (HR54 top row of jack strips, right end, and fourth jack position) to the "OUT" jack of the Rees Bearings polar dummy (bottom row of jack strips, third jack from the left and fifth jack position). These two patches are all the work that is required at the test office to complete the addition of a hub to provide the service restoration.

Conclusions

The system of circuit operation and W&R circuit handling methods described in this article has been successfully applied on a field trial basis at a representative test office. The trial confirms that the individual repeaters, leg terminating units, switchboards, and operating position wiring cabinets can be made to conform to a pattern that permits efficient circuit handling methods as well as dependable circuit operation. Also, the trial confirms that most of the existing types of central office equipment can be adapted to operate with the new system and where the provision of new equipment is required or can be justified, the use of highly standardized units of relatively simple design is entirely practical.

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E. F. Jaeger entered Western Union service in 1925 as a Student Morse Operator. He graduated from the University of Wisconsin, Electrical Engineering degree, in 1931. His communications experience includes assignments as Telegraph and Telephone Repeater Technician and Toll Testboardman for the Wisconsin Bell Telephone Company; Morse Operator, Night Manager, Manager, Engineering Apprentice, Chief Operator, Division T&R Inspector, and Supervisory Assistant-Circuit Layout Engineering for Western Union. Mr. Jaeger has actively engaged in the practical field application of many Western Union developments; he was in charge of circuit layout engineering incident to the Western Union-Postal consolidation, and since 1931 has supervised and coordinated many important special events as well as office and system cutovers. His present assignment is General Operations Supervisor on the staff of the Director of Operations.

Improved Equipment for Handling Book Messages

A. F. CLARKE

TECHNICAL REVIEW of October 1952 contains an article entitled "Switching Facilities for Multiple Address Telegrams" which describes a new type of book message adapter and outlines its proposed operating functions. A model of this adapter, shown in Figure 1 connected to a local operator's position, was given a field trial in the Western Union office at Philadelphia. After satisfactory completion of tests, the unit was redesigned as shown in Figure 2 and a number of these units, designated Movable Book Message Table 7044-A, have been fabricated and will be installed in the Telegraph Company's 15 high-speed reperforator switching centers for handling multiple address messages. These are messages with a single text directed to a large number of addresses.

Figure 1. Laboratory model of book message table connected to a Plan 21 type operator's position. (A) address transmitter

The new rolling table has flexibility of operation permitting its use, for the purpose of transmitting the same message text to various addresses, in the switching, sending or local operating sections of Plans 2, 20 and 21 Reperforator Switching offices. Reperforator Switching System Plan 2 makes use of plug-and-jack connections at the manual switching turrets. In Reperforator Switching System Plan 20 the switching is accomplished by means of push buttons at the manual switching turrets and automatic switching at the local operators' sending positions. In Plan 21, automatic switching is employed at the local operating positions and for switching messages from light and heavy tributary offices.

The movable book message table contains equipment for automatically checking message sequence numbers—an added feature which will make obsolete the two previous book message transmitter tables used to handle the heavy multiple address files in a field trial at the Detroit office. Mounted on the movable table is a sequence number indicator, a text transmitter and a subbase for carrying an address transmitter. The address transmitter appears in Figure 2 in the subbase normally occupied by the cross-office line transmitter of a local position to which the movable table has been connected. This address transmitter is equipped with a multiple conductor cable terminated on a plug which is inserted into the multiple socket in the movable book message table. The table is arranged to switch back and forth between the address and text transmitters on "equals" "period" combinations, and also to switch from a text transmitter back to the address transmitter on

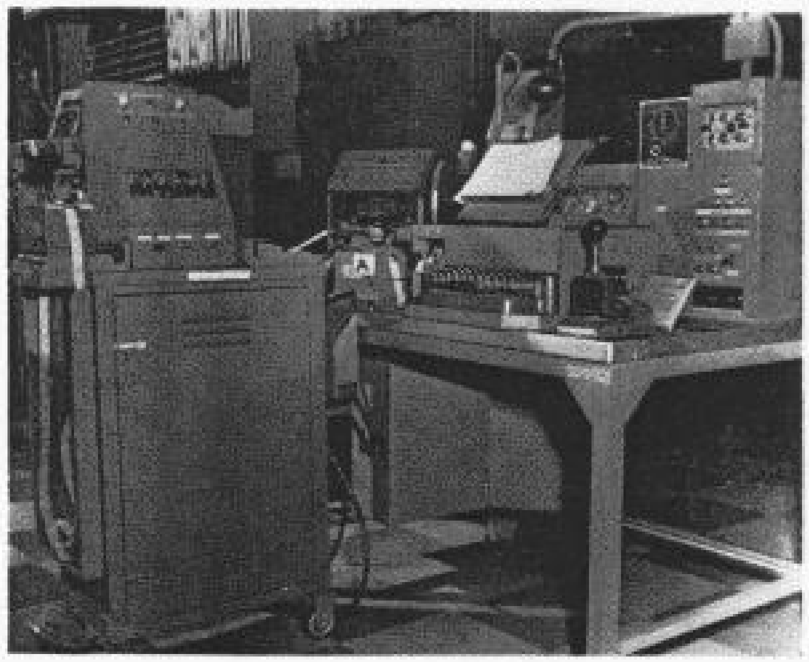


Figure 2. Movable Book Message Table 7044-A connected to a Plan 21 type operator's position. (A) address transmitter

the "double period" signal that terminates the message text. The address transmitter functions first to send the message sequence number and a book identification number, after which the text transmitter functions to send the top line. The address transmitter then restarts to send the address, after which the text transmitter again functions to send the body and signature of the message. Additional switches may take place between the two transmitters, on "equal" and "period" combinations punched in the tape, for the purpose of picking up excerpts from the address tapes and inserting them within the text or body of the message.

Two signal lamps may be seen in Figure 3, designated ADDRESS and TEXT; these show at all times which transmitter is connected to the cross-office or line circuit. An associated push button designated XTR TRANSFER may be utilized to cause a transfer from one transmitter to the other in the event an "equals" "period" combination has been omitted from the address or text tape.

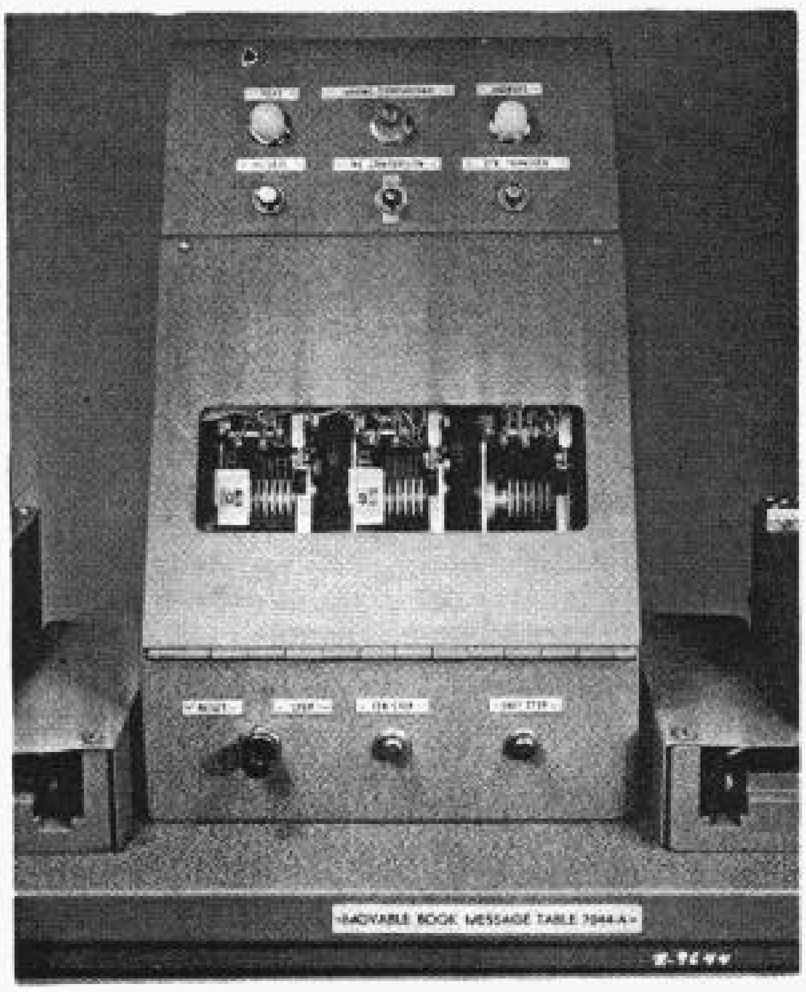


Figure 3. Sequence number indicator used for checking message sequence numbers

Switching of the message texts is accomplished automatically when the table is used at sending positions which work through automatic switching facilities. When it is used at positions not provided with number checking equipment, message sequence numbers associated with the addresses are checked automatically by the number checking facilities provided on the table.

When this table is used at local operators' sending positions or heavy tributary line receiving positions in Plan 21 offices, it functions on a fully automatic basis. The book messages are switched automatically in accordance with selection characters in the address tape, and number checking is accomplished automatically by the number checking equipment associated with these positions. In this application, it is not necessary to utilize the number checking equipment on the table. The NO COMPARISON on or off switch on the sequence number indicator, therefore, should be thrown to the off position.

When used at local operators' sending positions in Plans 2 and 20 offices, the book message table also functions on a fully automatic basis. Book messages are switched automatically in accordance with the selection characters in the address tape, and in this application the number checking is accomplished by the number checking equipment on the book message table. This equipment does not check the call letters, being arranged to check only the message sequence numbers. Three-digit numbering must be used. Only "tens" and "units" digits are actually compared, but a check is made for the presence of a "hundreds" digit. The number comparison takes place as the message is transmitted cross-office.

In the event of a wrong comparison, the book transmitter is auto-stopped and a visual WRONG COMPARISON light and an audible signal are actuated. Since the cross-office connection is maintained, the wrong comparison should be corrected promptly. The message may be "busted" by preparing a "bust this" tape terminated with a double period, or the nature of the wrong comparison may be such (transposed number, for instance) that it would be satisfactory for the message to resume. In any instance, the transmitter is restarted by depressing the RELEASE push

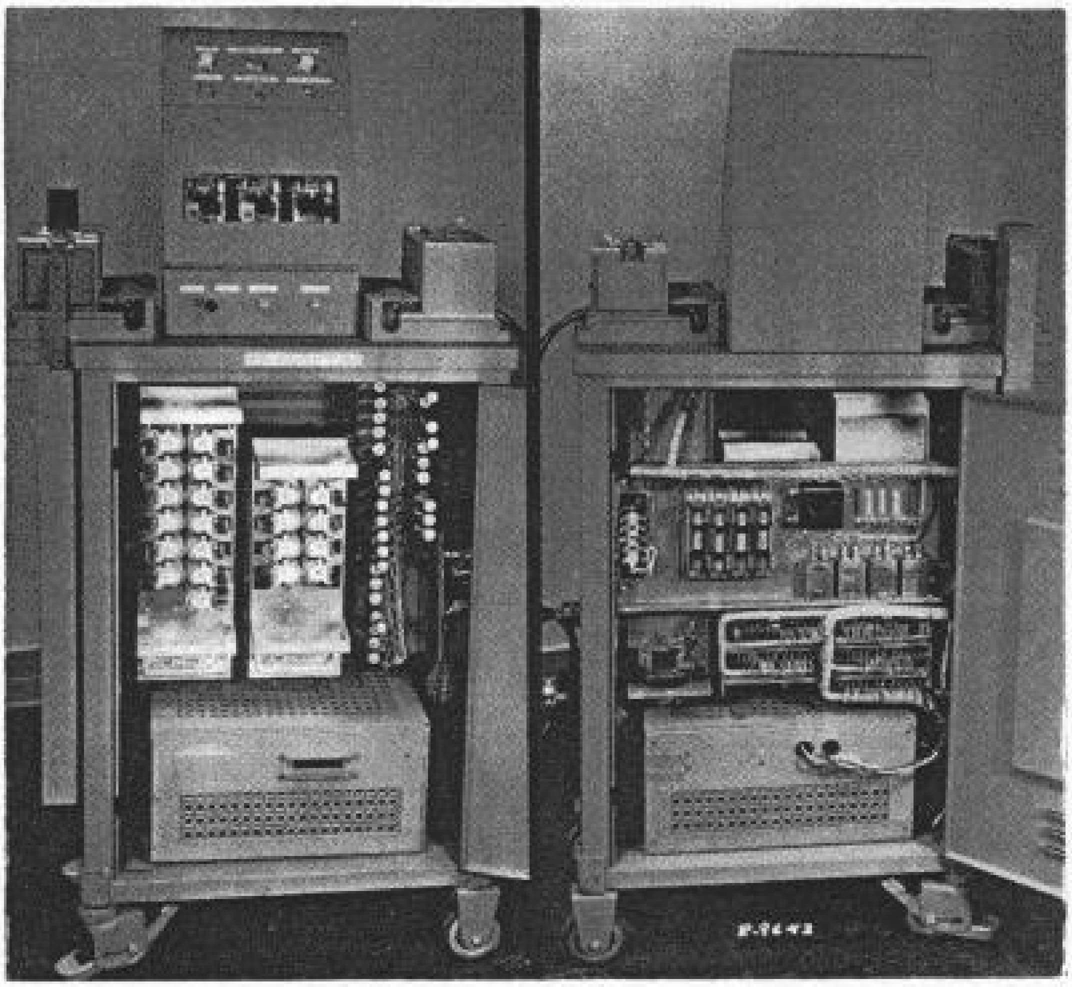


Figure 4. Front and rear views of table showing relays rectifiers, and other associated equipment and wiring

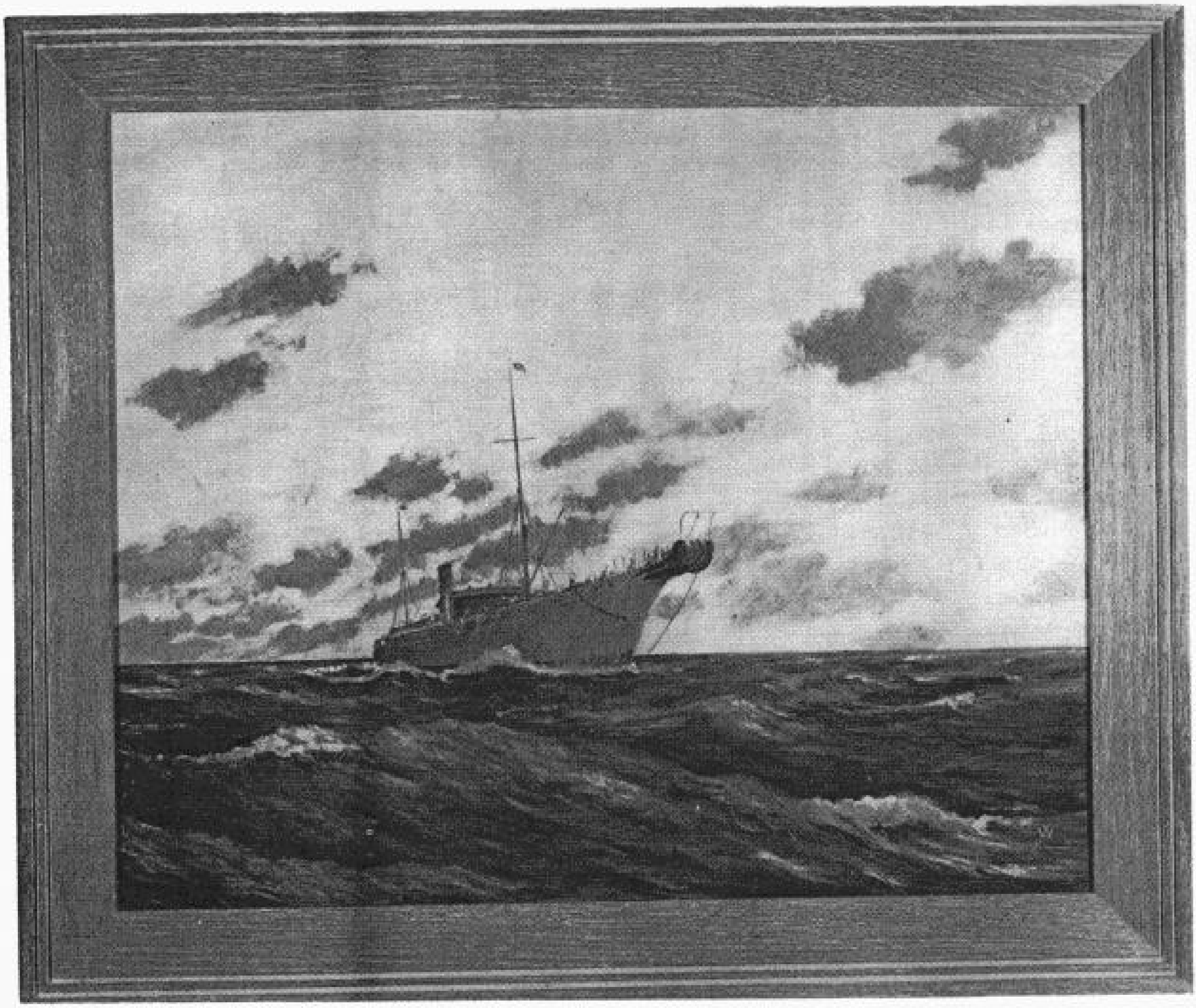
button. As the transmitter is restarted, the sequence number indicator is not advanced to the next number. In addition to a RESET lever key for resetting the sequence number indicator, the table is provided with a UNITS STEP and a TENS STEP push button (as shown in Figure 3) by means of which the units and tens switches may be advanced one step at a time.

A two-conductor power cord is provided for alternating current which is rectified to serve the power needs of the table.

Figure 4, the front and rear views of the book message table, shows how the component equipment has been arranged for easy accessibility and maintenance.

There is every reason to believe that Movable Book Message Table 7044-A will greatly expedite the handling of multiple address message traffic at all Western Union reperforator switching centers where these tables are provided.

A. F. Clarke, who received his engineering education at Columbia University while already employed by Western Union, has been with the company about 30 years. As an engineer in the Central Office Engineer's division of the then Engineering Department, he specialized first in illumination problems, and operating room layouts and equipment installations for reperforator switching systems. In 1948 he transferred to the Apparatus Engineer's division of Plant and Engineering, where he has been engaged in the design and development of equipment for reperforator switching systems and other apparatus such as the Book Message Table described in this article.



C. S. *Lord Kelvin* from the oil painting by Victor Weidner. Mr. Weidner, who is a staff engineer at Western Union headquarters in New York, has painted many covers for the marine publication *Rudder*

"A Lady of Quality"

SHE is probably the best and most favorably known lady in Halifax. There is hardly a section of Society in that renowned port which has not at one time or another made her acquaintance. For this lady—a cable ship flaunting, after the manner of George Sand, a masculine pseudonym *Lord Kelvin*—is to be seen, when at home, at her berth at Western Union wharf, right next to that of the busy ferry which links the town of Dartmouth with Halifax in Nova Scotia. Here thousands of commuters see her every day.

This publicity must be at times embarrassing, as she is no longer in her heyday. When dressed up in a fresh coat of paint she can compare with the best of them, but unfortunately she usually bears the marks of long periods at sea and "cabling" in all sorts of weather. Despite a few face liftings in the course of her career, it is hard to disguise the lavender of her age; but although other cable ships may be younger or larger, there is none with a greater tradition—none held in greater respect.

Although still as active as ever, C. S. *Lord Kelvin* is almost legendary in the port of Halifax. Fathers and sons, uncles and nephews, brothers and cousins have gone to sea in her. It would be difficult to convey the feelings of her crew for this ship. All who serve or have served aboard unquestionably feel a great affection for her. Sometimes, when the going is rough, uncomplimentary remarks may be made about her character, but this is strictly "in the family"; let an outsider presume to criticize and there is none of her men who is not prepared to rise in her defense. Nor is affection for *Lord Kelvin* confined to the seafaring fraternity—it is impossible to walk the streets of Halifax without meeting someone who will ask cordially, "How is old *Lord Kelvin?*"

The lady is well-known outside Halifax, too. She has friends elsewhere in Canada as well as in Newfoundland, St. Pierre, and in American Atlantic ports from Boston to Key West. She has visited Bermuda, Virgin Islands, West Indies, Puerto Rico and Cuba. She has "made her number" in the Azores and Cape Verde Islands, is always welcome in Valentia, Ireland, the Channel ports from Lands End to London, and enjoys an occasional visit to Le Havre.

A unique thing about *Lord Kelvin* is the way she has been identified with improvements in submarine communication. I first saw the ship in 1923, when she was loading cable at Greenwich. This was no ordinary cable, but cable of revolutionary design. It was a length of continuously loaded cable, which *Lord Kelvin* later laid off Bermuda for experimental purposes, and the success of the experiment led to the manufacture and laying of all our loaded cables.

Since then the ship has successfully undertaken other out-of-the-ordinary assignments. For example, there was the unheard-of project of ploughing in cables to eliminate trawler breaks on the fishing grounds off Ireland, an operation vividly described by Mr. C. S. Lawton in his AIEE paper "The Submarine Cable Plough". (*En passant*, an incident of interest comes to mind. There is an annual yachting regatta at Falmouth, Cornwall, the headquarters *Lord Kelvin* used for the ploughing operation. On one occasion Sopwith's yachts *Endeavour I* and *Endeavour II*, which unsuccessfully challenged for *America's* Cup, were competing, at the same time our plough was in the local shipyards, where it was promptly christened *Endeavour III*. Unlike *I* and *II*, *Endeavour III* was a winner.)

More recently, *Lord Kelvin*, for the Bell Telephone Laboratories, was asked to lay and recover articulated repeaters in deep water and this successful operation led to the equally successful laying by the ship of the Key West - Havana repeatered telephone cables. Equally successful has been *Kelvin's* performance in laying our own repeaters in North Atlantic waters, in any required depth.

These are a few highlights in the career of a ship no longer young. Needless to say she experienced many vicissitudes over the years, since she was built at Newcastle-on-Tyne and commissioned in 1916. On more than one occasion she has had to face storms which caused the loss of other vessels, but although often badly battered, *Lord Kelvin* always came through with flying colours. Apart from her busy and often hazardous peacetime life, there were the years of war, with their attendant dangers. *Lord Kelvin* was frequently called on, and with the protection of escorts from the Canadian and American navies, always successfully completed her cable repair assignments.

She is a link in a chain which stretches back to 1857, when U.S.N. frigate *Niagara* and H.M.S. *Agamemnon* made the initial but unsuccessful attempt to span the Atlantic with a submarine cable. The repository of a great tradition, this vessel has steamed in the wake of those pioneer ships which made cable history. She can easily resurrect the ghosts of the past—anchored in Valentia harbour, it is not difficult to see boats from *Niagara* landing a shore-end there; when loading cable at Greenwich, *Agamemnon* is with her; and across the Atlantic she is in company with *Great Eastern* when she drops anchor in Trinity Bay. Although old as ships go, *Lord Kelvin* is fitted with modern equipment, and when she considers the very limited facilities enjoyed by the original cable ships, she is lost in admiration when contemplating their wonderful performance.

She hopes that one day a future generation, in the very latest of cable ships, will say "Not bad jobs, those done by old *Lord Kelvin!*"—EDWARD O'DONOGHUE, Chief Electrician, C. S. *Lord Kelvin*.

LORD KELVIN STATISTICS

Size: Length over-all —333 feet
Breadth, maximum—41 feet 2 inches
Depth —25 feet
Mean draught loaded—21 feet 8½ inches
Cable capacity 30,271 cubic feet net coiling space (about 600 nautical miles of deep-sea-type cable)

Tonnage: 2,641 gross

Engines: Triple expansion steam (total indicated horsepower 2,400) twin screw

Fuel capacity: 1,150 tons, Bunker "C" oil

Crew complement: Master 1; Deck 42; Engine Room 19; Electrical 5; Stewards 13; Miscellaneous 3; Total 83

A Simplified Telefax Concentrator

SEYMOUR LEVINE

To PROVIDE a simple and versatile concentrator system for "one-to-one" type "Telefax" transceivers, a new experimental plug-and-jack "building block" concentrator, designated EM2123, has been designed. Provision was made in the design of this concentrator to allow for ease of installation and maintenance of the equipment and for sufficient flexibility to meet various conditions that may be encountered by Western Union customers.

A minimum of table space is required because of the simplicity and compactness of the equipment. This system will be relatively inexpensive to manufacture, and the maintenance costs will be at a minimum.

Figure 1. Development model of basic units of Concentrator EM2123 for 10 lines, and associated Desk-Fax transceivers

The Basic Concentrator

This facsimile communication system is built around the basic concentrator unit shown in Figure 1, utilizing a table space of 12½ by 13⅜ inches, and includes a line terminating section, a local terminating section and a potential cabinet. The line section affords termination for ten outside lines per unit, each line terminating in a Desk-Fax Transceiver 6710 or a letter-size Transceiver EM2127. The local section accommodates six local transceivers per unit. A modified version of the vertical drum "Telefax" Transmitter 5716 can be used in place of any local transceiver to handle regular telegram-size blanks, 8 inches by 5¾ inches.

If needed to meet increasing load requirements, two more 10-line terminating units can be added to accommodate up to 30 outside lines, and another local terminating unit can be added to accommodate up to a total of 12 local stations.

A-c power is brought into the concentrator with one power cable plugged into the back of the potential cabinet, the bottom section on which the other concentrator units are stacked. Power for each section is obtained from outlets on the potential cabinet. Power for the local transceivers is obtained from outlets at the back of each local terminating section. The power requirement for the concentrator, with all 12 local stations operating simultaneously, is approximately 15 amperes at 115 volts alternating current. A local ground wire is connected to the binding post on the back of the potential cabinet, and a toggle switch on the front of the cabinet controls power to the concentrator and local stations. A pilot light, also on the front of the potential cabinet, indicates when the power is on.

The individual units are connected to the potential cabinet by cables and Jones plugs which are passed down through open slots at the back of the stacked sections to sockets located in the recessed back of the potential cabinet. Thus all the cables are easily connected but are covered and out of the way when the concentrator is assembled. The outside lines are connected by screws to the terminal strip on the back plate of the line terminating section. The lines from the local transceivers or transmitters (three wires from each station) are connected by screws to the terminal strip on the back plate of the local terminating section.

After removing the two side screws on the front of each section, a sliding equipment shelf can be pulled out, making the components accessible for convenient adjustment or repair, as shown in Figure 2. A stop on the back of the shelf prevents it from being completely removed from the cabinet and a half-turn rotation of the stop will allow the sliding shelf to be removed.

Connections between the local stations and outside lines are made with patching cords inserted into the desired jacks located on the front panels of the individual sections. The signal lamps located directly above the selected jacks on the local terminating section will light during transmission.

Operation of Concentrator

To initiate a call from a local station to an outside line a blank is wrapped around the drum of the local transceiver. A patching cord is connected between the desired jacks of the local and line sections and the outgoing button on the local transceiver or transmitter is depressed. Phasing and scanning is accomplished when the outstation transceiver answers the call. At the completion of the message the local station will shut down automatically and the patching cord can then be removed.

Figure 2. Equipment shelf of line terminating section opened and accessible for maintenance

An incoming call will sound the concentrator buzzer and light the signal lamp over the calling line jack. The incoming call can then be picked up by connecting a patching cord between the calling station jack and any idle local station jack. This shuts off both the concentrator buzzer and the incoming signal lamp and causes the buzzer on the local transceiver to sound. The transceiver's incoming button can then be depressed and the message recorded. At the completion of the transmission the local and outstation transceivers will shut off. The patching cord can then be removed.

When enough outside lines call in at the same time so that all available local transceivers are in use, the concentrator buzzer will not sound when a new call comes in. As soon as one of the local transceivers is freed the concentrator buzzer will sound and the new call can be answered as before.

For test purposes and for obtaining duplicate copies of a transmitted message, two extra jacks are provided on the front panel of the local terminating section. These jacks are interconnected inside this section through an appropriate H-pad to provide a 25-db attenuation in the line circuit. Patching these jacks to the desired local station jacks interconnects the two selected local stations.

Master-Send Section

The master-send section used as part of "Telefax" Concentrator EM2123 will enable a transceiver or the vertical drum transmitter at the local station to transmit into a maximum of five selected outstation transceivers simultaneously. This section can be placed on top of or alongside the stacked units of the basic concentrator and is interconnected to the local and line sections by means of the patching cords. This unit is shown in Figure 3 on top of the stacked concentrator sections. A-c power for the unit is obtained from an outlet at the back of the potential cabinet. The cover includes the top and sides and is removable, affording ease in maintenance.

Operation of Master-Send Section

To initiate a master-send operation a patching cord is connected from any one of the jacks on the local terminating section to the input jack on the master-send section. This energizes a relay which provides a-c power to the master-send unit.

The desired outstations (up to five) are then connected to the master-send section by patching from the output jacks to the desired jacks on the line terminating section. The local station can now be started by depressing its outgoing button, which signals the outstation transceivers.

As each outstation transceiver answers the call the white signal lamp directly above the corresponding line jack on the master-send section lights, indicating that the outstation is ready and waiting to be phased to the local transmitter. When all the outstations have answered, pulsing of the outgoing line current will take place, allowing each station to phase to the local transmitter. After all stations have phased, the local transmitter will begin scanning the message, and transmission to each of the outstations will be accomplished. At the completion of the transmission, the local transmitter will shut down, removing the line current to all outstations, allowing them to shut down and readying the system for a new master-send operation.

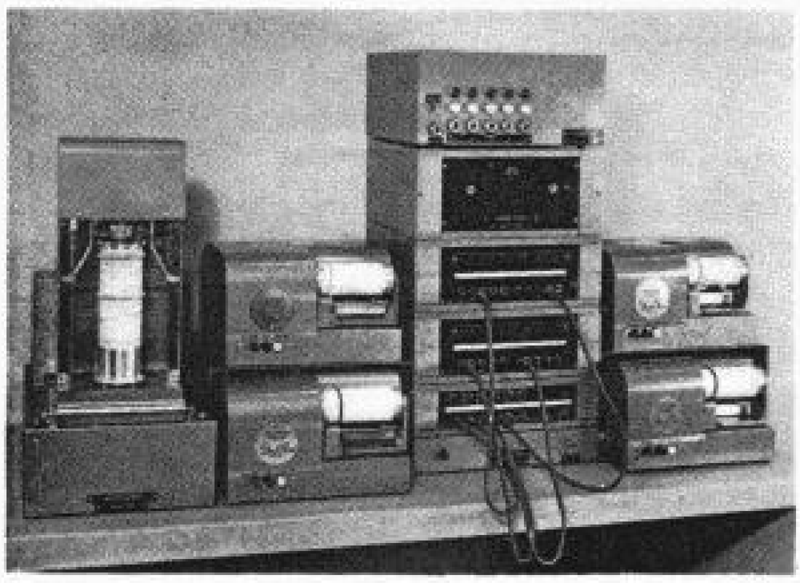


Figure 3. Model Concentrator EM2123 for 20 lines including repeater and master-send sections and a transmitter

If an outstation starts to transmit to the concentrator at the same time that a master-send operation is being initiated, the red signal lamp on the master-send section corresponding to that particular line will light. The concentrator operator will then remove this circuit from the master-send section and answer the call.

Directly above the input jack on the master-send section is an opening into which a screw driver can be inserted to adjust the output level of the amplifier to a value of +5 dbm. After this adjustment is made, the output level will remain constant regardless of the number of outstations used in any master-send operation.

Repeater Section

In order to enable one outstation to be in direct contact with another, a repeater section is used in conjunction with the concentrator. This section can be placed either on top of or alongside the stacked units of the basic concentrator and is interconnected to the line terminating section by means of the patching cords. This unit is shown in Figure 3 stacked just under the top master-send section. A-c power for the unit is obtained from an outlet at the back of the potential cabinet. The sliding equipment shelf is removed in the same manner as are the sliding equipment shelves of the basic concentrator units. (See Figure 2.)

To interconnect any two outstations it is necessary to patch the appropriate jacks on the line terminating section to the two jacks on the front panel of the repeater section. When the two outstations are in communication with each other the red signal lamp on the front panel of the repeater section lights. Two test jacks and two level controls on the inside of the sliding equipment shelf are used to adjust the output levels of the two repeater amplifiers to a value of +5 dbm.

Vertical Drum Transmitter

To provide a means of handling regular telegram blanks, some modifications and additions were made on a vertical drum "Telefax" Transmitter 5617, allowing it to be used in place of one of the local transceivers. This unit is shown in Figure 3 at the left-hand side of the entire concentrator system. The transmitter is mounted in a base that houses the control circuit, power supply and modulator. The layouts of these circuits are so placed as to allow complete accessibility to all components when the cover is removed. Subassemblies for the various circuits are used for ease in maintenance and replacement.

This new concentrator system can be used as a highly flexible and inexpensive central office unit for patrons' facsimile tie-line service. One possible arrangement is shown in Figure 3. Because of the relatively small space required and the ease afforded in expanding the system, installation of this concentrator in a business establishment would present no problem. Actual installation of the system is accomplished very simply and quickly with no soldering required. Once installed, operation is extremely simple and maintenance costs are low.

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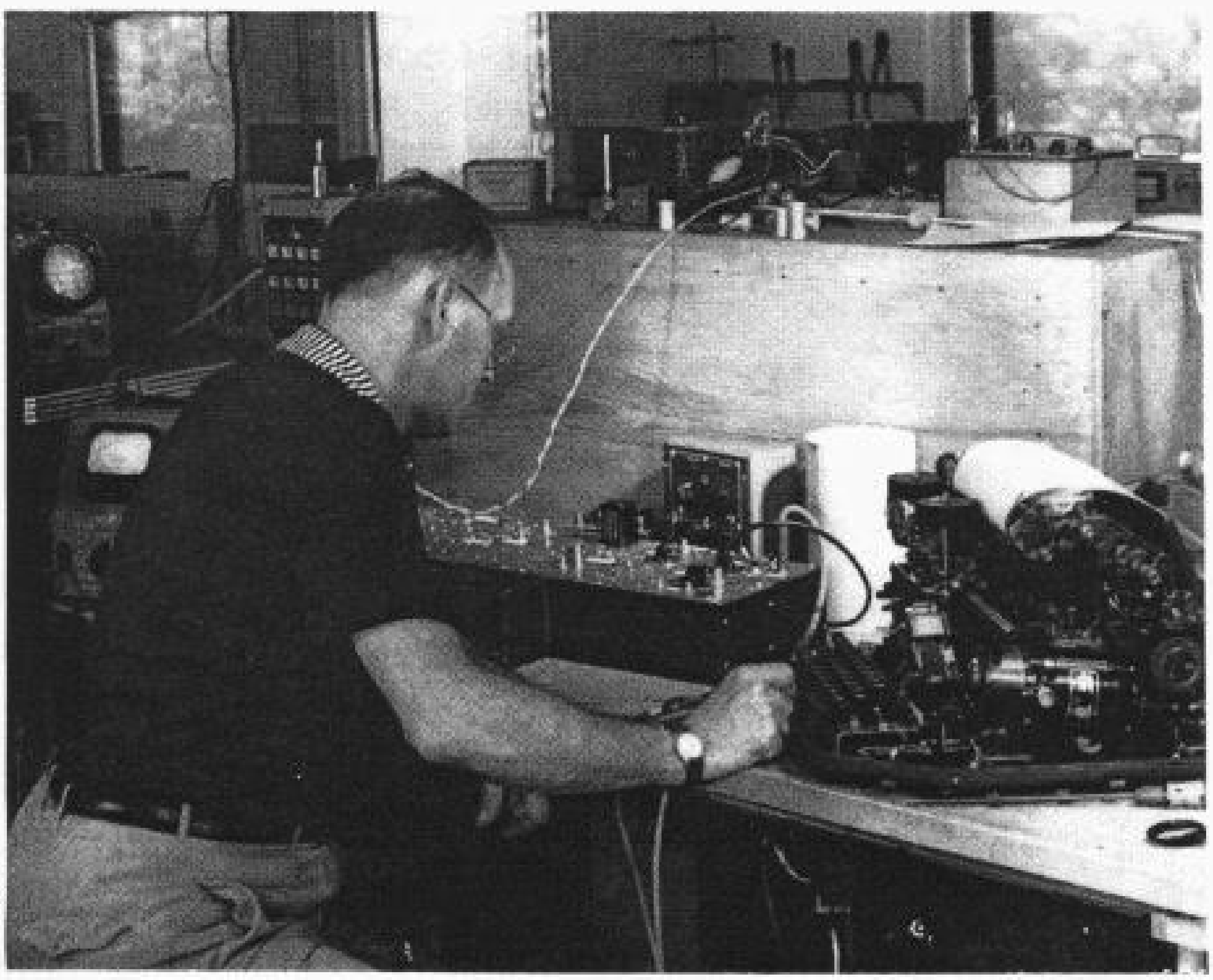
2. An Improved Desk-Fax Transceiver, G. H. RIDINGS and R. J. WISE, *Western Union Technical Review*, Vol. 6, No. 3, July 1952.
3. A Vertical Drum Telefax Transmitter, J. H. HACKENBERG, *Western Union Technical Review*, Vol. 4, No. 1, January 1950.

Seymour Levine graduated from the College of the City of New York in 1950 with a degree of Bachelor of Electrical Engineering, having previously served with the Army Signal Corps as a Communications Officer. His duties with the Signal Corps included supervision of the installation and maintenance of several radio carrier systems in the Pacific Theatre. In January 1951 he joined the Telefax Research Division of Western Union and has been mainly occupied with the development of facsimile apparatus and various facsimile systems. Mr. Levine has been closely associated with the design of the concentrator system described in this paper.

TRANSISTORS FOR TELEGRAPHY



Investigation of the characteristics of printing telegraph facilities is a continuous project in Western Union's laboratories. Here engineer F. T. Turner of the Electronics Research staff at Water Mill, L. I., author of "Communication Synchronizing Systems" in this issue, studies an application of transistors in that field.

Communications Synchronizing Systems

F. T. TURNER

PROPERLY designed synchronizing systems are capable of maintaining synchronism to very high orders of accuracy even in the presence of what appear to be very high noise levels.

It is the purpose of this paper to show how this is achieved by re-examining conventional synchronizing systems in the light of frequency-modulation communication theory, and also to discuss the synchronizing system as a servomechanism.

Synchronizing Signals

Where special waveforms of synchronized signal are required, these are usually known in advance, and their transmission would be redundant. Since any desired waveshape may be derived from a sine wave by appropriate clipping and shaping circuits, the synchronizing signal can be transmitted in the form requiring the least bandwidth, i.e., a sine wave. Where more convenient, the desired waveshape may be transmitted, but the added bandwidth required is of no significance for the purpose of synchronization.

If the transmitter were absolutely stable as to frequency, at least within the limits of the required accuracy, a local source of equal stability could supply synchronization and the transmission of this information would be redundant. It is only in those cases where the transmitter is expected to vary in frequency that synchronizing information must be transmitted.

The synchronizing signal, therefore, is a carrier modulated with certain intelligence, namely, the variations in frequency at the transmitter. The synchronizing signal is, therefore, a frequency-modulated carrier. Various methods are used to obtain from this carrier the required local signal. In the simplest case, the local signal is obtained from the transmitted signal either directly or by injection synchronization of a local oscillator or multivibrator.

Effects of Noise

Where noise in the transmission path is negligible, this system may be quite satisfactory. If noise is present at a significant level, however, the accuracy of synchronism may be degraded. The signal/noise ratio may be improved to any desired extent by inserting a band-pass filter in the signal path, provided that the filter is still wide enough to pass the maximum excursions of transmitter frequency. Since in many cases the transmitter frequency deviation, the noise level, or the required accuracy may not permit this solution, recourse must be made to other methods.

Analysis of many synchronizing systems which have demonstrated their ability to operate through high noise levels shows that they may be represented in their basic elements by Figure 1.

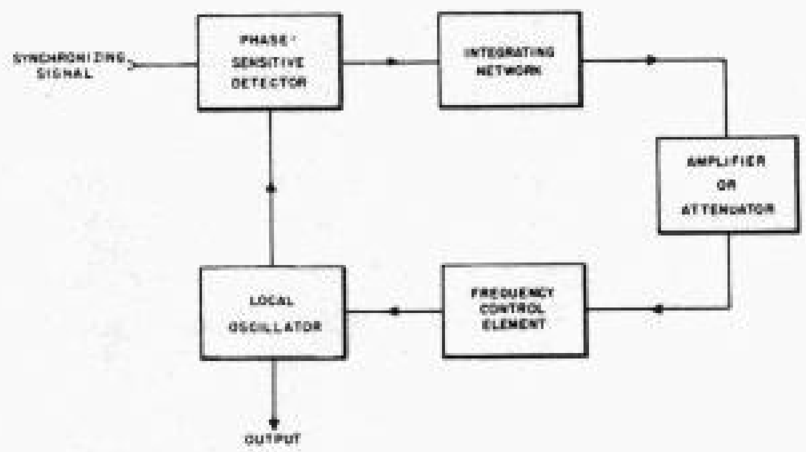


Figure 1. Basic elements of synchronizing systems

The incoming synchronizing signal is applied to a phase-sensitive detector together with the output of the local oscillator. At the output of the detector there appears a voltage which is a function of the phase angle between the two applied voltages, being zero at $\pm$ 90 degrees and positive or negative at other angles. This voltage is applied to a frequency-controlling circuit of the local oscillator in such manner as to reduce to a low value any

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A paper presented before the Summer General Meeting of the American Institute of Electrical Engineers in Atlantic City, N. J., June 1953.

difference in phase between the two input voltages.

It is customary in most cases to integrate the output of the phase-sensitive detector over a number of cycles of the synchronizing signal, in order to average out the effect of small random variations in the signal, usually resulting from noise. Such synchronizing systems have proved capable of maintaining synchronism to a very high order of accuracy through very high noise levels, often indeed when the other intelligence is for practical purposes completely lost.

A re-examination of the elements of the system, using concepts commonly encountered in FM communication, leads to a better understanding of the properties of synchronizing circuits. When employed in combination with the controlled local oscillator, the output of the phase-sensitive detector will have a constant value for a constant frequency deviation of a given polarity for a frequency lower than normal, and of opposite polarity for a frequency higher than normal. The combination is therefore, in effect, an FM detector.

Bandwidth Restrictions

The output voltage of the detector is proportional to the magnitude of the frequency swing of the synchronizing signal, and contains components of frequencies equal to the modulating frequencies. The "integrating" circuit commonly employed may be considered as a form of low-pass filter, imposing a restriction on the over-all synchronizing signal bandwidth as measured at the output terminals of the phase-sensitive detector. It is obvious that this circuit cannot restrict the bandwidth to less than that required to pass the highest modulating frequency (i.e., rate-of-change of frequency) without impairing the ability of the receiver to follow the variations of the transmitter. Its only value can be to reduce the amplitude of variations in the signal caused by noise components of frequencies outside the band required for transmission of the synchronizing signal, where the bandwidth at the input terminals of the detector is not already restricted to the minimum required.

In the practical case, it is easier to obtain this bandwidth restriction in this manner than by the use of band-pass filters ahead of the discriminator. Some improvement in performance might be obtained by redesign of the integrating circuits as low-pass filters, although the extremely low frequencies usually involved might make the construction of such filters impracticable.

Noise components or interference outside this band will produce output frequencies lying above the cutoff frequency of the integrating network and hence are of no concern. Noise components within this band will produce effective phase modulation. It appears, then, that noise is still capable of affecting synchronization. Since a true phase-sensitive detector, one form of which is shown in Figure 2, is not directly sensitive to noise, or to amplitude modulation of the received signal provided that it does not fall below that of the signal from the local oscillator, it is only the phase modulation produced by the noise which is of significance. The phase modulation is given to a first approximation as

$$\arcsin\frac{E_i}{E_s} \qquad (1)$$

where E_i = the interfering voltage and E_s = the signal voltage.

The Servo Concept

It is also of interest to note that a form of servomechanism is applied to the local oscillator. Assuming the transmitter to be constant in frequency for some period of time, any tendency of the local oscillator to drift produces an error voltage which is applied to reduce the drift. The local oscillator is, therefore, stabilized by a factor $S = 1 + Y$ where Y is the loop-transfer function of the servomechanism.

In some special applications it is desired that synchronism be maintained during a period of circuit interruption. In these cases a more stable local oscillator is employed, but new difficulties may thereby be introduced. If there is any significant lag in the response of the oscillator to a change in control voltage, another reactive element is introduced into the loop-transfer function Y, and a finite upper limit for Y is established beyond which the system becomes unstable. The accuracy

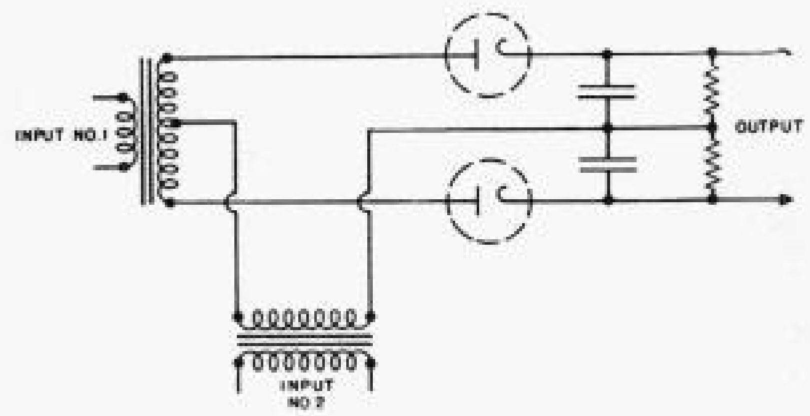

Figure 2. Phase-sensitive detector

with which the local oscillator follows the variations of the transmitter is determined by Y, and may be impaired if it is necessary to reduce Y to achieve stability.

Servomechanism practice employs differentiating circuits in the loop to compensate for reactive components elsewhere, but such circuits are seen to be of opposite characteristics to the integrating circuits referred to previously, and may increase the susceptibility of the system to noise.

In designing a synchronizing system, it is desirable to weigh carefully any requirement for maintenance of synchronization during a period of circuit interruption, and to consider if it may not as well be met by rapid stable re-establishment of synchronism at the end of the interruption.

Facsimile Requirements

Facsimile transmission is a typical case in which synchronizing problems arise and will serve to demonstrate the application of the statements made earlier. A typical facsimile system operating at 180 rpm with certain standards of definition will require a band 2400 cycles wide for its transmission.

It is often the case that the transmitter is operated by or synchronized with commercial a-c power. A study of a typical commercial power source has shown that the variation of frequency ordinarily encountered in this source will be of the order of 0.2 cycle, and the rate-of-change of frequency will be of the order of 0.024 cps/sec. Assuming that the synchronizing signal, however transmitted, will represent this source, one has then a signal which can be reduced to a carrier frequency of 60 cycles, a maximum excursion of ± 0.2 cycle, and a maximum rate-of-change of frequency of 0.024 cps/sec. In frequency-modulation terminology the first two quantities correspond to the carrier, F, and the peak deviation, ΔF, respectively. The quantity dF/dt can be shown to be equivalent to a maximum modulating frequency, f, of 0.0191 cycle. Then

$$\frac{\Delta F}{f} = \frac{0.2}{0.0191} = 10 \text{ approx.} = \beta \qquad (2)$$

the modulation index. Reference to a table of Bessel functions for $\beta = 10$ shows that side-band pairs of order higher than 14 have amplitudes less than 1 percent of the carrier and can be neglected. There is then a bandwidth before detection of

$$2 \times 14 \times 0.0191 = 0.535 \text{ cycle} \qquad (3)$$

The accuracy required for this type of service is of the order of 0.1 degree of revolution. This is 2 degrees of the 60-cycle driving voltage. The noise voltage capable of producing an error of this magnitude through equivalent phase modulation is $E_s \sin 2$ degrees or $0.035\ E_s$. Expressed in db this is a S/N ratio of 29 db.

Thus a S/N ratio of 29 db in a band 0.535 cycle wide is needed. If random noise is assumed present at this level, the S/N ratio in the total band required for transmission of the facsimile signal will be

$$29 - 10 \log_{10} (2400/0.535) = 29 - 36.5 = -7.5 \text{ db} \qquad (4)$$

Such a noise level would result in almost complete obliteration of the facsimile message.

The same combination of basic elements may be found in some television receivers for horizontal synchronization. A local oscillator operating at the horizontal sweep frequency supplies an input to a phase-sensitive detector. The other input is obtained from the horizontal synchronizing pulses. The resultant output is integrated and applied to a frequency control circuit on the local oscillator.[1, 2]

Printing Telegraphs

Another example of transmitted synchronization is found in automatic printing telegraph communication. A motor-driven sending commutator is controlled by a tuning-fork frequency standard of moderate stability. At the receiving end a saw-tooth wave is generated by auxiliary segments on the receiving commutator. A polar relay samples the saw-tooth wave at regular intervals under the control of the received signal. The samples thus obtained are integrated and applied to circuits for correcting the speed of the tuning fork at the receiving end. In this case, the sampling relay corresponds to the phase-sensitive detector of Figure 1. Its output in this case is not a cosine function of angle but may be made to closely approximate a linear function over quite a wide range.

In designing a system for synchronization by a transmitted signal, the first step is an analysis of the order of stability of the source. From this may be obtained the bandwidth required for transmission of the necessary information following methods given in any standard text on FM communication theory.[3]

The same analysis also leads to a first-order approximation for the time constant of the integrating network, i.e., that it be able to pass the highest rate-of-change substantially unattenuated. The requirement for accuracy may then be used to give the required signal-noise ratio in the band thus determined using equation (1).

The required accuracy also leads to a solution for the value of the servo loop transfer function Y in the following manner:

Let A = Frequency control constant in cps per volt.
B = Detector sensitivity in volts per degree, for angles near 90 degrees.
C = Maximum deviation of transmitter frequency in cycles.
D = Maximum deviation in cycles of local oscillator frequency in the absence of a controlling signal (local oscillator stability).
E = Required accuracy in degrees.
K = A loop constant determined by the integrating network and attenuators or amplifiers as required. Then

$\frac{C+D}{ABK}$ must equal E or

$$\frac{C+D}{E} = ABK = Y \tag{5}$$

A, B, and especially K may be complex, and the product Y must satisfy the requirement for stability as discussed in servomechanism literature.

It is of interest to consider the requirements for establishment of synchronism on initial application of the synchronizing signal. Depending on the waveshapes applied to the phase detector, the output may be a cosine, linear, or discontinuous function of relative phase angle. When sine waves are applied, it is a cosine function, having a maximum absolute value at 0 ± 180 degrees of $57.3B$. If the transmitter and local oscillator may differ by a maximum of $(C+D)$ cycles prior to establishment of synchronism, then the voltage required at the terminals of the frequency-controlling element to correct the local oscillator is $\frac{C+D}{A}$ volts.

As shown, the peak output of the detector for sine wave inputs is $57.3B$. Since this will be an a-c voltage of frequency $C+D$, a requirement can be established for K at $f = C+D$, relative to its value at $f = O$.

If
$$57.3\,BK_{C+D} \geq \frac{C+D}{A_{C+D}} \tag{6}$$
then synchronism will be established.

from equation (5)
$$K_o = \frac{C+D}{A_oBE} \tag{7}$$
from equation (6)
$$K_{C+D} = \frac{C+D}{57.3\,BA_{C+D}} \tag{8}$$
then
$$\frac{K_{C+D}}{K_o} = \frac{C+D}{57.3\,BA_{C+D}} \div \frac{C+D}{A_o\,BE} = \frac{A_o\,E}{57.3\,A_{C+D}} \tag{9}$$

If $\frac{A_o}{A_{C+D}} = 1$ then $\frac{K_{C+D}}{K_o} = \frac{E}{57.3}$. It will be seen that where the required accuracy is much less than one radian (usually the case), the transmission of the integrating network, which in most cases is the chief complex component of K, may be allowed to drop rapidly for frequencies higher than that representing the maximum rate-of-change of transmitter frequency, as long as

$$K_{C+D} \geq \frac{K_O E}{57.3}$$

The requirement $\frac{A_O}{A_{C+D}} = 1$ implies that the imaginary component of A is negligible over the frequency range of interest. It will often be found that this is not true when mechanical devices are a part of the frequency-controlling means.

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Mr. Turner's biography appeared in TECHNICAL REVIEW for April 1952.

A Bulletin Recorder for Weather Maps

THE WEATHER is a subject that almost everyone talks about—discusses or cusses one way or another—but, according to an old cliché, no one seems to do anything about it; no one, that is, except the U. S. Weather Bureau and Western Union. Data regarding temperature, pressure, wind direction and velocity, precipitation and the like, gathered from hundreds of observation points throughout the country (and from balloons as well), are sent hourly to the Weather Bureau in Washington. From this center maps, charts and graphs are prepared on 18- by 12-inch paper and transmitted over a National Facsimile Weather Network all over the country almost continuously 24 hours a day. Facsimile Set AN/TXC, the type equipment usually employed in this service, is a manual loading rotary drum transceiver.

Recently, Western Union developed a flatbed continuous type facsimile recorder as part of a receiving terminal set to permit ultimately unattended reception of these weather maps and charts. Essentially, the recorder is a grown-up brother to the regular 3-stylus recorder[1] now in widespread use in Western Union's facsimile systems.

The recorder, mounted on top of a cabinet containing the electronic and control equipment, uses *"Teledeltos" 19⅛ inches wide from a roll. The three styli are equally spaced 18.849 inches apart on a steel belt and traverse the "Teledeltos" at the rate of 60 strokes per minute. A total time of approximately 30 minutes is required for each 18- by 12-inch transmission. The recording paper is fed uniformly by a separate motor (approximately 5/8 inch per minute).

One innovation in this recorder design was the development of a magnetic track to keep the styli in vertical alignment as the belt moves them across the scanning line. In earlier designs, movement of the steel belt

* Registered Trademark W. U. TEL. CO.

was restricted by side guides which added to the load of the driving motor. Another improvement was the adoption of a length of straightened tungsten wire for the stylus instead of the machined "Elgiloy" point. This improvement reduced the cost per stylus from approximately 25 cents each to about 0.2 cent, while increasing the usable length of each stylus 13½ times. Both of these improvements are being incorporated in the manufacturing specifications for other multistyli continuous recorders.

Transmission of the maps and charts is done over voice band circuits. The fundamental carrier is 1800 cycles/second with a maximum theoretical modulation of 900. At the beginning of each "picture" a black signal interrupted once per revolution for 50 milliseconds (for phasing) is transmitted for about 30 seconds. The correct recording level is adjusted during this period and the recorder is phased. The percentage of modulation of the incoming signal (at the receiving terminal) varies between recordings, and the receiver must be provided with an expander to take the incoming signal with a margin sometimes as low as 6 db and expand it to give a good record on the "Teledeltos."

The electronics consist basically of a preamplifier which feeds a phasing amplifier, a level-setting amplifier, and an expander which in turn passes the facsimile signal to the recording amplifier. The motor for driving the stylus belt is driven from a frequency standard using a power amplifier employing thyratrons. Provisions were made whereby the recorder can be brought into phase position manually if for some reason the initial phase sequence fails.

The essential characteristics of the receiving terminal are:

Line feed: 96/inch
Length of scanning stroke: 18.849 inches
Strokes per minute: 60
Size roll "Teledeltos": 19⅛- by 7-inch o.d. 2¾-inch i.d. (650 feet long)
Index of cooperation: 576 (International)
Stylus: 0.010-inch tungsten wire
Size: 30 by 21 by 51 inches; 350 pounds
Power: 370 watts, 105-130 volts, 60 cycles

Facsimile recorder for weather maps

Electronic and control equipment of weather map recorder

A number of engineers assisted in this development. Particular reference should be made to Mr. D. M. Zabriskie under whose direction the mechanical section of the recorder was designed, and to Mr. G. B. Worthen who contributed to the design of the electronics.—G. H. RIDINGS, Ass't Telefax Research Engineer.

Reference

1. THREE-STYLUS FACSIMILE RECORDER FOR CONCENTRATOR SERVICE, F. G. HALLDEN, *Western Union Technical Review*, Vol. 4, No. 1, January 1950.

Pole Yard Operations at Chattanooga

E. J. TRENT

ANY SERIES of articles written on the operating functions of Western Union's Chattanooga Works would be incomplete if the handling of a pole yard and the operation of a pole treating plant were not included. At the present time, pole yard and pole treating activities there are at a low level compared with earlier days, but the capacities and knowledge of pole yard techniques are available and utilized daily.

A wide variety of functions has been performed by the Chattanooga Works since 1910 when it became a part of the Telegraph Company's system. Practically all of these operations have been the accumulative result of keeping pace with a fast-changing telegraph industry. But in spite of all the changes, additions and new shop techniques initiated in over 40 years of service, the Chattanooga Works, which started as a storage and distribution point for wood poles, still operates a pole yard and a pole treating plant.

Historical

One of the factors involved in the operation of a pole yard is its dependency on the surrounding forest area to supply wood suitable for telegraph poles. As the types of wood obtained from different parts of the country are quite variable the geographic location of a pole yard has a definite bearing on the practices to be applied. Chattanooga, Tennessee, is located on the boundary line of Tennessee and Georgia, and therefore the Chattanooga Works has in the past relied mainly on the forests of Tennessee, Georgia, Alabama, and North and South Carolina for its pole supply.

Around the middle of the 19th century the country was fairly well covered with forests from which wood poles suitable for the construction of pole lines could be obtained. Poles adequately spaced and firmly anchored, supporting overhead electrical conductors, were the accepted standard for carrying communication intelligence between telegraph centers. Cedar was the preferred wood for poles because it naturally resisted ground decay on that portion of the pole buried underground, and also resisted elemental deterioration above the ground line far longer than any of the other abundantly available woods. Therefore practically all of the first pole lines were of cedar wood construction.

Railroads were reaching out to cover the country with transportation facilities during the same period that the telegraph lines were developing to provide nationwide communications, so telegraph pole line and railroad construction were closely associated, an association that was mutually beneficial in the procurement and shipment of wood. As the telegraph lines and railroads spread out, expanding in capacity and bringing commercial and social contact to more of the country, there was a westward movement of population and the open tracts of forest rapidly changed to farms, towns and cities. Pole lines already in use required maintenance, and elemental violence at times created an immediate demand for complete reconstruction in addition to the expanding construction work. Permanent pole yards storing an assortment of sized poles to assure a uniform and readily accessible supply became a necessity.

Near the end of the 19th century a 5-acre rented tract of land in the suburbs of Chattanooga, known as the Boyce Yard, was established as a company pole yard. Southern red cedar trees from the surrounding forest areas were used exclusively, and since no rot preventative treating was required for this wood, the Boyce Yard was utilized only for pole storage and distribution purposes. Gin poles with rope and chain networks operated on a turntable principle and powered by teams of mules loaded and unloaded poles for rail transportation.

In 1909, approximately 11 acres of land

were purchased about three miles south of the Boyce Yard. A year later all activities were transferred to the new location, then known as the Chattanooga Pole Yard and later the Chattanooga Works. The practices of the Boyce Yard were followed generally at Chattanooga, but on a larger scale. Southern red cedar poles continued to be the primary type handled until early in 1918. Then furniture and pencil manufacturers bought up large tracts of cedar-bearing land, and increasing population centers decreased the forest areas. Increasing cost considerations plus the decreased supply of cedar made the use of a comparable type of wood advisable, and by the end of 1918 chestnut wood poles began replacing the cedar.

Early Pole Treating Methods

Cedar, with its natural ground decay resistance, was far superior to chestnut, although the elemental deterioration resistance above the ground line of chestnut was not far inferior. To equalize this difference, the chestnut poles were given what was called a "butt treatment". This meant that the end of the pole which is buried underground was impregnated with a rot preventative. Actually the coating was applied from the butt end to a point from 18 inches to 2 feet above the intended ground line. Butt treatment originally consisted of brushing that portion of the pole with a coat of creosote and allowing it to soak into the wood. This method took plenty of time and the penetration was slow and uncertain. A limited measure of protection was obtained but a deeper and more uniform penetration of creosote was indicated in order to realize optimum value from pole treating.

By 1921, all new poles handled by the Chattanooga Yard were chestnut and the first hot creosote pole treating plant was installed. It was a very simple installation: cylindrical, heavy gauge steel tanks about 15 feet long and 5 feet in diameter were half buried vertically in a pit in the ground, mounted on a metal and concrete base containing a fire box. Creosote was poured into the tank and poles immersed therein. The hot creosote treatment of poles required that they remain in a hot bath of creosote at over 200 degrees F for a specified period of time, and then in a comparatively cold bath of creosote for another specified period of time. A fire in the fire pot retained for the hot treatment and diminished for the "cold" treating period constituted the treating cycle. The control of heat and time with this first installation gave much better results than the brush-on type of treating but the demands for poles increased and a larger, more comprehensive plant was required. An open tank butt treating plant with a complete steam generating system, creosote preheating and storage tanks, and testing facilities, was installed in 1923.

Chestnut poles were handled at Chattanooga until about 1930, when a blight which attacked only chestnut trees appeared in the southern forests. This blight attacked the bark, encircled the main trunk of the tree, cut off its food supply from the ground, and quickly killed the whole tree. By 1938 the southern forests were practically devoid of any living chestnut trees. The blight, which first appeared in the forests of New England and gradually spread southward, has left evidence of its destructive powers in the large areas of dead chestnut trees in the mountains of Tennessee, North Carolina and Georgia. Recent forestry surveys report that young chestnut trees in the affected areas will thrive well until the trunk reaches a diameter of about three inches when the blight again appears and kills the tree.

In 1938, all new poles received at the Chattanooga Works were creosoted yellow pine, designated as "CYP". They were treated by outside sources where facilities were available for treating the full length of the pole. Standardizing the full length treatment of yellow pine poles and stubs limited the usefulness of the Chattanooga treating plant which was originally designed only for butt treating. Therefore only very short poles and stubs have been creosote-oil treated at Chattanooga since about 1940.

The Pole Yard

The entire Chattanooga works occupies 13.7 acres of which about five are used for pole yard operations. The operation of a pole yard means primarily receiving poles, unloading and correctly storing them by size, class and grade; solidly loading poles on rail cars or trucks for reshipment; and keeping records of inventories, shipments and stocks. Scheduled inspections and tests are made at the Yard, not only of new poles but also of old ones from abandoned or rebuilt lines which must be checked before being classified as suitable for reuse. The quantity of poles handled has varied, with 1926 being the peak year. During that year over 100,000 poles were received, treated and shipped, and in addition an assorted stock of 50,000 was maintained.

Established techniques in a pole yard must be closely followed as very disasterous results might be incurred from incorrectly anchored poles loaded on flat cars, subject to railroad braking and hauling shocks. Also improper loading in pole storage bins can cause distorting bends and warp a straight solid pole into a bowed arc. Insufficient air circulation, or contact with the ground or decaying wood encourages deterioration of stored poles; and an avalanche of loose poles breaking away from careless piling will move dangerously and destructively fast.

In Figure 1 is shown the locomotive crane loading poles from the storage bins to a flat car. A part of the rail siding network which covers the entire yard can be seen paralleling the long row of well-stacked poles. The locomotive crane is a Browning of Cleveland steam crane, with 65-foot boom, vertical tubular type boiler with 125-pound maximum steam pressure, feeding two separate steam engines. The main engine operates all functions except that of rotating the cab; the second smaller auxiliary engine rotates the cab thereby enabling an entire lifted load to be turned to a desired position while the main engine is moving the unit to a new location. The crane has a lifting power of 15 tons with the boom in its uppermost vertical position. The cab is entirely enclosed for all-weather operation. The crane is also used to move rail cars around the yard,

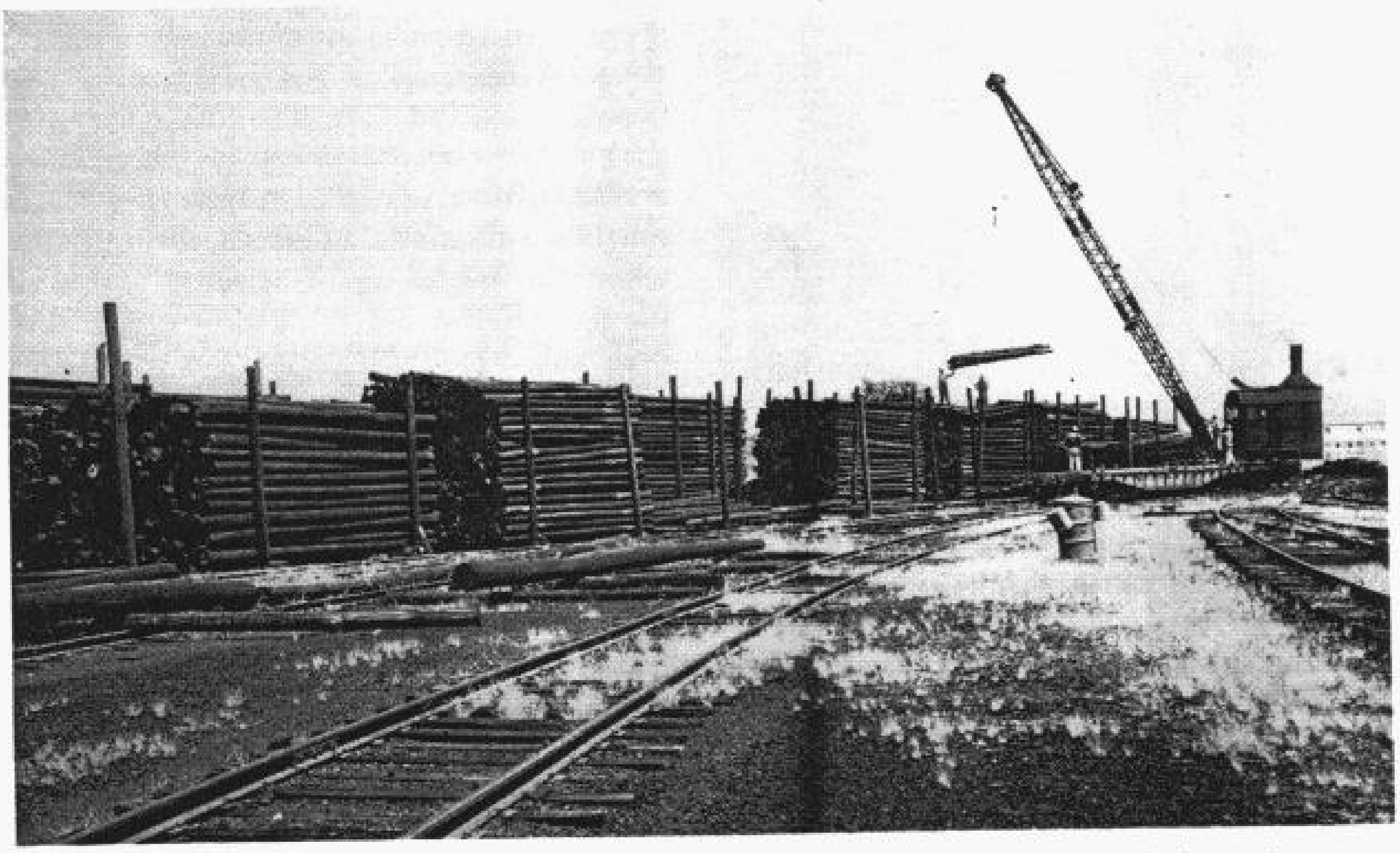

Figure 1. Partial view of pole stock at Chattanooga with crane loading poles in background

as well as loaded coal cars, or camp cars to be repaired. Accessories, such as an assortment of clam-shell buckets, give the crane additional value for yard work such as unloading coal cars or ground leveling jobs.

The storage bins shown in Figure 1 are constructed of vertical poles firmly anchored in the ground and lashed together with tie wires. Cross poles are fastened to the vertical poles about one foot above the ground line to form a skid which keeps the bottom layer of poles from coming in contact with the ground. Each bin contains one specific type of pole classified for class and size as shown in the following chart:

a 20-degree slope on the top end of the pole for water drainage; cutting a flat longitudinal surface along the pole a specified distance from the top to provide a flat bonding surface for mounting crossarms; and boring a number of holes, dependent on the pole class and size, which serve as the mounting holes for bolting crossarms to the pole.

Stubs are actually very short solid poles which are normally used to reinforce poles that have deteriorated at or below the ground line but are still useful above the ground line. The stub is installed in the ground adjacent to the pole and tightly

Class		0	1	2	3	4	5	6	7	8WU
Minimum Top Circ. (Inches)		29	27	25	23	21	19	17	15	12
Length of Pole (Feet)	Ground Line Dist. from Butt (Feet)	Minimum Circumference at 6 ft. from Butt (Inches)								
16	3¾						21.5	19.5	18.0	14.0
18	4				26.5	24.5	22.5	21.0	19.0	15.0
20	4¼		31.5	29.5	27.5	25.5	23.5	22.0	20.0	16.0
22	4¾		33.0	31.0	29.0	26.5	24.5	23.0	21.0	
25	5	36.5	34.5	32.5	30.0	28.0	23.0	24.0	22.0	
27	5¼	38.0	36.0	33.5	31.0					
30	5½	39.5	37.5	35.0	32.5	30.0	28.0	26.0	24.0	
35	6	42.0	40.0	37.5	35.0	32.0	30.0	27.5	25.5	
40	6¼	44.5	42.0	39.5	37.0	34.0	31.5	29.0	27.0	
45	6½	47.0	44.0	41.5	38.5	36.0	33.0	30.5	28.5	
50	6¾	49.0	46.0	43.0	40.0	37.5	34.5	32.0	29.5	
55	7	50.5	47.5	44.5	41.5	39.0	36.0	33.5		
60	7¼	52.5	49.5	46.0	43.0	40.0	37.0	34.5		
65	7½	54.0	51.0	47.5	44.5	41.5	38.5			
70	8	55.5	52.5	49.0	46.0	42.5	39.5			
75	8½	57.0	54.0	50.5	47.0	44.0				
80	9	58.5	55.0	51.5	48.5	45.0				
85	9½	60.0	56.5	53.0	49.5					
90	10	61.0	57.5	54.0	50.5					

Poles are received at the Chattanooga Yard with the bark completely removed, sawed at the butt, trimmed of protruding branches or knots and butt marked for class and size. Framing is done at Chattanooga and includes roofing, gaining and boring, which means, respectively, cutting

lashed to the lower part of the good above-ground section. The lower condemned section is then removed leaving the stub to support the pole. Stubs are stocked in 6-inch steps from 8½- to 15-foot lengths. The same storage and handling practices used for poles are applied to stubs.

Pole Treating

There are some species of wood, such as cedar or cypress, that resist decay naturally longer than do other kinds that have been treated, but economics and availability have made logical the use of the less resistant types for telegraph pole lines. Such poles obviously require treating to protect them from insect and plant life deterioration, and to insure an economical pole depreciation period. Briefly, pole treating means getting creosote deep enough into the pole, by forcing with pressure or creating inner vacuum, to obtain a lasting protection. The basic compound used for the short poles and butts treated at Chattanooga is a creosote-fuel oil mixture.

Figure 2 shows the creosote treating plant at the Chattanooga Works, and Figure 3 gives an idea of its general layout. In the immediate foreground on the left-hand side of the picture one of the four open-type treating tanks can be seen. A heavy protective cover plate over the tank is removed and poles are inserted vertically for treatment. The platform on three sides of the tank is used to support and anchor the upper part of the poles, and the slanting structure just to the right is the roof of an underground room in which the control valves and pumping facilities are located. All valves are operated manually and control the steam pressure to a steam coil in the bottom of the treating tank; the flow of preheated creosote between treating tanks and preheating tanks; and the flow of unheated creosote between the treating tank and the cold storage tanks. Each of the four open-type treating tanks has individual similar underground control rooms and is used individually.

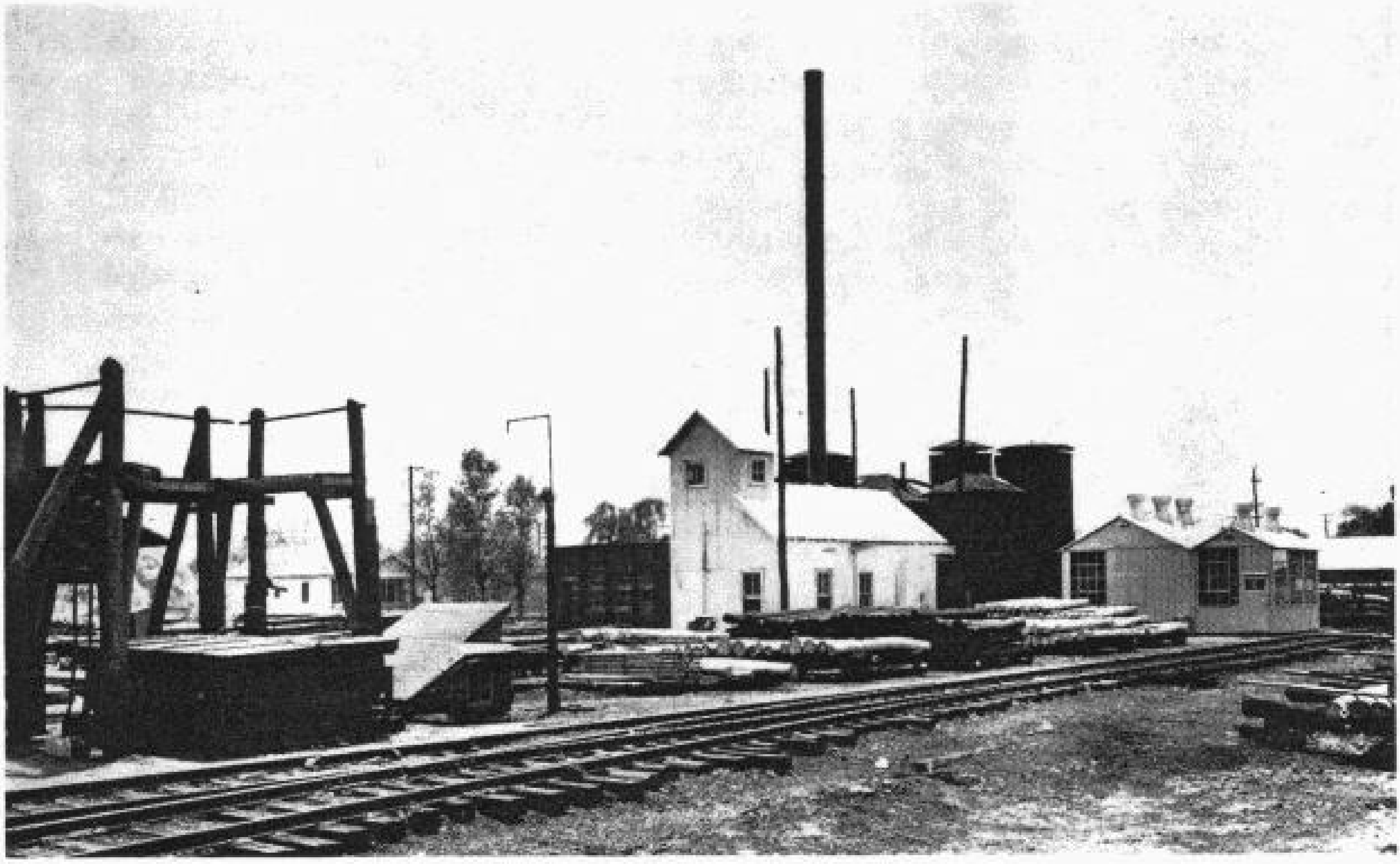

Figure 2. Boiler house, tanks and tool houses of Chattanooga pole treating plant

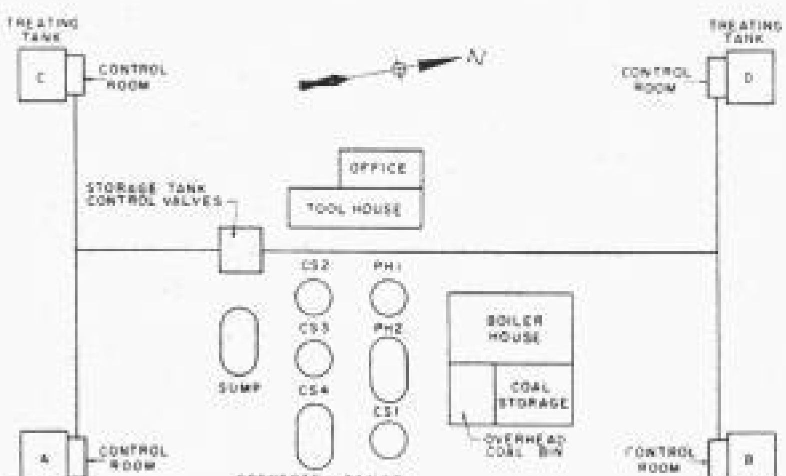

Figure 3. Layout of pole treating plant

Figure 4 shows the control valve system for one treating tank. Manipulation of the valves will allow hot or cold creosote to gravity-flow from a storage tank, and use of the pump will force hot or cold creosote back into a selected storage tank.

The treating tanks measure 7 feet in width, 12 feet in length, 11 feet in depth, and are constructed of ¼-inch steel plate. A ⅝-inch thick perforated steel grid extends across the tank one foot above the bottom. A steam coil located immediately below the grid heats the creosote in the tank and the perforated grid allows circulation of the heated creosote while serving as a platform for the poles inserted in the tank.

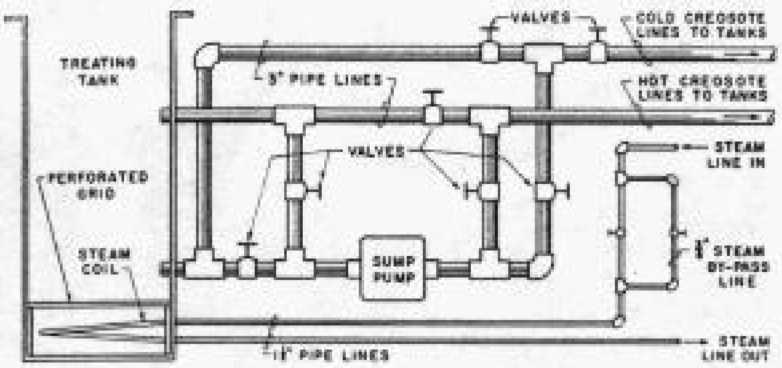

Figure 4. Control valve system for one treating tank

Each of the four underground control rooms is equipped with one pump: Goulds, single-stage, double-suction, all iron, centrifugal Type 38 with 4-inch suction and 3-inch discharge. Operation left-hand, capacity 150 gallons per minute of creosote oil at a temperature of 225 degrees F against a head of 65 feet. Each pump is flexibly coupled to a motor, G.E. squirrel cage, 3-phase, 60-cycle, 1750-rpm, 7½-horsepower. The pump is used to pump creosote oil back to the storage tanks. Treating Tank A has the additional feature of a coupling pipe line from the pump to an adjacent rail siding. Tank cars delivering creosote can thereby be coupled to the pump in Control Room A with gravity-flow from the tank car to the pump where it is then forced to a selected storage tank.

A thermometer recording instrument containing an accurate spring-wound clock mechanism with facilities for mounting a circular graph calibrated with hours versus temperature, upon which an inked stylus is actuated by the temperature in the treating tank, is installed in each control room. Accurate temperatures and times of every lot of poles treated are recorded on graphs and kept for future reference. The circular graph of one treating period appears in Figure 5.

The building in the center of Figure 2 with the cupola and tall smoke stack is the engine room where steam for the treating plant is generated. The two smaller buildings to the right are the tool shed and yard office respectively. The engine room supplies steam for the treating tanks and for the creosote preheating tanks and is equipped with a Walsh and Weidner steam boiler, 80-horsepower, horizontal return tubular 125-pound pressure, coal-fired.

The creosote preheating and storage tanks are the high dark circular tanks just beyond the engine room (Figure 2). The two preheating tanks designated as PH1 and PH2 (Figure 3) have capacities of 7775 and 6050 gallons, respectively. Tanks CS1 through CS4 are cold storage tanks and have capacities of 16,000, 15,600, 12,500 and 6000 gallons respectively for a total storage capacity of approximately 50,000 gallons. Each tank is equipped with a liquid level indicator. The sump tank is pipe-line connected to each of the storage tanks and serves as an overflow receiver. This is a precaution against overfilling a tank or expansion of heated creosote causing a tank to overflow.

The network of feed lines for all the preheating and storage tanks is brought to a manually operated control valve system at the base of storage tank CS2. By manipulation of these valves a choice of flow from or to any preheating or storage tank can be made. The control valves associated with the treating tanks can be set for the type of creosote oil required but cannot choose the storage tank to be used. The two separate valve systems must be used in conjunction to obtain desired results. Figure 6 shows the control valve system for the storage tanks.

Creosote is the basic treating medium but past experience and tests have

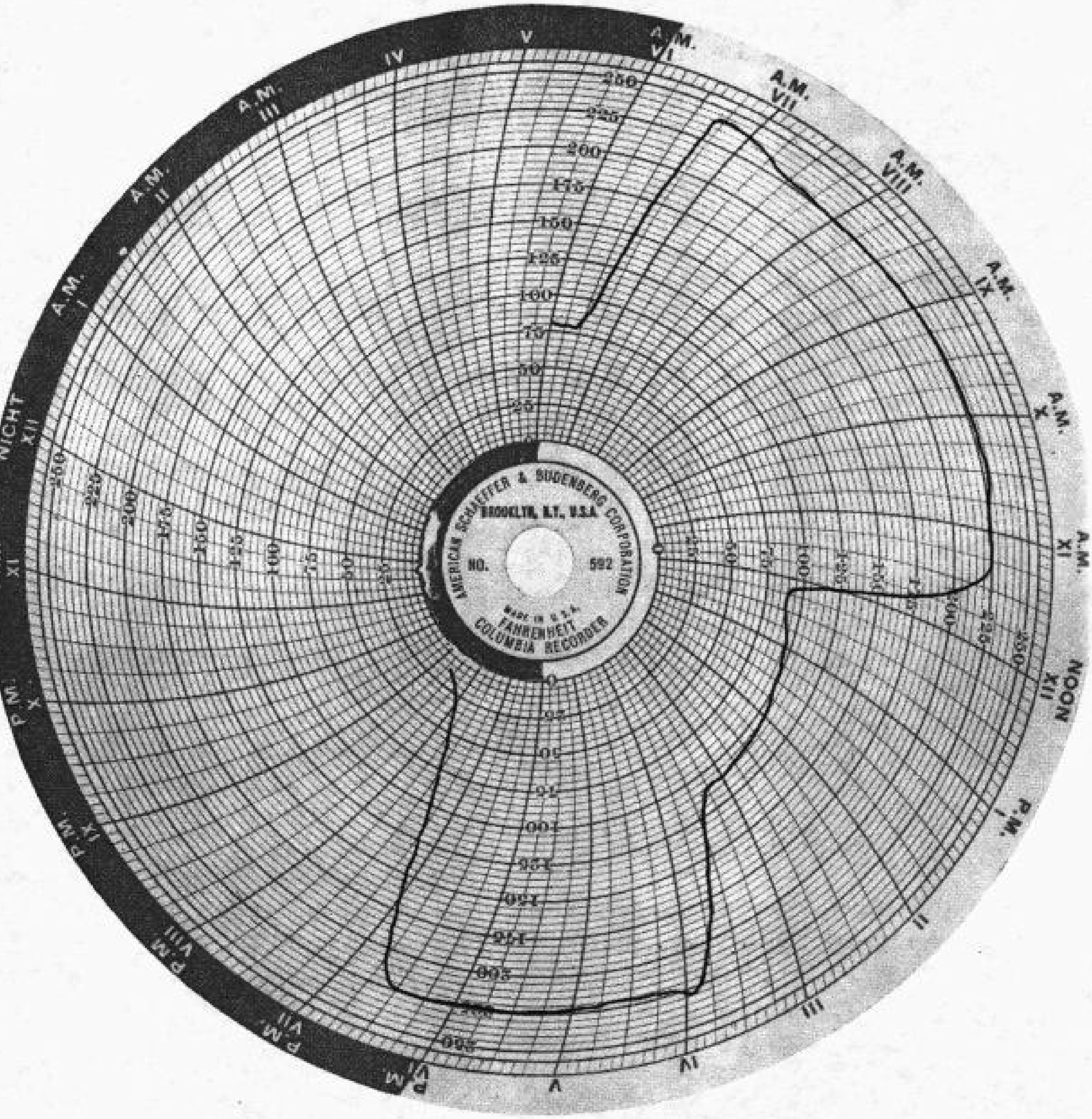

Figure 5. Graph of one treating period

dictated the use of a mixture of 70 percent creosote and 30 percent fuel oil No. 2 grade. Both the hot and cold storage tanks contain this mixture. In a complete treating cycle, starting with an inactive plant condition, these procedures would be followed:

1. Close all creosote flow and steam control valves.
2. Activate the engine room and generate a head of steam.
3. Open the steam valves to the creosote preheating tanks and maintain steam pressures to reach a temperature of 225 to 230 degrees F. (A thermometer cor nected to each preheat tank is located i the engine room.)
4. Load the empty treating tanks with pol or pole stubs; those over 11 feet long a inserted vertically, shorter stubs can b placed in tank horizontally and blocke in place.
5. Open the steam control valve at th treating tank.
6. Open the hot creosote gravity-flow valv at the treating tank and at the preheat ing tank, allow creosote to gravity-flo until the treating tank has filled to th

desired depth, and close both sets of valves in the hot creosote feed line.

7. Maintain steam pressures to the treating tank to reach and retain a creosote temperature of 225 degrees F.
8. Allow poles or stubs to remain in the creosote for a period of two to six hours depending on the condition and type of wood.
9. At the end of the treating period, start the pump at the treating tank, open the valves on the hot creosote return line to the top of the preheating tank and the valves in the cold creosote gravity-flow line to the treating tank, allowing cold creosote to flow into the bottom of the treating tank. This forces the 225-degree-F creosote out a port in the top of the treating tank connected to the pump, which forces the hot creosote back to a preheat tank. The flow of cold creosote continues until the temperature of the treating tank creosote reaches 100 degrees F. All control valves are then closed and the pump stopped.
10. Poles or stubs are kept for four hours in the creosote maintained at 100 degrees F. The by-pass on the steam line at the treating tank permits easier maintenance of this temperature with the main steam line closed.

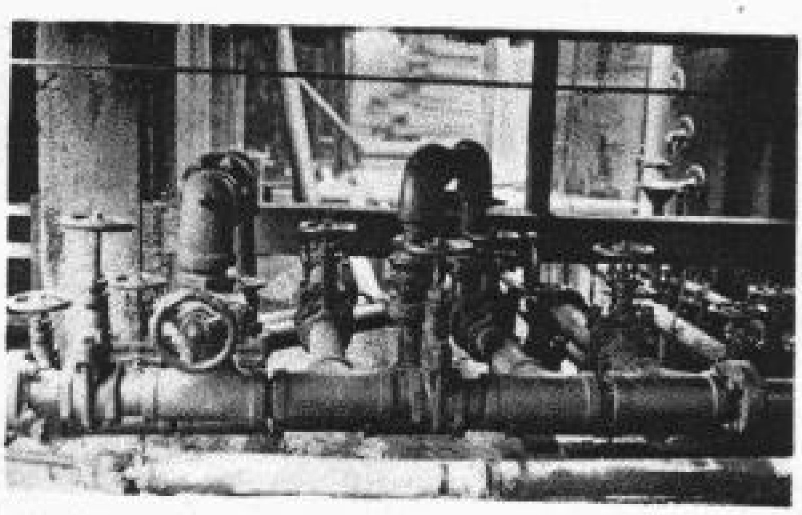

Figure 6. Control valve system for storage tanks

With chestnut poles, the butt treatment ended here. Treatment of yellow pine stubs or poles requires an additional hot flush creosote bath. The 100-degree-F creosote is pumped back into a cold storage tank and 230-degree-F creosote fed to the treating tank. This time the latter temperature is maintained for four hours and then the treating tank is emptied by pumping the hot creosote oil back into a preheating tank. The treated poles or stubs are left in the empty treating tank overnight to allow excess surface creosote to drip off, and are removed from the tank the next day and stored in bins.

At the completion of the treating cycle the wood will have a minimum creosote-oil penetration of 2½ inches from the surface and a creosote-oil retention of 8 to 10 pounds per cubic foot. To check this retention, a test can be made by weighing the wood before and after treatment, the difference in weight giving a fairly accurate measure of the amount of creosote oil the wood has absorbed. To check the depth of penetration a tool called an increment borer is used. This is a hollow, fluted wood drill ⅛ inch in diameter, made of high grade Swedish steel and formed with a T handle. It bores into wood in the same fashion as an ordinary wood drill, but being hollow leaves a thin long plug in the center of the hole when the borer is carefully withdrawn. The entire plug is then removed by using a long, extremely thin extracting tool. Measuring the length of the discolored portion of the wood plug gives an accurate depth of creosote-oil penetration.

New techniques in the telegraph art and advances in transmission engineering have provided carrier and microwave systems which allow large increases in circuit facilities without need for more pole lines. Nevertheless pole-supported aerial cables and open line wires still carry most of the country's telegraph communications. An effective program for preservation of the millions of telegraph poles throughout an area of over three million square miles is essential, therefore, in the efficient maintenance of Western Union's modern communications network.

Mr. Trent's biography appeared in Technical Review for April 1952.

Patents Recently Issued to Western Union

Facsimile Transmitter
J. H. Hackenberg
2,657,259—October 27, 1953

A facsimile scanner intended for concentrator use and adapted to operate a vertical drum. The drum is mounted between a pair of spaced supporting centers, the upper one of which is axially movable for easily inserting or removing the drum. The lower, or driving center, is coupled to the drum by a coupling automatically separable when the drum is removed. A scanning carriage, with scanning elements mounted thereon, moves downward under control of the lead screw followed by a quick return upward at the end of the message.

Optical Scanning Device
R. J. Wise, G. H. Ridings
2,658,940—November 10, 1953

Facsimile transmitter adapted for scanning coded messages on tape including an adjustable lens, prism and aperture optical system disposed between the photocell and tape. The plate bearing the aperture, which determines the scanning area of the tape, is enclosed between a pair of glass plates as dust protection. To provide a tape-out signal for transmission to the receiving end, a disc bearing an appropriate code signal on its surface rotates beneath the tape at the scanning position, but is normally obscured by the tape. Absence of tape permits scanning and transmission of the tape-out signal.

Repeater Switching System
F. B. Bramhall, E. L. Newell,
P. H. Wells, C. H. Cramer
2,658,945—November 10, 1953

A switching arrangement for a submerged repeater which sets up various testing and operating conditions including a repeater by-pass. A relay, responsive to 60-cycle a-c pulses but unresponsive to low frequency cable signal pulses, introduces into the cable circuit a control magnet which, in response to d-c pulses, steps a rotary switch to the desired position. The receiving shore station sends the necessary a-c and d-c pulses, conducts the test, and includes a device for indicating the momentary switch position at the distant repeater.

Facsimile Machine and System Employing Electric Stylus Transmission and Recording
G. H. Ridings, J. H. Hackenberg,
G. B. Worthen
2.647,945—August 4, 1953

A facsimile system employing light portable machines suggested particularly for military radio applications. The message is inscribed with pencil on a sheet having a conducting base and insulating surface coat to provide conducting marks for stylus pickup. The drum type transmitter sends a synchronizing pulse at each overlap period which, at the receiver, releases the reciprocating stylus which traverses the width of the web, with rapid return, for each line. Under adverse transmission conditions, synchronous reception using a local oscillator may be resorted to instead of start-stop phasing. A number of unique vacuum tube circuits enter into the phasing process, the suppression of radio interference by amplitude selection, and pulse shaping.

Interpolating Circuit
A. E. Frost
2,652,452—September 15, 1953

A multiplex distributor for telegraph signals reinserts dot frequency signals lost during transmission over long circuits. The distributor comprises a solid ring connected to positive battery, a segmented ring containing ten segments per multiplex channel, and a brush contacting both rings and synchronized with the transmitter. The grids of a two-tube thyratron trigger circuit are connected to odd-numbered segments through a differentiating network to permit conduction of the tubes alternately, in the absence of input signals, at the dot frequency rate. Input signals are impressed, through relays, on the thyratron grids and overcome the impressed positive voltage from the distributor when signals exceed dot length. The even-numbered segments of the distributor connect to printer magnets via the contacts of a channel selector relay.