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Western Union Teletape Facsimile

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In the application of facsimile to the telegraph industry, development has primarily been directed toward the handling of regular telegraphic traffic in the form of messages on telegraph blanks. The introduction of Western Union's "Teledeltos"[1] recording paper some years ago provided a practical recording medium which was one of the principal things necessary to make facsimile telegraphy a success. Facsimile messages can be recorded directly on Teledeltos paper telegraph blanks, ready for delivery without any special processing or handling.

A number of articles[2] have been published describing the equipment which has been developed by Western Union engineers and is now used on Western Union, railroad and airline facsimile telegraph circuits. Some machines require the message to be manually placed in position on drums, while other machines are self-operating to the extent that it is necessary only to drop a message in a slot of the transmitter. The message is automatically wrapped around a revolving drum, scanned and transmitted to the receiving instrument, where the functions of recording and discharge of the message are again performed automatically.

In all machines of this class, the light-beam scanning and the photoelectric method of pickup are used and recording is accomplished by means of a metallic needle point on Teledeltos paper. During the war, civilian engineers at Camp Coles Signal Corps Laboratory made the discovery that pencil marks on Teledeltos paper provided a convenient medium for conductive pickup. While optical methods of pickup produce excellent copy and do not require special transmitting papers, the cost of the necessary equipment components somewhat restricts the field of application. With the disclosure that Teledeltos paper could be utilized for the purpose of transmitting as well as receiving facsimile messages, an entirely new field for this system of communication became available.

Western Union has subsequently developed facsimile equipment embodying this new type of pickup, specially designed for local intercommunication by means of hand-written messages. The machine used for this purpose is a transceiver which is called the "Teletape". It has been so named because Teledeltos paper in the form of tape provides a convenient and practical way of accomplishing the dual purpose of transmitting and receiving. Two of these small sized Teletape transceivers, located at the terminals of a two-wire circuit, will operate satisfactorily over a distance up to several miles. Messages written directly on Teledeltos tape are scanned, transmitted over the line and reproduced in facsimile form on the tape at the opposite end. Transmission can be carried out in either direction, as the machines automatically function as either transmitters or receivers.

As this is the first time that Teledeltos paper has been used as sending copy, several problems encountered in the development of the system may be of interest. When using Teledeltos for transmitting purposes, the intelligence is impressed on the surface of the paper either by means of a soft lead pencil or from a specially prepared carbon paper. In the Teletape system a pencil is used. As the message is written, the film on the surface of the paper is ruptured and graphite from the pencil forms a low-resistance

[1] Registered Trademark of The Western Union Telegraph Co.

[2] See References.

path through the paper. The paper, which has a conductive backing, rests on a metallic platen and scanning is accomplished by means of a fine metal stylus which is progressed across the surface. As the point of the stylus passes over the paper, the resistance between the stylus and the platen is reduced by several thousand ohms at the points where the film of the paper has been broken and graphite deposited. This resistance change is utilized to produce the actuating impulses for the electrical transmission. For satisfactory operation of this conductive pickup system, it is necessary to use a stylus having a small area of contact and yet of such design that the surface of the paper will not be damaged during scanning.

After the investigation and trial of a number of standard scanning systems, a simplified method was developed for the Teletape in which several of the difficulties encountered in other systems have been overcome. In all facsimile systems there are two fundamental requirements which must be fulfilled. First, the facsimile receiver must run in synchronism with the transmitter, and second, some method must be employed for phasing the machines to insure proper registration of the received message. When both ends of the circuit are powered from the same 60 cycle system, synchronism is automatically maintained; however, phasing is still required and is usually accomplished by means of a phasing pulse from one end of the circuit which, through a system of relays and commutators, orients the machine at the opposite end.

Figure 1 illustrates the principle of the Teletape scanning system. Teledeltos tape having a width of three-quarters of an inch is directed through a concave guide and passes by a rotating four-pointed stylus which brushes over the surface of the paper. This stylus is mounted on the shaft of a small synchronous motor running at 1800 rpm. The concave guide has a radius of exactly one-half inch about the axis of the stylus shaft, and the diameter across the tips of the stylus is slightly in excess of one inch. A narrow recess is machined in the concave guide directly behind the line of contact of the stylus with the tape. Because the radius of the stylus is somewhat greater than that of the concave guide, the tape is slightly depressed into the recess, as it passes by the stylus during scanning. This insures a positive rubbing contact of the stylus tips with the surface of the tape. Furthermore, as the tape passes over the recess in the guide, the edges are flattened just sufficiently to allow the tips of the stylus to miss contact at the extreme edge and prevent cutting the paper.

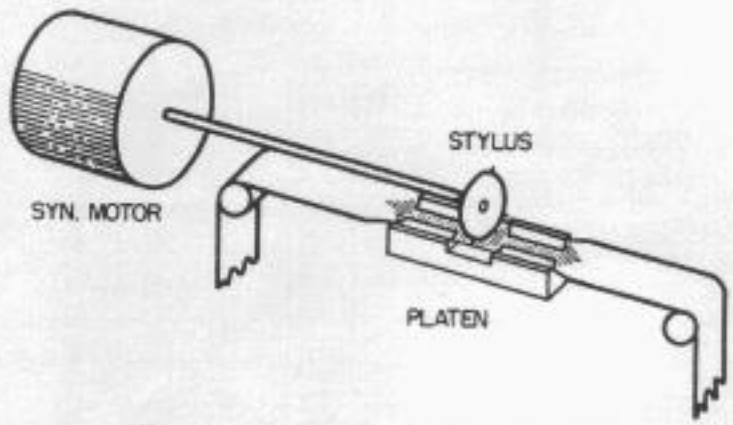

Figure 1. Method of scanning

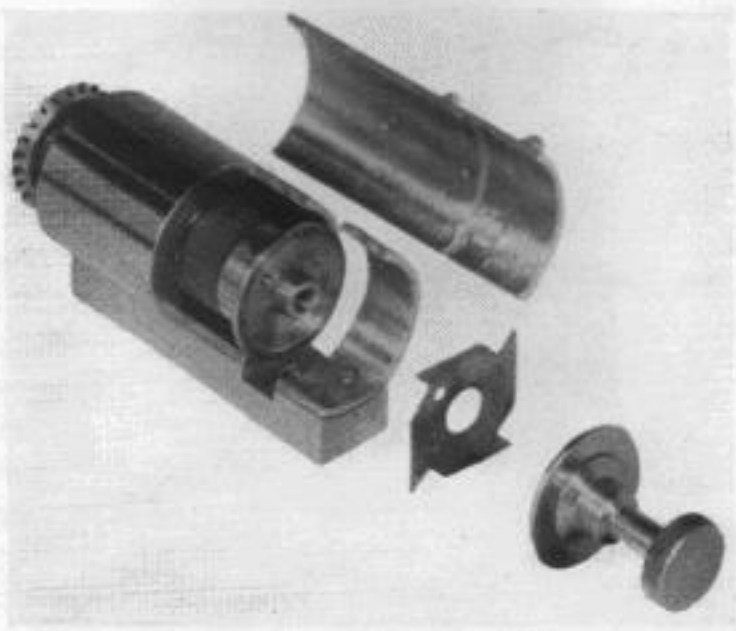

Figure 2. Exploded view of Teletape scanning head

Figure 2 shows an exploded view of the scanning head used in the Teletape machine. A polished cylindrical housing serves as a platen against which the tape is firmly pressed by a concave shoe as it is drawn through the machine. The stylus is a thin four-pointed metal wafer, so constructed that the tips are accurately spaced by 90 degrees and of equal radius. The narrow recess in the concave shoe

aligns with a cut-out portion of the cylindrical housing and the stylus engages the tape at the center of this opening. The cylindrical housing also contains two precision type ball bearings supporting the rotating stylus shaft. On one end of this shaft is a small miter gear which, when assembled in the machine, engages a similar gear mounted directly on the shaft of the synchronous motor. The other end of this shaft carries an insulated stylus mounting, provided with a knurled thumbscrew to hold the stylus rigidly at right angles to the shaft. On the surface of this stylus mounting is a small pin which engages a hole punched in the stylus, thus orienting the stylus in a definite relationship with respect to the motor poles. It will be observed that with a four-pointed stylus, one point for each pole of the 1800-rpm motor, it is not necessary to phase the transmitter and receiver each time they are started. After initial phasing when the machines are installed, providing of course that both the transmitter and receiver are powered from the same 60-cycle system, no phasing is required.

Figure 3 shows a Type 5006-A Transceiver and its associated amplifier-power control unit Type 5046-A. These two units connected together through a twelve-conductor flexible cable comprise one terminal of a Teletape circuit. The transceiver unit consists of the scanning mechanism, a tape reel holding a five and one-half inch roll of Teledeltos tape, and a pull motor for feeding the tape through the

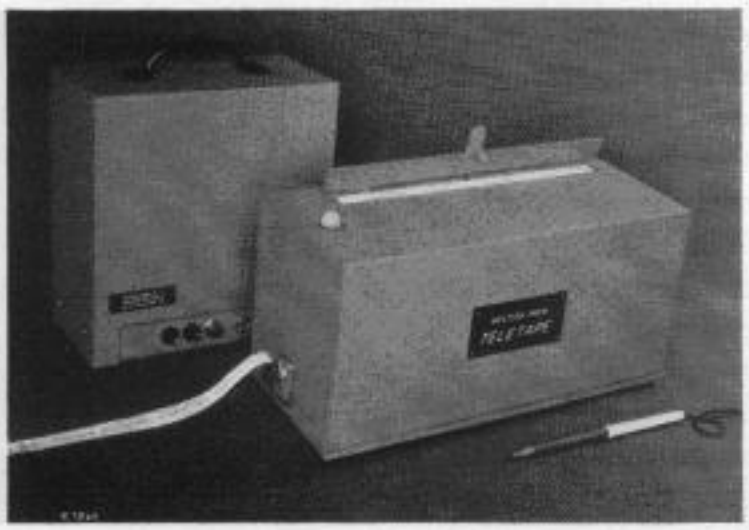

Figure 3. Teletape transceiver with amplifier-power control unit

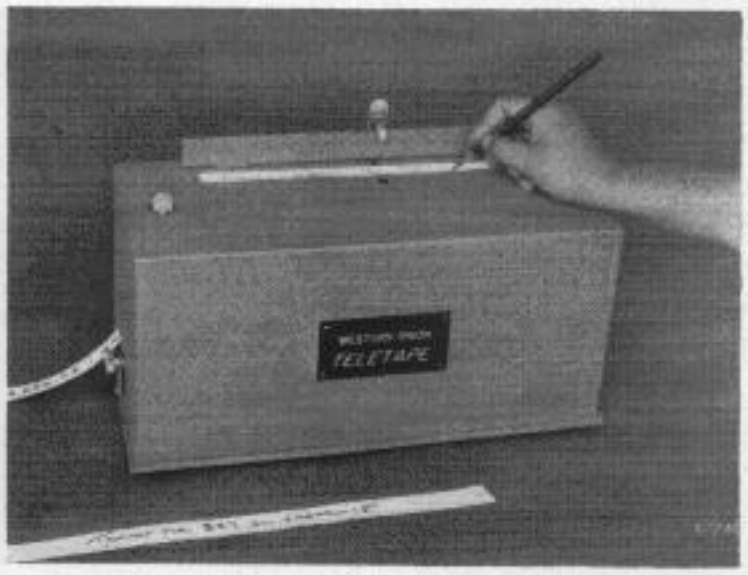

Figure 4. Preparing message for transmission

machine. The amplifier-power control unit contains the transmitting and receiving amplifiers and the necessary relays and power supply equipment. When installed in an office or other terminal position, the transceiver unit is placed in a convenient location for the user, and the power control unit is located in a more or less out-of-the-way place where it is accessible only for turning on and off once a day.

It will be noticed that in the top of the transceiver unit is a long narrow opening. In this opening and flush with the top of the case is a writing platform over which the Teledeltos tape from the storage reel is passed. A hinged cover with a short projecting handle covers this tape guide. In this particular model of the Teletape, the opening and closing of this cover actuates switches which in turn operate the circuit control relays. When not in use, the covers are always left in a closed position to maintain a normal stand-by condition.

To illustrate the operation of the machines, let us assume that station "A" desires to transmit a message to station "B". The operator at station "A" first opens the cover over the tape guide (Figure 4). This is necessary to expose the tape on which the message is to be written, but as the cover is opened, a circuit is made which lights indicating lamps at both stations "A" and "B". At the same time, cover locks at both stations are energized and the cover over the tape guide at station "B" is now locked in a

closed position until the completion of the transmission. This prevents the operator at station "B" from attempting a simultaneous transmission. The operation of opening the cover at station "A" also energizes relays at both ends of the circuit, so that station "A" will function as a transmitter and station "B" as a receiver for this particular transmission. After the operator at station "A" has written his message on the tape, he closes the cover. This operation of closing the cover starts the motors and scanning mechanisms at both terminals and transmission is accomplished. At the end of the message both machines are automatically stopped and restored to a stand-by condition, ready for the initiation of another transmission from either end. When the cover at station "A" was closed, it also was latched to prevent further opening until this message had been completed.

Should station "B" desire to transmit to station "A", the same functions are carried out in a reverse direction. Opening the cover at either end of the circuit preempts the circuit for transmission from that end and at the same time prevents the operator at the opposite end from attempting to initiate a transmission.

Figure 5 is a view of the interior of the machine. It shows the relationship of the scanning head, tape reel and writing platform and the tape-pulling gear with its associated motor. The scanning head motor located behind the supporting bracket drives the scanner through a miter gear. It is mounted on a circular plate capable of rotation about the center of the motor shaft, by which means the relationship of the motor to the stylus may be conveniently changed for initial phasing purposes. It will be observed that as the tape leaves the writing guide, it passes over a roller and then assumes the concave form in passing through the scanning head. It thence passes over a second roller and through the draw-off mechanism.

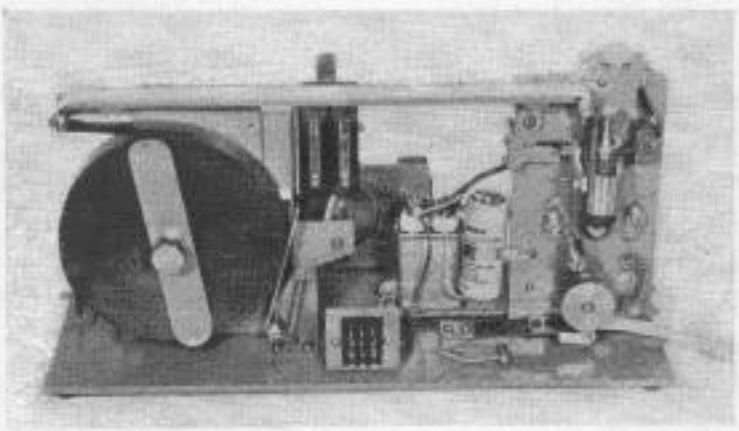

Figure 5. Inside view of transceiver showing scanning mechanism

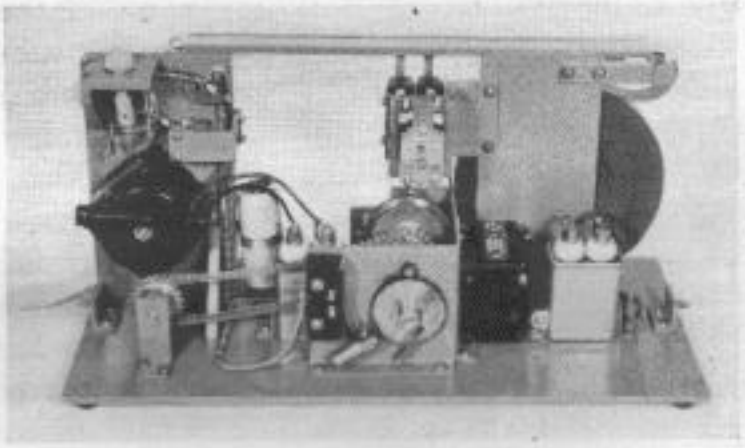

Figure 6. Inside view of transceiver showing tape pull-off mechanism and stop switch

Figure 6 shows the reverse side of the machine. The tape draw-off motor as well as the scanning motor is of the synchronous type. Connected through a reduction mechanism from this motor is a low-speed gear which makes one complete revolution during the transmission of a single message. A lever on this gear wheel actuates a trip switch just as the end of the written message is exposed out of the side of the machine. The motors of both machines are thereby stopped at the same instant at the end of each transmission.

As mentioned before, a-c power to the machines can be turned on at the beginning of the day and turned off at night. This insures that the amplifiers are in a warmed-up condition and ready for instantaneous operation. In order that the operator at one end of the circuit can be assured that the equipment at the opposite end is in an operating condition and ready to receive messages, a series line switch is incorporated with the power switch. The initiating circuit which is energized when either cover is opened, is a series circuit through both line switches. Therefore, if, when the operator at one end lifts the cover on his machine, the signal lamp at his end does not light, he knows that

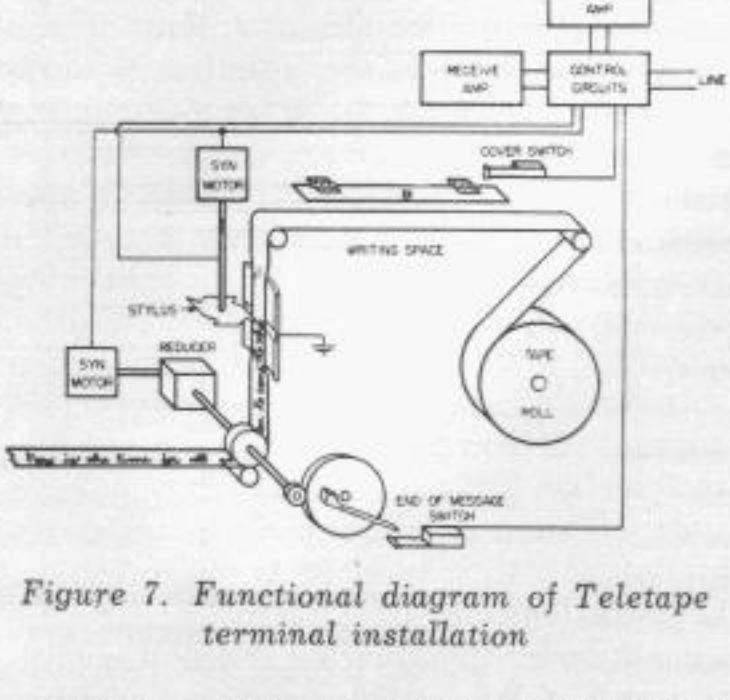

Figure 7. Functional diagram of Teletape terminal installation

power has not been applied to the distant end and no message can be transmitted.

Figure 7 is a functional diagram showing a Teletape terminal installation. In this particular model of the Teletape, the length of exposed tape in the tape guide on which a message may be written is eleven inches. The transmission time for each message is eighteen seconds. The tape reel holds a 600-foot roll of tape, sufficient for a total of about 325 messages. The styli used at present are hardened steel and each stylus has a life of between three and four hundred messages. A worn stylus may be easily replaced by the operator. Development work is still in progress to determine whether any other materials or forms would be more satisfactory for multi-pointed styli.

The interior of the amplifier-power control unit is shown in Figure 8. On the lower chassis are the signal control relays and the power supply. The upper chassis carries two amplifiers, one for transmitting and one for recording. The conversion of the written message to electrical impulses is somewhat unique in that the circuit from the stylus through the Teledeltos tape to ground forms one arm of a Wheatstone bridge, the output of which is fed to the transmitting amplifier. The signal frequency applied to the bridge is generated by a 5000-cycle local oscillator. This comparatively high frequency is dictated by the high scanning speed of 94 inches per second, employed in this system. If the bridge is balanced for background resistance, positive transmission results, because a pencil mark on the tape unbalances the bridge with consequent signal to amplifier. Conversely, if the bridge is balanced for a solid mark on the tape, negative transmission results. Practice limits line input levels to about zero dbm and one stage of amplification following the bridge is more than adequate to fulfill this requirement. The recording amplifier consists of a voltage-amplifier triode, and a power-amplifier pentode which has a high impedance output to the recording stylus. Adequate gain is provided so that this equipment may be operated over lines with as much as thirty db loss.

Another design of the Teletape transceiver is shown in Figures 9 and 10. In this model, both the transceiver unit and

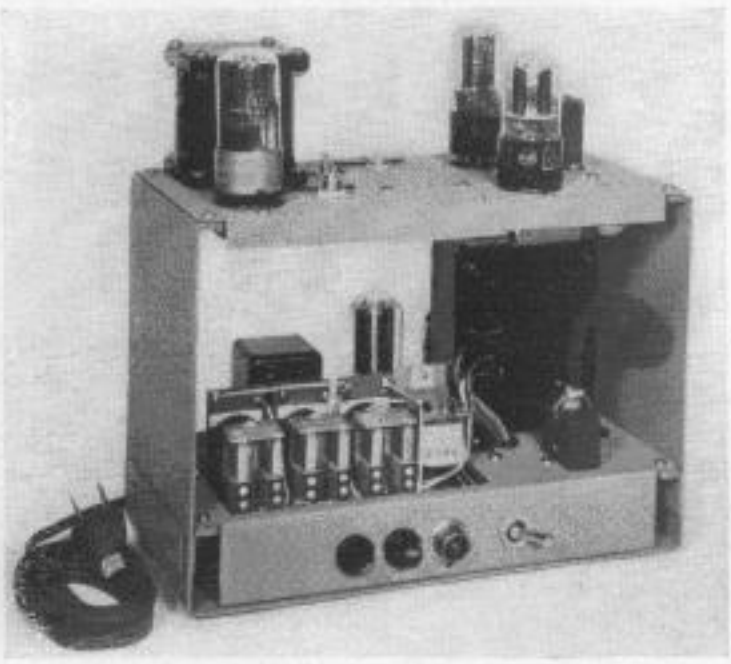

Figure 8. Interior view of amplifier-power control unit

Figure 9. Transceiver with self-contained amplifier and control unit

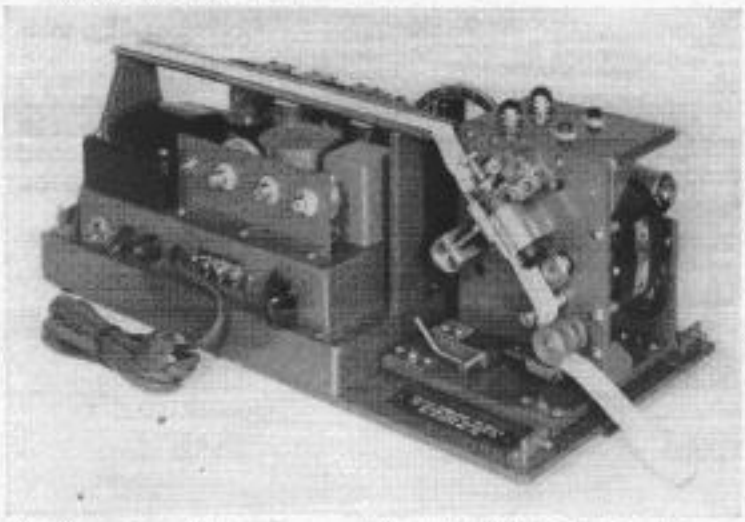

Figure 10. Interior view of transceiver with self-contained amplifier and control unit

the amplifier and control unit are mounted in one assembly. The tape reel is housed in a sliding drawer under the electronic equipment. The cover over the tape track has been eliminated in this model and circuit control and transmission are accomplished by means of two push buttons.

From the foregoing description it will be evident that Teletape, utilizing facsimile as a means of transmission, will have numerous applications in intercommunication systems. It provides a means for the speedy transfer of written intelligence from one point to another. It does not require the immediate attention of the recipient and it can be handled by anyone without the need for special training in its operation. There are many instances where such a system is desirable. A specific application is the linking of a teller in a branch bank with the bookkeeping department, located in another building. Another application is the connection between a ticket clerk and the reservation bureau, such as found in railroad stations and airline offices. Dispatching systems and quotation services also present possibilities for this type of communication. Teletape equipment is now undergoing tests in order to explore its field of usefulness and to determine operational requirements, with a view to its subsequent manufacture and distribution.

References

FACSIMILE TELEGRAPHY, SOME NEW COMMERCIAL APPLICATIONS, J. H. HACKENBERG, *Electrical Communication*, volume 18, No. 3, January 1940.

THE HANDLING OF TELEGRAMS IN FACSIMILE, R. J. WISE and I. S. COGGESHALL, *Proceedings of IRE*, volume 29, No. 5, May 1941.

THE APPLICATION OF FACSIMILE TO COMMERCIAL RECORD COMMUNICATIONS, R. J. WISE, *presented before the Twenty-Second (Annual) Session of the Telegraph and Telephone Section, Association of American Railroads.*

TRAIN ORDERS BY FACSIMILE TELEGRAPH, J. H. HACKENBERG and G. H. RIDINGS, *Electrical Communication*, volume 21, No. 2, 1943.

THE AUTHOR: L. G. Pollard joined Western Union in 1922, after graduating from the University of Vermont, and for the next three years was engaged in research work under the Transmission Engineer. In 1925 he was transferred to Water Mill, to assist in the organization of the laboratory which is now the Electronics Division of the Development and Research Department. In this undertaking, his ability in every phase of the Laboratory's work was soon demonstrated. During the war, Mr. Pollard was put in charge of the model shop, where he was responsible for final designs and production of specialized devices for the Army and Navy. In 1943 he became Assistant Electronics Research Engineer, second in charge of the Laboratory. He has recently contributed many new developments to facsimile design and directed the construction of new facsimile equipment.