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CONTENTS FOR OCTOBER 1961

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INDEX

For contents of Technical Reviews published previous to 1958, see separately printed Index for 1947 — 1957

For Index January 1958 — October 1959 see Vol. 13, No. 4, October 1959

For Index January 1960 — October 1961 see Vol. 15, No. 4, October 1961

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VOLUME 15
NUMBER 4

H. JORGENSEN, Senior Project Engineer, Patron Systems

Plan 115 Switching System

Western Union Switching System Plan 115 is designed to place at the disposal of private wire communication users a versatile arrangement, readily installed, easily maintained and simple to operate. Success with initial installations of this system prove, it is believed, that this purpose has been accomplished.

In today's electronic world, with thousands of "bits" of information being recorded in seconds on magnetic tape, and with increasing emphasis being placed on satellite communications, it may seem quite a comedown to speak about a new development operating at a maximum of 75 bits per second or 100 words per minute. Yet, it is a fact that a large percentage of wire communication networks still operate at speeds of 60 to 75 words per minute.

Plan 115 uses the single circuit principle of operation; the most economical method of exchanging traffic between stations on the same circuit. As many as 20 stations can be accommodated on one circuit. Teletype's new Model 28 automatic send-receive sets are used at all stations. Speeds of operation can be 60, 75 or 100 words per minute depending on the type of gears installed on the ASR sets and the type of circuit ordered.

A Plan 115 user may start with a circuit operating at 60 words per minute. As his message load increases or more stations are added to the system, he may have 75 or 100 words per minute operation simply by ordering a change in gears and a higher speed circuit. No exchange of equipment is required for speeds up to 100 words per minute.

To obtain maximum utilization of line time, the transmitter of the Model 28 ASR set is normally used for all transmissions and each transmitter on the circuit is invited to send in rapid sequence. To accomplish this, one station, acting as a control station, initiates the invitation-to-send to each station sequentially as the circuit becomes idle. When an invitation-to-send sequence is transmitted over the line one of two things happens; either the invited transmitter starts immediately, in which case the control station waits until a message ending is sensed to invite the following station, or a "no traffic response" is received, in which case the next station in the sequence is invited immediately.

Each station on the circuit is assigned two identification codes; an "invitation-to-send" code and a "call", each of which consists of two letters. The first letter of the invitation-to-send code is the same for all stations. The second letter is different for each station on a circuit. The first letter of the call code is the circuit call and is the same for all stations on one circuit. The second letter is different for each station and would normally be the same as the second letter of the invitation-to-send code.

For example, if an invitation-to-send code for a station is "XB", the call code would be "AB". Figure 1 shows one method used in assigning the identification codes.

Plan 115 operating procedure requires the transmission of only the identification code of the receiving station followed by a space and a message ending code after the text. If more than one station is to receive the message, the identification code for each called station is added in direct sequence without a space character intervening. This is necessary because the space acts as a cutoff for all other stations on the circuit.

In the Plan 115 switching system the sending station is automatically cut in on the circuit. It is not necessary to include the originating station code as it is in some other systems.

Generally, multipoint systems use selector equipment housed separately, either adjacent to the telegraph units or at a re-

TYPICAL CALL LETTERS AND INVITATION TO SEND PATTERN									
		CIRCUIT "A"			CIRCUIT "B"			CIRCUIT "—"	
STA	CODE	CALL LTR	INV TO SEND	CODE	CALL LTR	INV TO SEND	CODE	LTR	INV TO SEND
1		AB	XB		BA	XA			
2		AC	XC		BC	XC			
3		AD	XD		BD	XD			
4		AE	XE		BE	XE			
5		AF	XF		BF	XF			
6		AG	XG		BG	XG			
7		AH	XH		BH	XH			
8		AI	XI		BI	XI			
9		AJ	XJ		BJ	XJ			
10		AK	XK		BK	XK			
11		AL	XL		BL	XL			
12		AN	XU		BN	XN			
13		AP	XP		BP	XP			
14		AQ	XQ		BQ	XQ			
15		AR	XR		BR	XR			
16		AS	XS		BS	XS			
17		AU	XU		BU	XU			
18		AW	XW		BW	XW			
19		AY	XW		BY	XY			
20		AZ	XZ		BZ	XZ			
CKT BCST CALL		A=			B=			— —	

NOTES

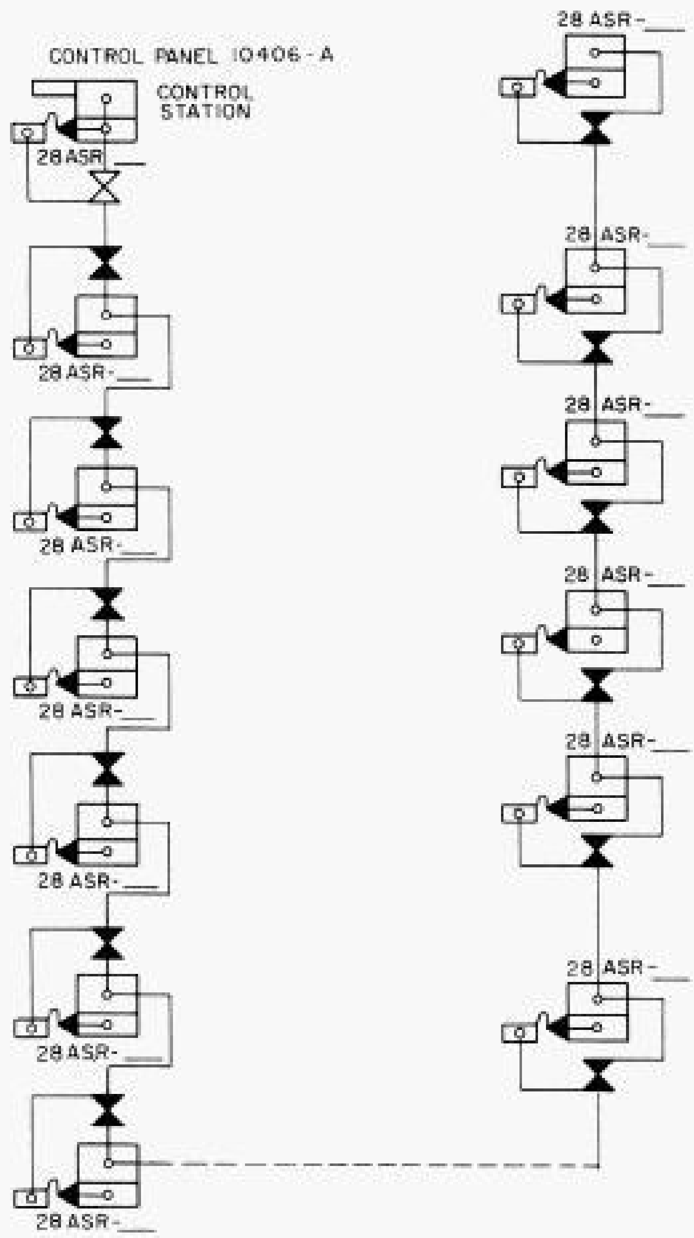
A:— M,O,T,V,& X CAN NOT BE USED AS STATION CALL LETTERS.

B:— "X" IS FIRST LETTER PRECEDING INVITATION TO SEND.

C:— ANY WAY STATION OPERATED WITH WAY STATION SELECTOR 10414-A CAN BE, OPERATED AS A CONTROL STATION BY THE ADDITION OF A CONTROL SHELF AND A CONTROL PANEL.

D:— A MAXIMUM OF 20 OUTSTATIONS, INCLUSIVE OF THE CONTROL STATION, CAN BE USED ON THIS SYSTEM.

TYPICAL CIRCUIT LAYOUT



NOTE

ONLY 28 ASR SETS 1A, 1B, 1C, OR 1D MAY BE USED AS DESCRIBED BELOW:—

TYPE	DESCRIPTION	OPERATION
28 ASR-1A	— LPE - NON TYPING PERF.	— PUNCH ONLY
28 ASR-1B	— LRPE - NON TYPING RE-PERF.	— PUNCH & REPUNCH
28 ASR-1C	— LTPE - TYPING PERF.	— PUNCH & PRINT
28 ASR-1D	— LPR - TYPING RE-PERF.	— PUNCH REPUNCH & PRINT

THE STATIONS SHOWN CONSIST OF 28 ASR-1A SETS

LEGEND

— SINGLE CKT

⧖ CONTROL STATION SELECTOR - 10410-A

⧗ WAY STATION SELECTOR - 10414-A

Figure 1. Plan 115 Typical Circuit Layout

mote location necessitating cable runs between the two units. In the Plan 115 design the selector is housed within the Model 28 ASR console, and at the control station the control panel is fastened to the outside of the console thus removing the requirement for any additional space. The arrangement is shown in Figure 2. As indicated, the total floor area required is 42″ x 18½″.

The selector, a self-contained unit with its own power supply, is connected within the ASR set by a multiwire connector plug and socket. At the control station the same method of interconnection is employed. This packaging makes it possible to assemble and test a complete station at our shops with a minimum of installation and testing work done on the customer's premises. In addition, the relays and rotary switches are "plug in" units, facilitating "swap-outs". It may also be pointed out that all relays used in Plan 115 are identical. One signal relay can be plugged into any component of the circuitry of the selector. For the information of those who

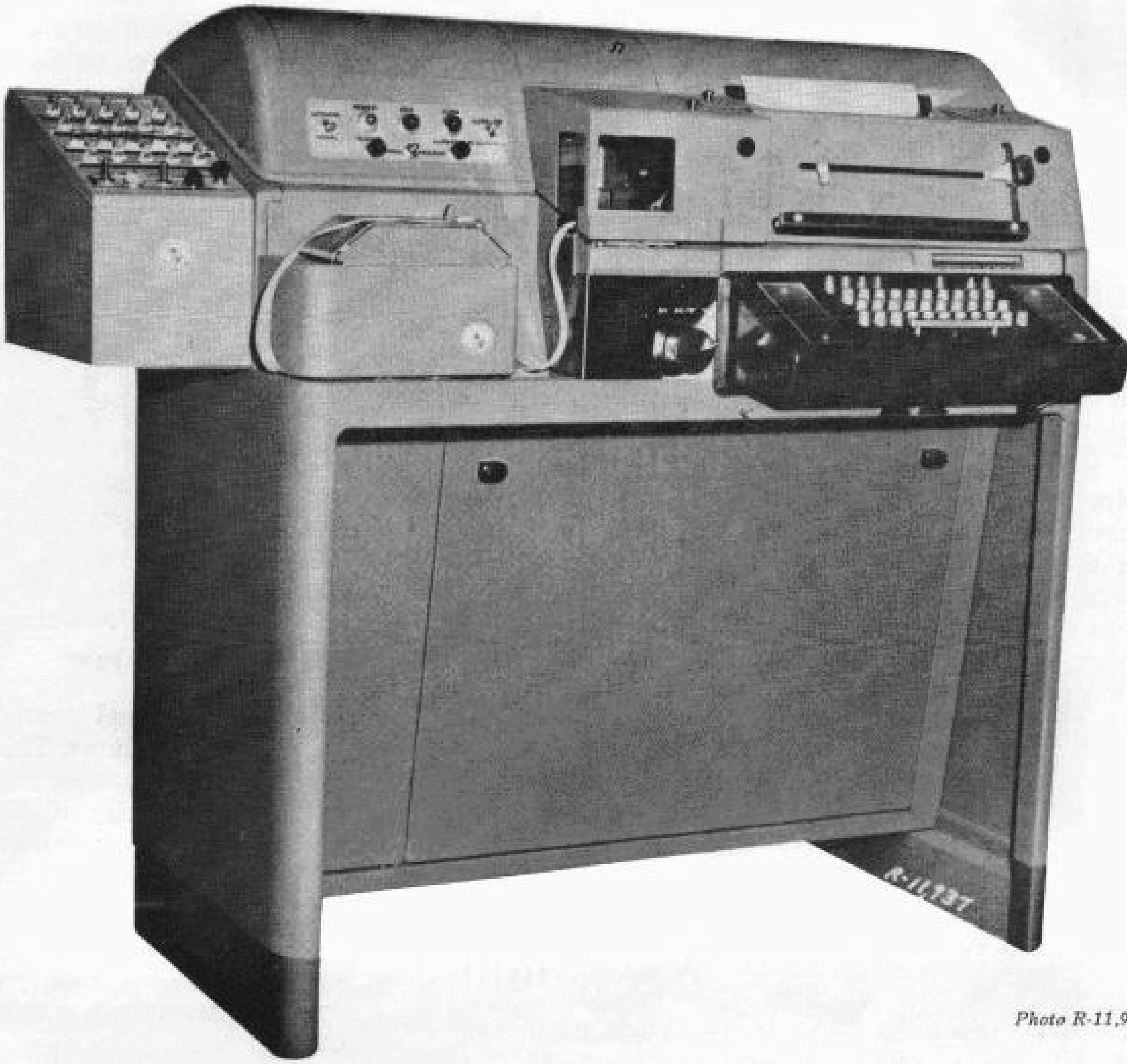


Photo R-11,937

Figure 2. Control Station Selector 10410-A

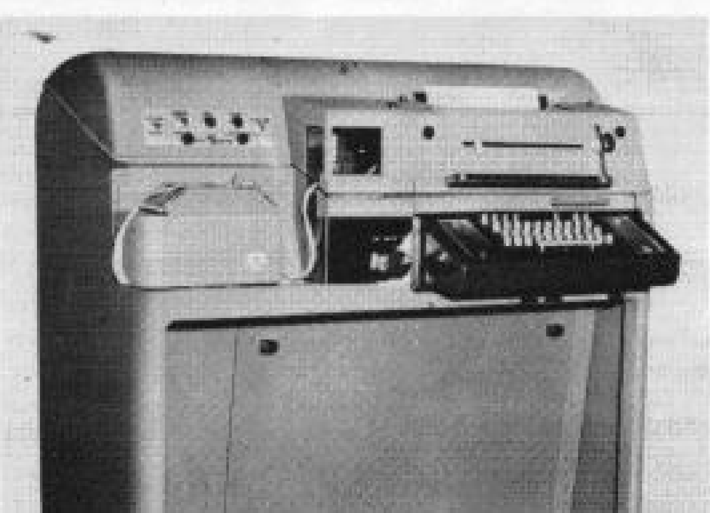


Photo R-11,939

Way Station Selector 10414-A

may have heard remarks about "relay contact trouble" in various other switching systems, Plan 115 uses "twin contact" relays. These new type relays are expected to give longer trouble-free service than single contact relays provide.

One circuit can accommodate a total of 20 send and receive stations. At the time of installation, the control station is equipped to originate 20 "invitations-to-send" even though fewer stations may be installed. This gives the user two advantages. First, where less than 20 stations are on a circuit, a selected number of stations with heavier message loads can appear more than once during one invitation-to-send cycle. Second, where additional stations are to be added later, no additional work is required at the control station ex-

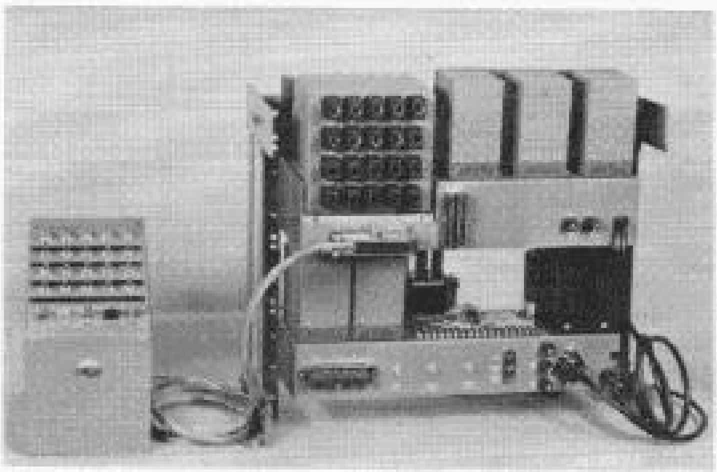


Photo M-4083

Control Station Components

cept rearranging the coding plugs. The method used to accomplish this is unique in that each of the 20 invitation points

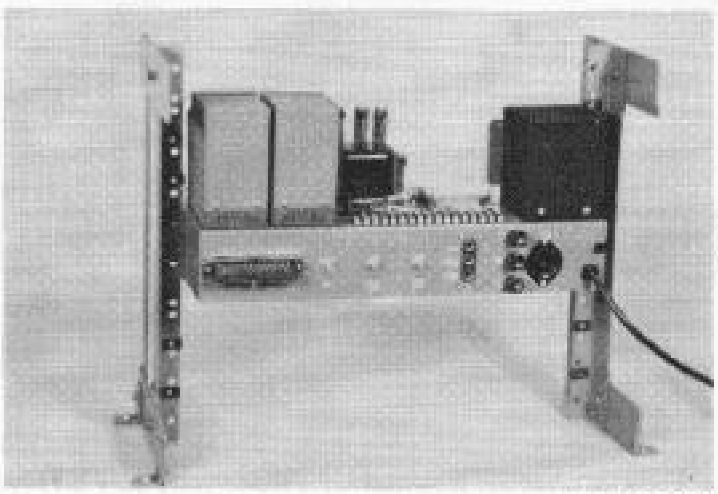


Photo M-4084

Way Station Selector Shelf 10413-A

appear on individual sockets. Matching plugs, coded for the desired stations, are inserted into the sockets. By this means,

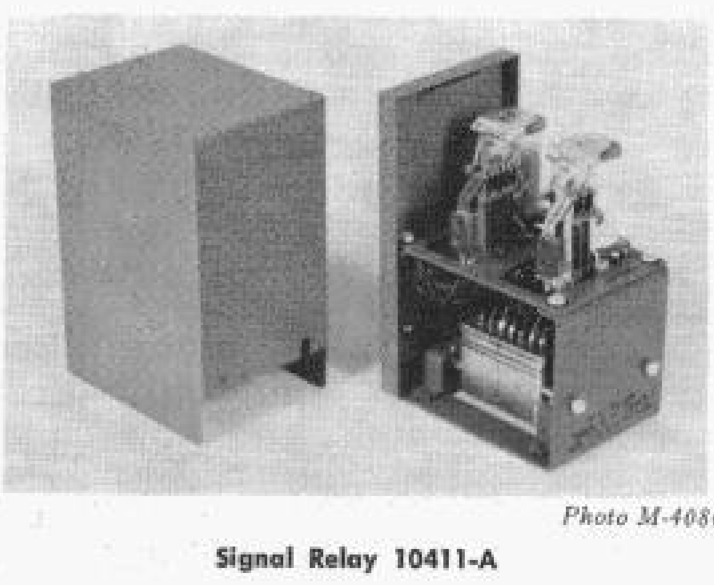


Photo M-4086

Signal Relay 10411-A

flexibility is achieved in setting up a pattern to match the load requirements of a circuit. Also, any change that may be required, at any time, is accomplished by merely moving or swapping out plugs.

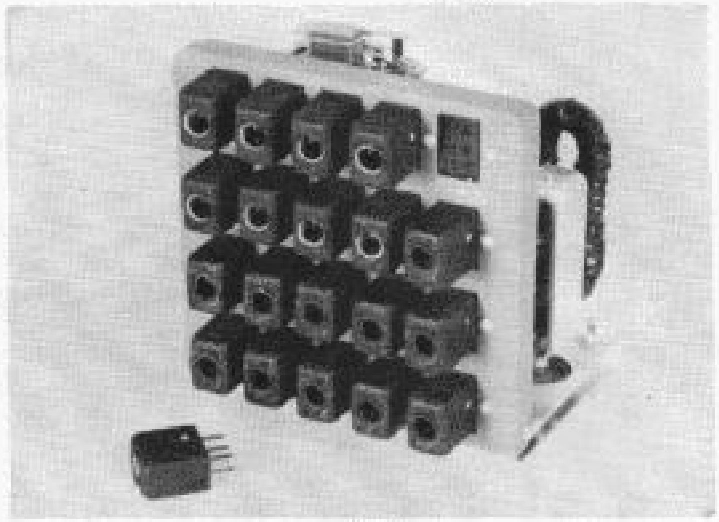


Photo M-4087

Rotary Switch 10431-A with coding plugs

Figure 3 shows the control panel located above the transmitter at all stations. This panel is used to operate the station and indicate the condition of the circuit. To illustrate its use let us assume a message to be transmitted has been prepared as follows:

↓↓↓↓↓↓	= LETTERS. PERMITS EASY INSERTION OF TAPE INTO THE TRANSMITTER (LEAD TAPE)
A	= CIRCUIT CALL. PREPARES ALL STATIONS TO RECEIVE STATION CALL.
B	= STATION CALL. PREPARES STATION "B" TO RECEIVE MESSAGE AND SEND ANSWER-BACK.
■	= SPACE. LOCKS STATION "B" IN AND ALL OTHER STATIONS OUT.
TEXT	= ADDRESS AND BODY OF MESSAGE IS DESTINED FOR STATION "B".
↑H↓↓↓↓↓↓↓↓	= FIGURES H 7 LETTERS (OR MORE). DISCONNECTS BOTH STATIONS AND PREPARES ALL STATIONS TO RECEIVE. INITIATES INVITATION TO SEND TO NEXT STATION IN SEQUENCE.

The tape is placed in the transmitter and is positioned to permit at least one letters character to be transmitted first. The request button on the control panel is depressed. The request lamp (above the button) will light if the following conditions are met:

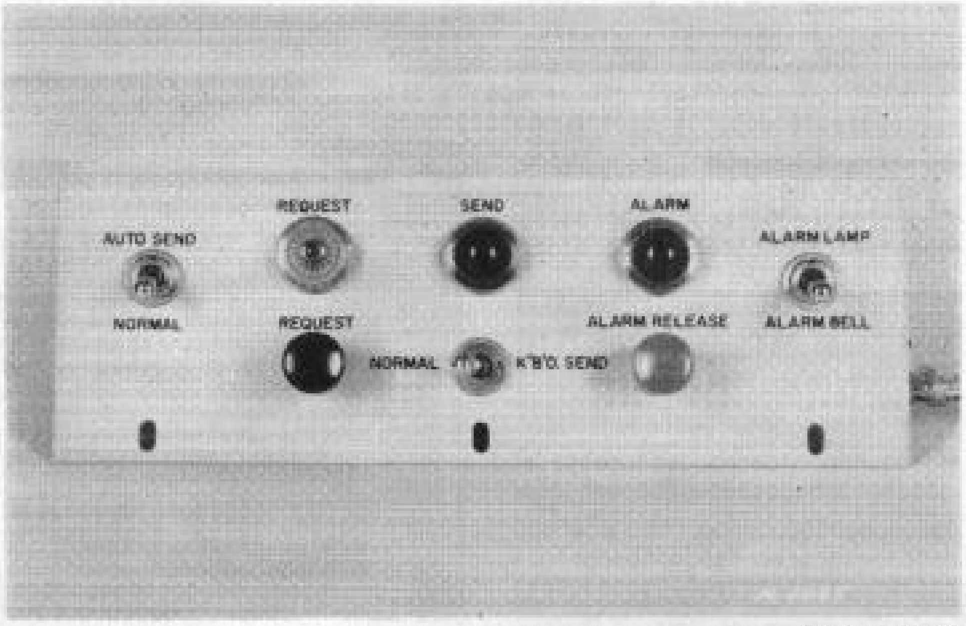
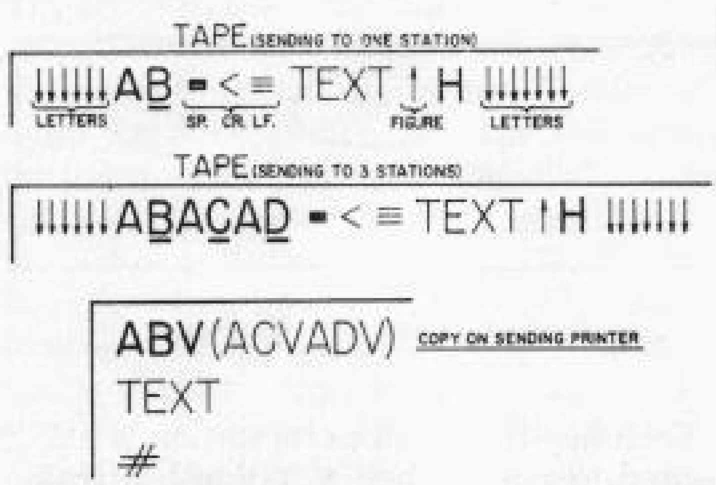


Photo M-4085

Figure 3. Control Panel 10412-A

1. Tape correctly placed in transmitter (tape latch down and tape-out pin covered)
2. TD switch is in the "run" position.

With the request lamp lighted the station is prepared to seize the circuit upon receipt of its "invitation-to-send". When this invitation is received, the send lamp will light. The transmitter starts, transmits the letters "AB", then stops awaiting receipt of the answer back.



Plan 115 Tape Format

The AB is recorded on the printer at the sending station. The selected station, in response to its call, sends a "V" answer back which is also recorded on the printer at the sending station.

Upon receipt of the letter V, the transmitter is restarted and space is now transmitted, then the text and FIGURES H LETTERS. After sending FIGURES H LETTERS, the transmitter stops and the request and send lamps on the panel are extinguished.

During the period when LETTERS AB V SPACE is transmitted the transmitter is under the control of the selector which senses these combinations. Should a character other than A (circuit call) appear in the tape the transmitter will stop. If a combination other than V SPACE is received, the transmitter will also stop. In effect, the transmitter is guarded against transmitting a wrong circuit call and also against transmitting a message unless an answer back is received. In addition, the sequence ABV recorded on the printer is a positive indication that the selected station was called and that an answer back was received. Where more than one station is to receive the message an additional call code is sent out immediately after the answer back from the previous station is received. The only restriction is that a space must **not** appear between the call codes.

Referring again to Figure 3, the alarm lamp will light whenever an abnormal condition is sensed by the selector such as when the answer back V is not received from a station or whenever transmission stops during a connection. Depressing the alarm release push button will extinguish the lamp. Proper action should, of course, be initiated by the operator as a result of the alarm condition.

Adjacent to the alarm lamp is a switch marked ALARM LAMP—ALARM BELL. Moving this switch to alarm bell will give an audible signal whenever the alarm lamp is lighted. This is useful whenever an operator, busy with other duties, is not directly observing the transmission.

The switch marked AUTO SEND-NORMAL, located on the left side of the panel, provides a feature which, we believe, is exclusive with Plan 115. With the switch positioned to "auto send", it is possible to prepare a continuous tape containing a number of messages for different stations. With the switch in the auto send position the request is stored; therefore, the transmitter will restart automatically at each invitation to send. The switch must be returned to normal during transmission of the last message otherwise the station will remain in a false-request condition. However, if the switch is in the normal position and torn tape methods are used, a false request will not occur regardless of the number of letters characters left in the tape.

A third switch is located in the center of this panel marked NORMAL — KEYBOARD SEND. This switch is only used in the event that the transmitter or tape punch unit becomes inoperative. The keyboard also can be utilized whenever a patron requires a conference arrangement. Procedures for setting up a conference must be established and should be under the control of the control station.

At the designated control station an additional control panel, installed on the left side of the console as shown in Figure 4, is used to observe and control the operation of the circuit. The four rows of five keys each are of the illuminated press-turn type. A card holder, located below each row of keys, is used to indicate the identification code for each station on the circuit.

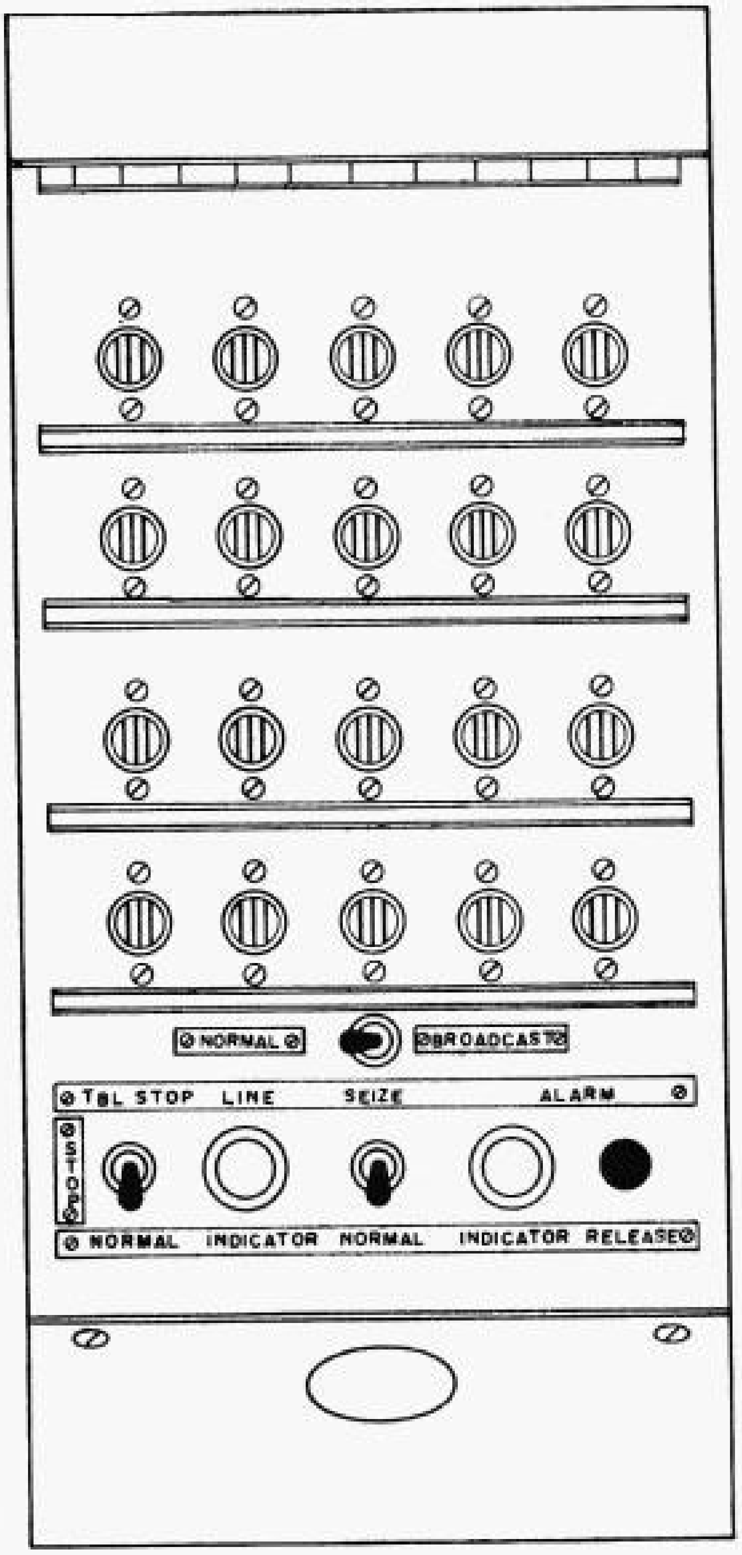


Figure 4. Control Panel 10408-A

Each key is lighted as its station is being invited to send. When a station has traffic to send, the key for this station remains lit during the transmission period. As the station disconnects, the next key is lighted.

By observing the keys, the traffic condition of each station will be known. For example:

1. By the length of time a key remains lit,
2. Whether the station sends every time it is invited,
3. If a station functions properly.

When it is desirable to remove a station from the invitation-to-send cycle, the associated key is turned to its horizontal position. This is done in those instances where the circuit operates in different time zones, or when a station goes "off line". The latter operation should be done only on a scheduled basis since a station cannot send unless invited.

Plan 115 Invitation Sequence

Below the group of keys is a row of two switches, two lights and a push button. The lamp to the left, "line indicator" indicates activity or pulses transmitted over the circuit. When the circuit is idle, the lamp is dark; when signals are transmitted, the lamp flickers. Several conclusions can be reached by observing this lamp. For instance, when a station is sending (key illuminated), the "line indicator" lamp should flicker continuously. If it remains dark, transmission has stopped and the line is idle (closed). If the lamp remains lit, the line is open. With some practice it is possible to observe invitation to send, answer back, whether one or more stations are called in during one transmission, and other operating conditions.

The "alarm indicator" lamp lights and remains lit until released by the adjacent "release button" whenever a station fails to acknowledge the receipt of its invitation-to-send code.

To the left of the "line indicator" is a three-position switch marked TROUBLE STOP — STOP — NORMAL. This switch is used to control the operation of the invitation to send. In the "normal" position, invitations to send take place in the regular manner. In the "stop" position the invitation cycle is stopped. The "trouble stop" position is used to pin point a station failing to respond to its invitation-to-send code. As was brought out previously, invitations take place whenever the circuit is idle. Should a station fail to send a "no" traffic response, rather than stop all action, the invitation cycle is continued after a short predetermined period. With the switch in the trouble stop position, the cycling will stop at this station and appropriate steps must be taken to correct any malfunctions at the station.

The seize-normal switch in its normal position interconnects the controls for the normal operation of the circuit. Moving this switch to the seize position deactivates certain automatic control functions and enables an operator at the control station to perform these operations manually from the keyboard. This type of operation is used when a station requests a conference setup with one or more stations without the restrictions normally imposed. During normal operation a station receiving a message cannot transmit to the sending station since it has not received an invitation to send. However, with the switch in the seize position, these functions are performed manually by the control station operator. All stations to be included in the conference are both "called in" and "invited to send" thereby enabling the stations selected for a conference setup to communicate with each other. During a conference, no additional stations will be invited to send. Therefore, it is good procedure to notify all stations beforehand that a conference setup is to be made and how long it is expected to continue.

Where a patron having more than one circuit requires the ability to broadcast to all circuits a switch is added above the seize-normal switch. Moving this switch to broadcast on each control panel connects a preselected transmitter of one of the Model 28 ASR sets for transmission to all stations by the use of one broadcast call. Before start of transmission, all circuits must be in their idle condition.

This concludes a short description of Western Union's new Plan 115 switching system. To sum up, it is believed that the system will fit into a variety of new and existing telegraph applications, both large and small. The continuous invitation to send and the associated alarms act as a circuit assurance feature. The circuit utilization in Plan 115 is high, the operating procedure is simple, and the equipment is compact thus providing the versatility, plus the ease of operation and of maintenance for which the system was designed and the monthly rental is relatively low.

Methods of expanding the application of Plan 115 are under development and it is hoped to have the new features available in the near future.

HJALMAR JORGENSEN, a native of Bergen, Norway, emigrated to the United States in 1928 and became a naturalized citizen.

Mr. Jorgensen joined the Postal Telegraph Company upon his arrival from Norway and after a brief training period was assigned to contact customers in connection with the installation and operation of tieline printers. Shortly thereafter he was transferred to the Semi-Automatic group of Postal where he worked on the packaging and installation of this equipment for a number of Semi-Automatic Postal and Signal Corps switching centers.

Following the merger of Postal and Western Union Mr. Jorgensen joined the Patron Systems Engineer's section in 1945. He has since been responsible for the design, packaging and installation procedures of patron leases and private wire switching systems and the adaptation of this equipment to individual Patron's requirements.

DOUGLAS M. ZABRISKIE came to the company with the Western Union-Postal merger. He had joined the Engineering Department of Postal in 1922, after two years in the U. S. Army, and in 1925 was appointed chief draftsman. From 1940 until the merger, as chief designer he directed the design of mechanical equipment for Postal's semiautomatic tape reperforator switching system, which was installed in many cities and later adopted by the U. S. Signal Corps for their administrative network. Mr. Zabriskie continued in the same capacity for Western Union and worked on the Signal Corps project until its completion in 1945. He was then assigned to the Facsimile Research Engineer's staff and subsequently placed in charge of machine design. His activities in Telefax equipment have resulted in seven patents issued to him as sole inventor, and five issued jointly with others.

DOUGLAS M. ZABRISKIE, Senior Project Engineer — Facsimile

Application of "Gilmer-Type" Belts to Weatherfax Recorders

RECORDING equipment, furnished by Western Union and employed in the Air Force weathermap network[1] and at most of the Air Force drops on the Weather Bureau network, was developed and manufactured by the Westrex Corporation. The RJ-3-1000 Weathermap Recorder, of which there are now approximately 380 in the network service, is a continuous-type facsimile recorder using an endless steel belt as the carrier of three equally spaced recording styli.

After the inauguration of the weathermap network service by Western Union, steel belt breakage developed into a serious supply and maintenance problem. The average life of a steel band on a continuously operated circuit is approximately one month. At a cost of $40 per belt, in addition to the cost of maintenance calls, the gravity of the situation was obvious. However, this problem was solved as described hereinafter.

The steel belt has an annular groove which, when engaged with a mating ring imbedded in the pulley rims, serves to prevent disengagement from the pulleys. It is driven by a dual motor drive mechanism consisting of an idler "sync" pulley located at the left side of the scan line, the function of which is merely to support the belt. An arm rotating concentrically with the sync pulley and driven by a synchronous motor through a unidirectional coupling, engages lugs which are equally spaced, and attached to the belt. The belt, overdriven by the "run" pulley, is held back to synchronous speed by the sync arm.

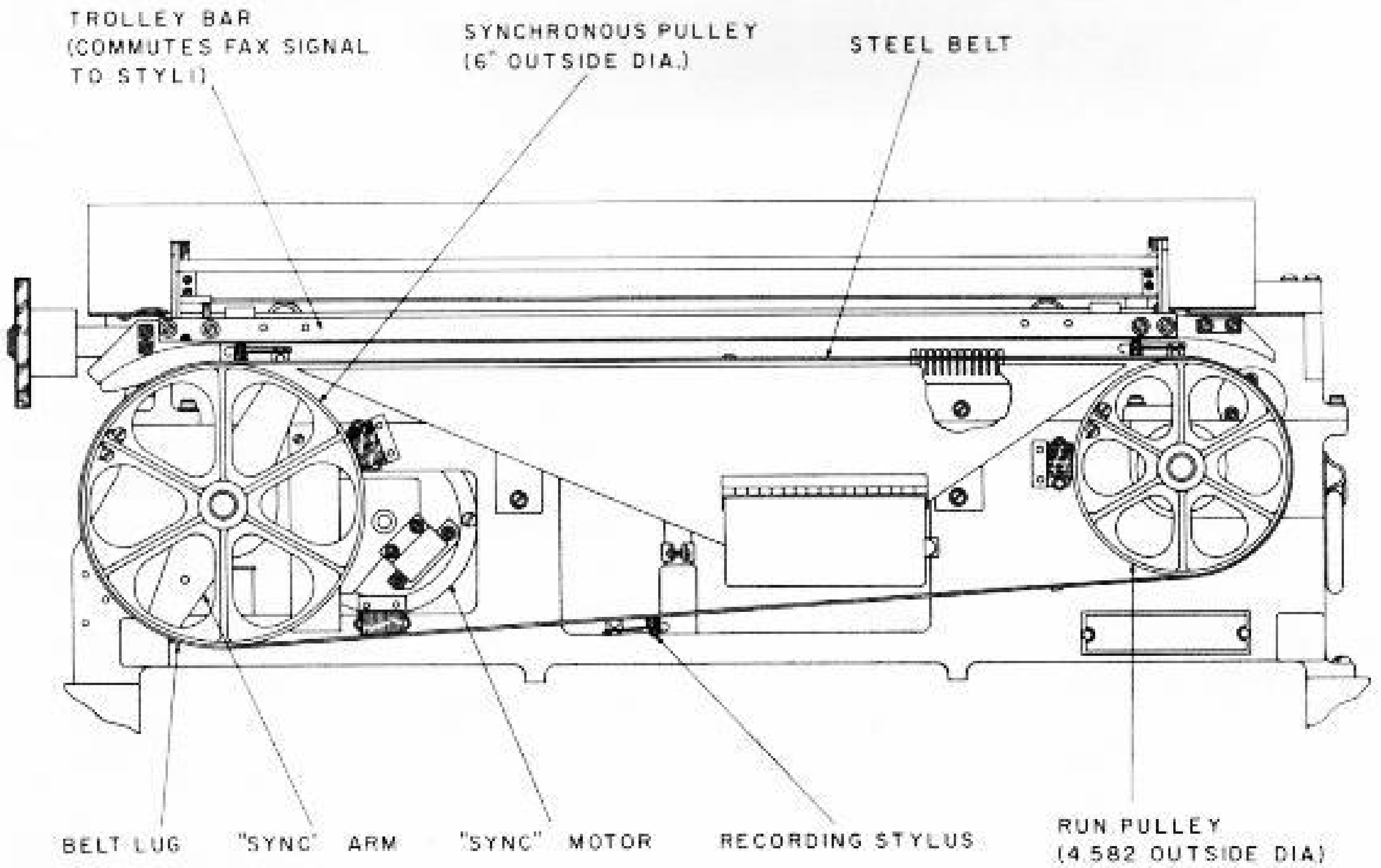


Figure 1. Front view — standard steel belt assembly

The run pulley, located at the right-hand side of the scan line, is driven at slightly faster than synchronous speed, through reduction gears and a slipping clutch which is adjusted to slip at the instant that the run system catches up with the sync system. Thereafter the sync arm, engaged with the lugs on the belt, restrains the belt to synchronous speed. Inasmuch as the fixed diameter pulleys are located on fixed, unyielding centers, it becomes necessary, with this type of belt, to maintain a precisely limited circumference in order to provide the tension required for good recording.

The Gilmer* Belt

"Timing" belts have been applied with complete success to Western Union's standard Letterfax[2] and other facsimile page recorders[3] as stylus carriers. Some of these belts have been in service on heavy circuits for over three years and no failures due to breakage or deformity have occurred. Therefore it was decided to design a "timing belt" application for the weathermap recorder.

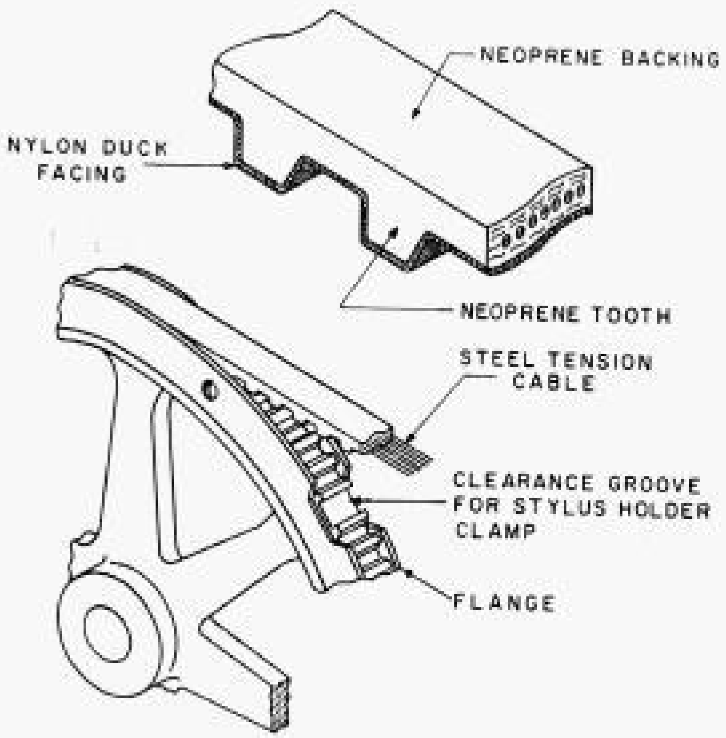


Figure 2. Isometric of Gilmer belt on a section of pulley

Timing belts, hereinafter referred to as Gilmer belts, are built on a "tooth-grip" principle. Moulded teeth on the belt make positive engagement with mating axial grooves on the pulleys. The teeth enter and leave the grooves in a smooth rolling action, with little friction, similar in manner to gear teeth. Gilmer belts are simple in construction, employing four components of three materials, viz., steel, neoprene and nylon. Great strength and dimensional stability are derived from continuous, helically wound, stranded steel cables imbedded in a thin neoprene backing which is moulded integral with the teeth. Resistance to wear is derived from a tough nylon duck facing which also is moulded integral with the teeth. Dimensional accuracy of the tooth form and spacing is derived from precision moulds. A Gilmer belt requires no lubrication, a most desirable characteristic for facsimile recording applications.

Off hand, it would appear to be a simple matter to replace the steel belt and its driving elements with a Gilmer drive, using existing pulley centers; however, more than mere substitution is required because of:

1. Construction features of the stylus-equipped Gilmer belt.
2. Knowledge, from previous experience, that best results, copywise, are derived from a Gilmer drive having one of the pulleys, preferably an idler, spring-loaded to provide uniform belt tension and floating to yield to minute resistances developed from inherent irregular loadings.

Synchronous Pulley

A Gilmer sync pulley with a pitch diameter of 6 inches was mounted on the existing sync drive shaft position, maintaining the established scan line position and 18.8496-inch length. (6 in. $\times$ pi = 18.8496 in.)

Inasmuch as the teeth of the Gilmer belt serve the same purpose as the lugs on the steel belt, studs to engage with the sync arm were added to the sync pulley, thus coupling the sync drive mechanism with the belt.

Circular pitch selection was governed

* This designation, commonly used in specifications of Western Union's Research & Engineering Department, is derived from the name of the original producer, The L. H. Gilmer Co., now a division of the United States Rubber Co.

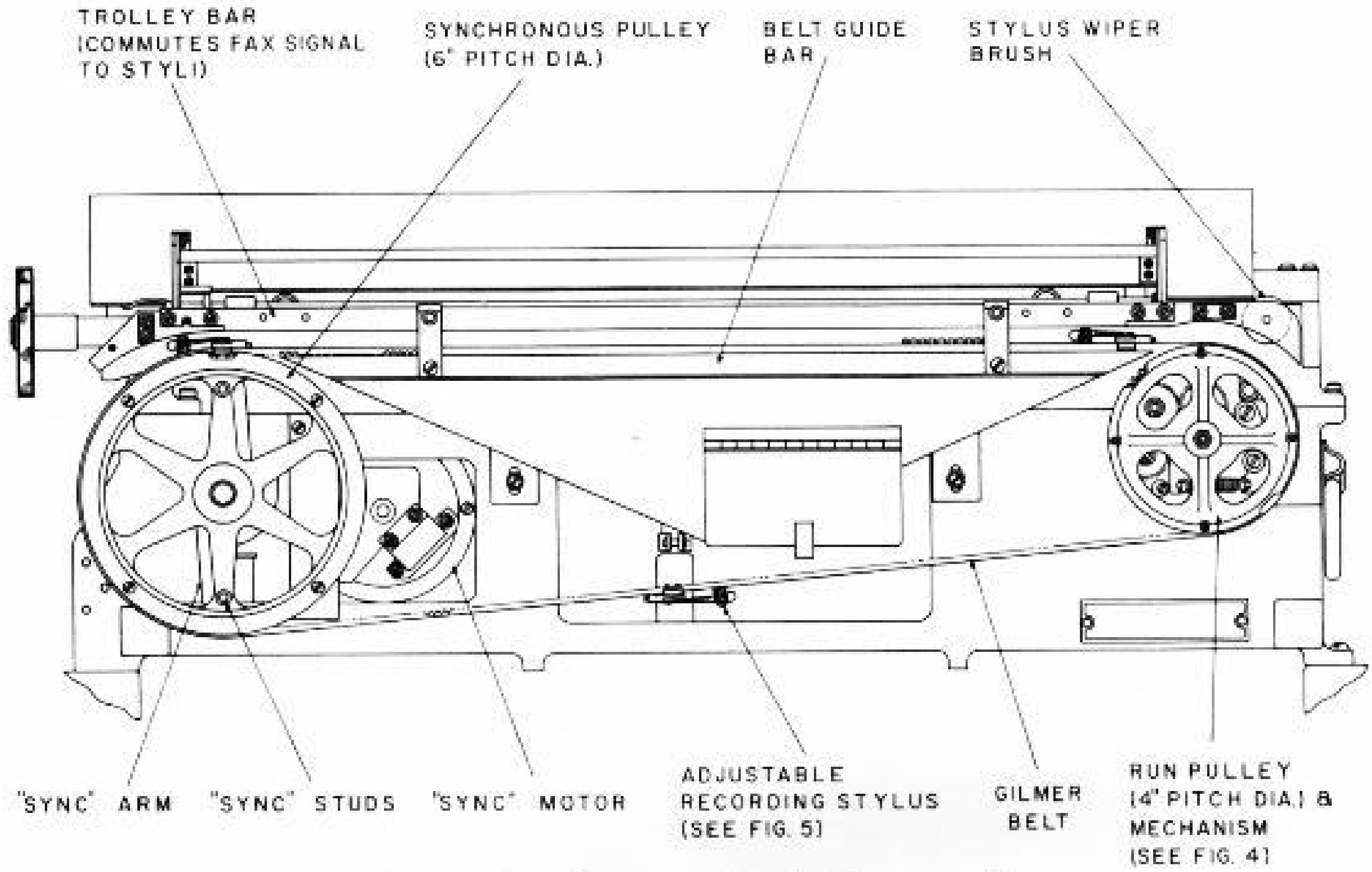


Figure 3. Front view — recorder with Gilmer assembly

by the need to have the number of teeth in the sync pulley and the belt divisible by three so that the stylus holders would mesh with a single clearance in the rim of the pulley. Also it was desirable, though not imperative, to have the selected circular pitch closely approach the satisfactorily tested pitch of 0.187 inch as used in the Letterfax recorder installations. Therefore a circular pitch of 0.1848 inch was established, resulting in a belt having 306 teeth and a pitch circumference of 56.5488 inches.

$$\frac{\text{Belt sections} \times \text{scan line length}}{\text{circular pitch}} = \frac{3 \times 18.8496''}{0.1848''} = 306\ \text{T}$$

The 6-inch pitch diameter sync pulley therefore has 102 teeth.

$$\frac{\text{Pitch diameter} \times \text{pi}}{\text{circular pitch}} = \frac{6 \times 3.1416''}{0.1848''} = 102\ \text{T}$$

Secure platforms, in the nature of clamps, must be provided for the attachment of the styli. One of the two clamp members necessarily occupies space normally taken by a belt tooth. Therefore a 3-stylus belt with a circumference equal to 306 pitches (teeth) is moulded with the 102nd, 204th and 306th teeth missing. It follows that meshing pulleys must also have one or more clearances, in lieu of normal grooves, to permit interference-free passage of all the stylus holders.

Run Pulley

Design of the run pulley for the Gilmer belt application was considerably more complex, first because the existing pulley diameter (4.582 inches) cannot be divided equally by the circular pitch of the belt (0.1848 inch) and, secondly, the existing run pulley drive shaft is rigidly fixed in ball bearings.

A 4.000-inch pitch diameter run pulley was chosen for the Gilmer application, because its circumference ($4'' \times \text{pi} = 12.5664''$) is equally divisible by the circular pitch into 68 teeth $\left(\frac{12.5664''}{0.1848''} = 68\text{T}\right)$. Since 68 is two-thirds of 102, it may be seen that two diametrically opposed clearances in the pulley rim permit the passage of the stylus holders. Since one-half of the pulley circumference (34 T) is one-third the distance betwen stylus holders (102 T), it follows that each stylus holder passes each pulley clearance alternately with each successive belt revolution.

The position assumed by the 4.000-inch run pulley, when a taut belt and a horizontal tangency plane with the sync pulley is maintained, is favorable for providing a positive drive from the existing run drive shaft, along with a flexible or floating mounting.

Run Pulley Drive

The run pulley is driven to rotate with an increasing spur gear train having a ratio of 8 to 7, which increases the surface speed of the 4-inch run pulley to approximately equal the surface speed formerly attained by the larger, replaced pulley.

The spur gear train consists of a 24-tooth driving gear on the existing run drive shaft, three idler gears and a 21-tooth driven gear on the run pulley shaft. The third idler gear meshes with the driven gear on the run pulley shaft, which is ball-bearing mounted in a spring loaded lever. The lever is pivoted on the third idler gear center, an arrangement which permits the run pulley to oscillate while being driven.

Gilmer Stylus Belt

The plunger-type stylus components used on the Gilmer belt are standard parts, identical with those used on the steel belt. They consist of tungsten-tipped brass styli, jewelled bushings, leaf and backer springs.

In the steel belt application the stylus bushing is fixture-aligned relative to lugs on the belt which engage the sync arm. The adjustment obtained thus is supposed to give perfect stylus registration and is final.

A similar fixture, designed to register the styli relative to the belt teeth, was made for the Gilmer application, and tests showed that although the fixture is useful to establish an approximate location of the styli statically, dynamically registration varied up to approximately 0.010 inch. Inasmuch as these variations always appeared in a symmetric pattern, an adjustable stylus holder and a new technique for obtaining good registration, dynamically, was developed.

Heretofore, page recorder belts have been made with nonadjustable factory registration, established statically, in fixtures. When these belts have registration faults resulting from dynamic operation, the user must return the belt to the shop for reworking, tolerate the fault, or discard the belt.

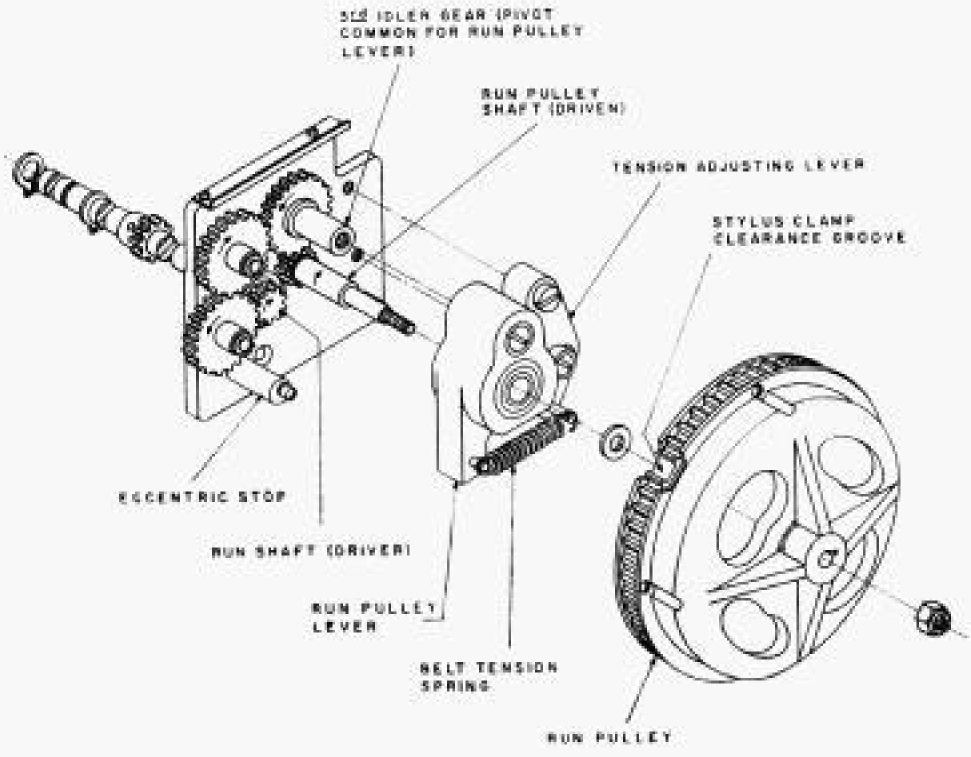


Figure 4. Exploded view of run pulley assembly

The Adjustable Stylus

Refer to Figure 5. The stylus leaf and backer springs are attached to a male aluminum dovetailed slide with two pan-head cap screws. Clearance holes in the leaf spring are ample to allow a wide range of adjustment, so that the stylus bushing can, with loosened cap screws, be easily positioned to conform to an aligning fixture, subsequently referred to. The slide is movable in a female dovetail formed in a nylon block. The block fits over the protrusions of four cap screws which clamp the two steel members securely to the belt. Self-locking nuts fasten the nylon block.

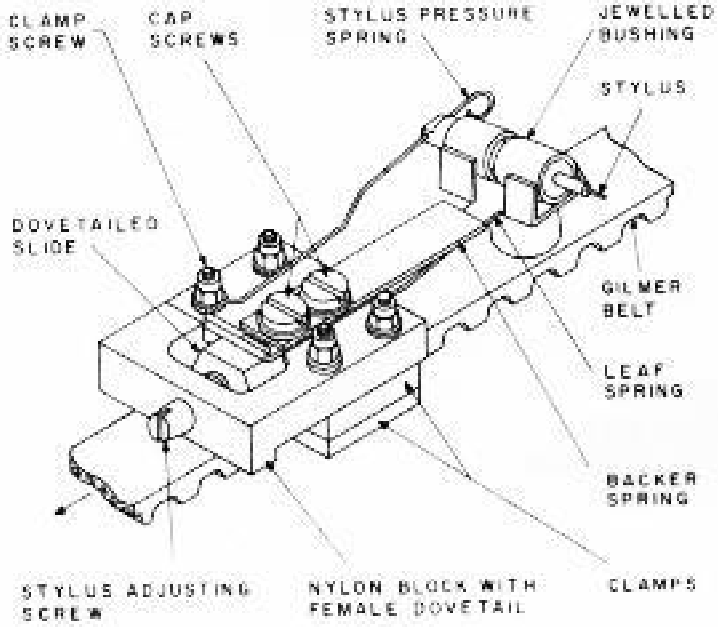


Figure 5. Isometric of stylus assembly

Movement of the slide, and consequently the stylus bushing, is controlled by a self-locking adjusting screw. The screw is held captive in the nylon block with a retaining ring. The threaded end of the screw engages threads in the end of the slide. Relative to the normal direction of belt movement, which is from left to right, a full clockwise turn of the screw moves the stylus 12-1/2 mills to the right. Similarly, a one-quarter counterclockwise turn will move the stylus 3 mills (0.003 inch) to the left.

Stylus Alignment Fixture

Refer to Figure 6. Belts are furnished to the field fully assembled, but not aligned. The only precision required of the manufacturer in assembly is to position the two steel clamping members relative to the teeth of the belt, with relatively liberal tolerances.

An alignment fixture showing a stylus assembly in position is illustrated in Figure 6. The fixture is supplied to field personnel, who make the final alignment of the belts. The fixture has a rack of several grooves (equivalent to the teeth in the Gilmer pulleys) into which a belt is seated. Clamping screws hold the stylus assembly while adjustments are being made. A bushing, located in a predetermined position, is used in conjunction with an alignment pin to establish the correct position of the stylus bushing relative to the edge and teeth of the belt.

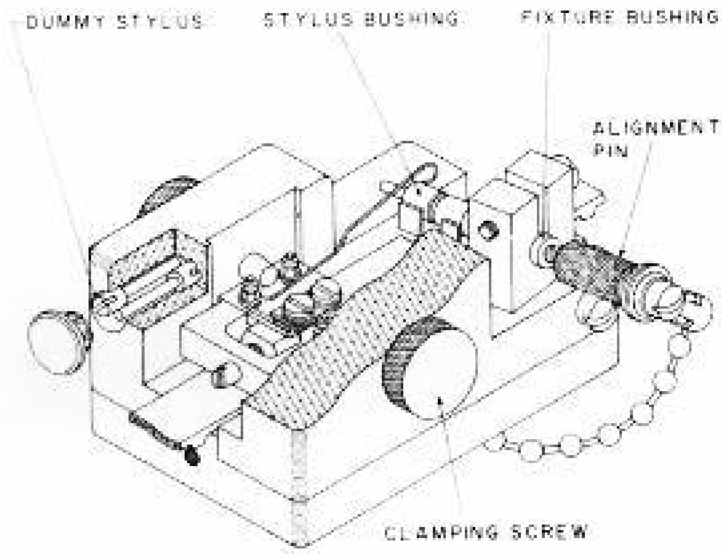


Figure 6. Fixture assembly with belt

STYLUS ADJUSTMENTS

Static Adjustment

The stylus alignment fixture is used to align the stylus bushings relative to the belt teeth to obtain an approximate registration and an exact position for adequate stylus deflection.

Dynamic Adjustment

The fixture aligned belt is installed on a recorder, styli are added and an inch or two of vertical bar pattern copy is recorded.

Observation of the copy may reveal a symmetric registration pattern. A typical pattern, exaggerated, is shown in Figure 7.

This pattern indicates that one stylus (a) is leading, needing adjustment to the left, and another (c) is lagging, needing adjustment to the right. Obviously identi-

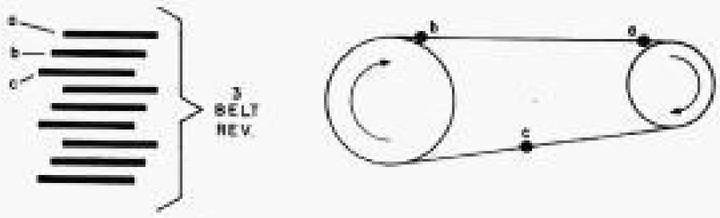


Figure 7. Three (live styli)

fication cannot be made conveniently while the belt is in motion; however, if one stylus, chosen at random, is replaced with a dummy stylus (one that is too short to mark) an inch or two of test copy will appear as in Figure 8.

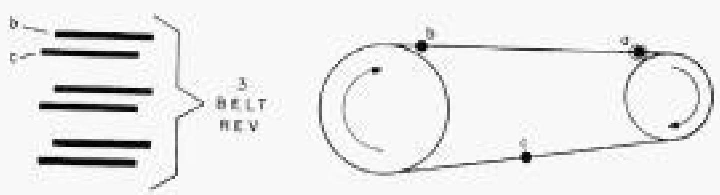


Figure 8. Random placement of dummy happened to be position "a"

This pattern suggests that the stylus (b) following the dummy space needs adjustment to the left (counterclockwise rotation of the stylus adjusting screw), and/or the stylus (c) preceding the dummy space needs adjustment to the right (clockwise rotation of the adjusting screw). If after the adjustments are made test copy appears as in Figure 9, this stage of adjustment is satisfactory.

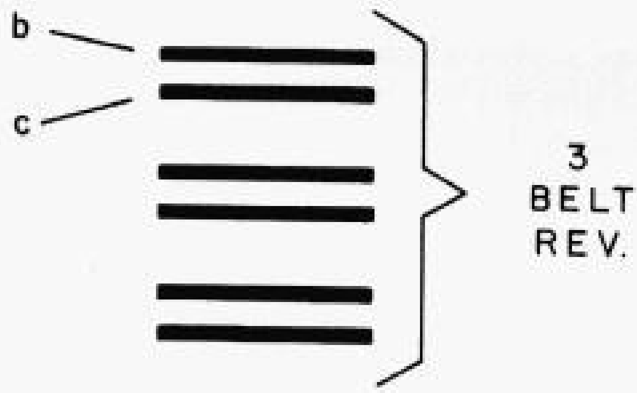


Figure 9. Pattern of Figure 8 after corrective adjustment

Next, move the dummy stylus backward (to the left) one stylus position (b), and place a recording stylus in the position (a) vacated by the dummy. Take an inch or two of test copy which will appear as shown in Figure 10.

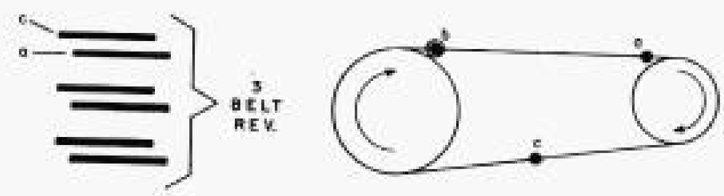


Figure 10. Dummy moved backward (to left) one position. Live stylus in former dummy position (a)

It is now obvious, knowing that the stylus (c) following the present dummy position was previously adjusted, that the remaining stylus (a), in need of adjustment, precedes the dummy space and should be adjusted to the left (counterclockwise rotation of adjusting screw).

If after this adjustment test copy similar to that shown in Figure 9 appears, the registration alignment may be considered complete and satisfactory.

After replacing the dummy with a recording stylus, test copy will appear as in the satisfactory pattern shown in Figure 11.

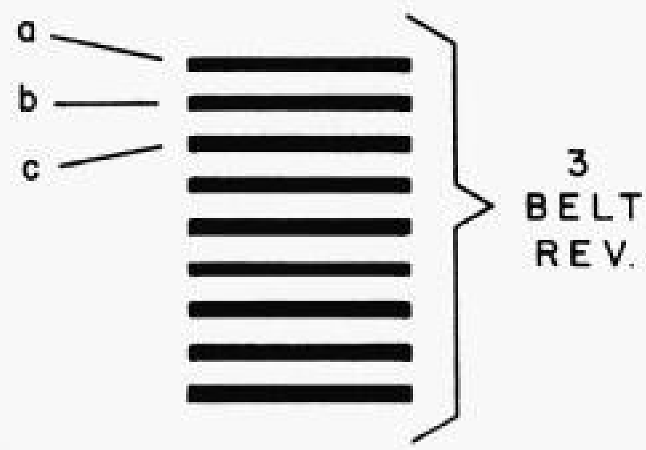


Figure 11. All styli aligned

A teflon-coated guide bar, a member not required for steel belts, is suspended from the existing trolley bar to support the Gilmer belt underneath the scanning area. The guide bar prevents belt flutter, and generally stabilizes the scanning run.

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C. S. LAWTON, Operations Manager, International Communications

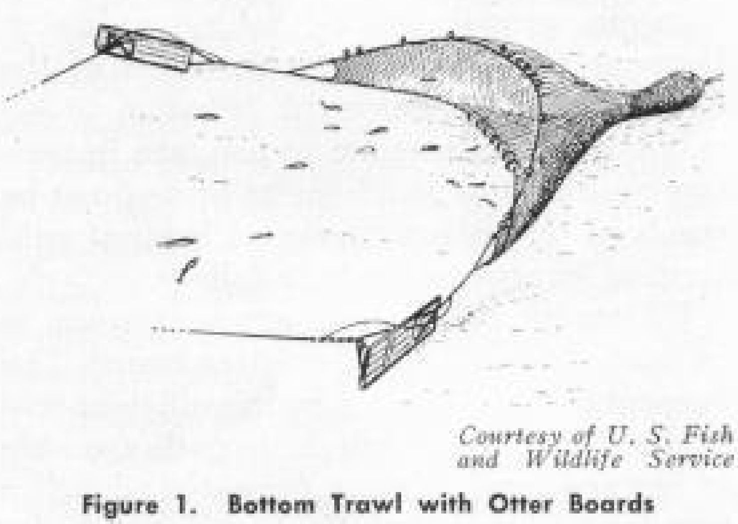
Fishing versus Cables

Can Two Basic "Freedoms of the Seas" be Reconciled?

EVEN in the earliest days of ocean cables, commercial fishing constituted a hazard, but radical developments have come about in both industries to so aggravate the situation that now it is causing grave concern to the communications companies.

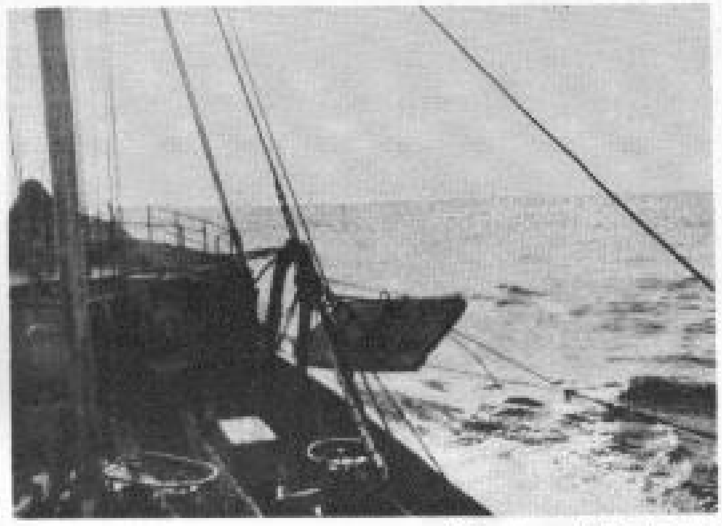
Years ago fishing was carried out with hand lines by small local groups with limited financial resources and little, if any, government assistance. However, the popular realization of the importance of developing this potentially vast source of food has brought with it great emphasis by the governments of the world upon basic research to improve fishing methods, the granting of financial aid to the fishing industry, and exploration of the marketability of a greater number of species.

The introduction of bottom trawling in the early 1900's at once increased the hazard, particularly since, instead of using two ships to keep the net spread between them, most trawlermen tow the net from a single vessel, dragging a pair of Otter boards (Figure 1) along the bottom attached to, but in advance of the outer edges of the mouth of the net, and so oriented as to pull away from the axis of forward movement, exerting thereby enough force to keep the net spread horizontally. The foot-rope of the net is weighed down to keep it on the bottom. Figure 2 shows a board at the "gallows" ready for launching.



Courtesy of U. S. Fish and Wildlife Service

Figure 1. Bottom Trawl with Otter Boards



Courtesy of U. S. Fish and Wildlife Service

Figure 2. Otter Board ready for launching

The safest bottom for cable is flat and even. Irregularities cause suspensions across small concavities. Because cable is inherently stiff and sometimes has a tendency after having been uncoiled from a ship's tank to retain a bit of helical screwiness, these suspensions cannot be avoided entirely by laying cable without residual tension. As a matter of fact, if the bottom is sufficiently flat and even, better results sometimes may be achieved by laying it bar-tight.

Naturally, if a cable is not resting on bottom at all points and a trawl board, its lower edge scraping along the bottom, is towed across it where the cable is suspended, the probability of fouling is great, as may be seen in Figure 3. Poor maintenance of the iron shoes which sheath the lower edge of the boards and the bolts which hold them in place, as well as the shape of the boards themselves and their attachments, often are contributory fac-

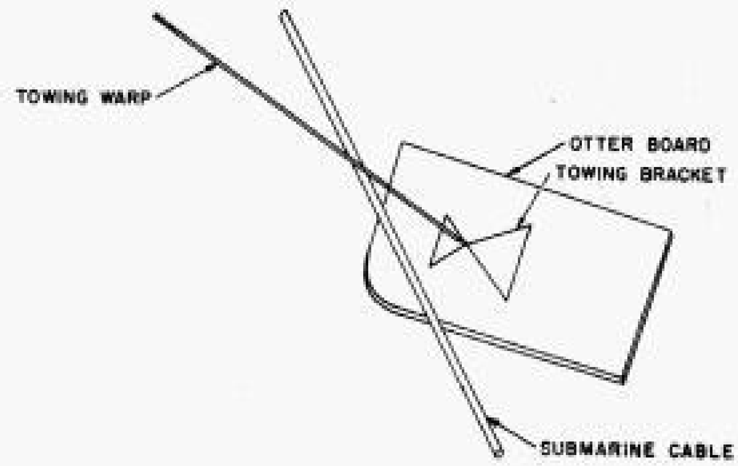


Figure 3. Otter Board caught on cable

tors, but the chief causes of fouling reside in

(a) the cableman's inability to make cable conform closely to the contour of the sea bottom and

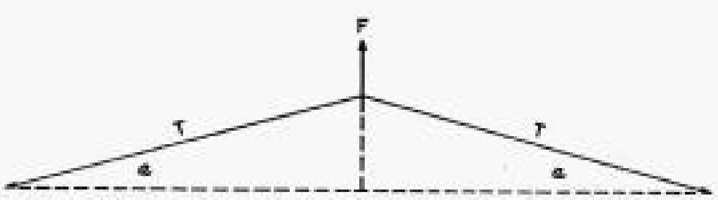
(b) the fishermen's conviction that the boards cannot be towed off bottom and still function properly.

(The causes are placed in that order since many existing cables antedate the invention of the bottom trawl.)

The fishermen's stock argument runs: "The fish were here before the cables," but even this "ain't necessarily so." Fish have a way of migrating from one area to another with minor changes in water temperature brought about by shifting currents which carry their food (plankton) and by the gradual melting of the polar ice caps. As an instance of the latter, Cape Cod, Massachusetts, the waters around which were teeming with codfish when the Cape was named, supports little commercial cod-fishing today whereas this fish is plentiful in the waters around southern Greenland, the inhabitants of which scarcely knew what a codfish looked like sixty years ago.

The advent of refrigeration at sea and the ability to ship frozen fish inland have revolutionized the fishing industry. The number, size and power of trawlers and the depths in which they operate, all have increased. It is not uncommon for a cable repair ship to find a fleet of twenty to forty large trawlers of several nationalities milling around in a small area on the continental shelf, well over a hundred miles from land, wherever bottom fish are abundant. The season is limited only by the presence of heavy field ice. Cable damage occurs in practically every month of the year and in depths to well over 200 fathoms of water.

There was a time when a cable could be designed for a reasonable degree of protection by sheathing it with heavy wire armor. That day has passed. Some of the modern trawlers and their gear are so powerful that they can break the strongest communication cables, in some cases possibly without even being aware of them. These cables have tensile strengths on the order of twenty tons or more but under certain conditions it takes less than the full tensile strength of a cable to break it. (Figure 4.)



WHERE F = VERTICAL FORCE REQUIRED TO BREAK CABLE
T = ULTIMATE TENSILE STRENGTH OF CABLE
α = ANGLE OF CABLE TO HORIZONTAL

THEN $F = 2T\sin\alpha$ HENCE, WHEN $\alpha = 30°$, $F = T$
" " $= 14\frac{1}{2}°$, $F = T/2$
" " $= 7\frac{2}{3}°$, $F = T/4$

Figure 4. How cables are broken

We all are aware of the tremendous increase in the capacity of modern coaxial lines and the growing importance of cable communications which have paralleled the vigorous growth of the fishing industry. Because two of the basic concepts of the Freedom of the Seas; the freedom to lay cables and the freedom to fish, are in serious conflict, the problems at issue must be resolved on an international basis if substantial improvement is to follow.

Efforts have been, and are continuing to be made to re-design the Otter board. The present bottom trawl is not an efficient tool in that most of the fish in its path are able to escape and almost one-third of a trawler's propulsive effort is absorbed by the friction of the boards scraping along the ocean bottom. Nevertheless, where fish are plentiful it is serving its purpose. Attempts to have fishermen use other methods probably will not be successful unless it can be demonstrated that more fish can be caught, or governmental action makes a change mandatory.

In the past those fishes which inhabit depths intermediate between the surface and the sea bottom have been most difficult to catch (except by hand-lines). Recently, however, the science of "mid-water trawling" has been the object of considerable research by government agencies and a few private inventors. One product of this research is the buoyant Otter board which can be controlled so as to operate off bottom. Theoretically it should be possible to utilize such boards with bottom trawls, since the boards are positioned some distance ahead of the net and a slight upward pull of the boards so positioned should not be enough to lift the heavy weighted footrope of the net off bottom. Their elevation by as little as a fathom or two would cause them to ride harmlessly over cables whilst from the fishermen's standpoint there would be either a substantial saving in propulsive effort or a substantial increase in speed of towing (which improves the chances of catching fish).

Other methods of catching bottom fish such as by the use of lights and acoustical effects have not been noticeably successful in the depths with which this article is concerned.

Where the bottom is consistently penetrable to a depth of from 7" to 24" and currents are not too strong for a surface vessel to maneuver, cables have been successfully buried over distances of about 20 miles in the ocean bottom across a fishing area ranging in depths between 100 and 450 fathoms of water, but this technique is too limited in application in the present state of the art to be of much general assistance. Research is going forward, however, in the extension to deeper water of methods utilizing a bottom vehicle, television-controlled and powered from a surface vessel. The underwater television camera, with its ability actually to photograph cables lying in situ and trawl nets in action gives scientists a new and powerful tool for probing these mysteries, but how long it will take to bring about the desired new techniques of cable laying and fishing is anyone's guess. They certainly are not imminent.

To the extent practical, efforts have been made to move cables out of heavily-fished areas. Ten years ago Western Union moved several of its transatlantic cables northward off the east coast of Newfoundland on the advice of government biologists that the cod would never be found there in sufficient density to support commercial fishing. It was known that redfish were there but at that time redfish were not considered too suitable for the market and when caught most of them either were thrown back or used for fertilizer. From about 1956, however, as cod became less plentiful east of Newfoundland and other nationalities sent their trawling fleets across the ocean to fish, the lowly redfish, under the more attractive name of ocean perch, became "socially acceptable" and now can be purchased in frozen form almost anywhere here in the United States. The result has been that the cable diversions which were costly and time-consuming to make, afforded only a few years of immunity from damage.

One of the chief complaints of the trawlermen is that unless they have the positions of the cables they cannot very well avoid crossing them, but until quite recently these positions have had to be kept confidential for security reasons. However, the wide-spread damage since the last World War has convinced most governments that the fishermen already have a fair acquaintance with cable routes so that not much is to be gained through continued secrecy.

Now that most of the countries concerned have agreed to eliminate the security restriction it has been possible to publish charts for distribution to trawlermen covering fishing areas where there are cables, showing the route of each cable but without individual identification as to owner or terminal points; cables not now in use are clearly marked, however.

On the western side of the Atlantic The Western Union Telegraph Company, American Telephone & Telegraph Company and American Cable & Radio Corporation have been working co-operatively on the formulation and distribution of cable charts to ship agents, trawler owners, and governmental agencies associated with the fishing industry. These efforts are being fully co-ordinated with a Cable Damage Committee having headquarters in London and composed of representatives from the British Post Office, Cable & Wireless, and practically all the private cable operators.

At the International Fishing Gear Congress in Hamburg, Germany, in October 1957, a paper was presented by Western Union entitled "Ocean Cables and Trawlers: The Problem of Compatibility" which called attention to the need for a co-operative approach in the design of fishing gear and its use. Also, at the annual meeting of the International Commission for the Northwest Atlantic Fisheries at Bergen, Norway, May 1960, an address by Mr. Eldon Nichols of the American Telephone & Telegraph Company discussed the problem comprehensively and frankly in the light of further developments. Copies of both these articles are available upon request to Western Union or American Telephone & Telegraph Company.

Every available means is being employed to bring this matter to the attention of trawler owners, government officials, and the fishermen themselves and to see that they are kept fully informed. The October 1960 issue of the United States Navy Hydrographic Office's Monthly Pilot Chart of the North Atlantic Ocean (H.O. 1400) which circulates widely among mariners, carries on its reverse side an illustrated article entitled "Ocean Cables and Deep-Sea Trawlers" which includes the text of the International Convention of March 14, 1884, for the Protection of Submarine Cables, as evidence that broken cables have been an international problem of long standing.

The twenty-seven signatories agreed that anyone who hooked a cable must sacrifice his gear rather than cut the cable. Cable owners were required to pay for the lost gear.

Appropriate legislation enacted by the member nations still is in force but has done little to alleviate the problem. Before the advent of the bottom trawl, ships' anchors had been the chief cause of cable damage, confining it to fairly shallow water. But when a fisherman has to sacrifice a trawl net, complete with Otter boards, he may well find himself called upon to sacrifice a catch of fish in the net and, unless he has a spare set of gear on board, valuable fishing time while he proceeds to port to replace it. When he returns the fish may not be there, of course.

These consequential damages (as opposed to the sacrifice of the fishing gear itself) are difficult to assess with any reasonable degree of accuracy and the cable operators take the view that they cannot be held responsible for them. Were they to accept responsibility, the way would be open for fishermen to ignore the presence of cables entirely, whereas it is most essential from the cable operators' point of view that there remain some deterrent to the practice of trawling over cable lines.

When a fisherman's trawl gets caught on something, not knowing what he is foul of, the natural tendency of the fisherman is to try to free his gear. In doing so, if it happens that he has hooked a cable, he is in grave danger of damaging it electrically, even if he does not break it entirely. Thus, whether he elects to cut away his gear and claim damages merely on suspicion of having hooked a cable, or whether he brings the cable to the surface and cuts his gear away with the full knowledge that it is indeed a cable (thereby still further increasing the probability that he has caused damage), the fact remains that it is a hazardous practice to tow a bottom trawl over cable lines. Cable operators cannot prevent this practice but they can, and do, insist that when indulged in, there remain some element of financial risk to the fisherman.

Apart from this, the assurance of complete remuneration would be a temptation to the unscrupulous fisherman to claim damages whenever he lost any gear, re-

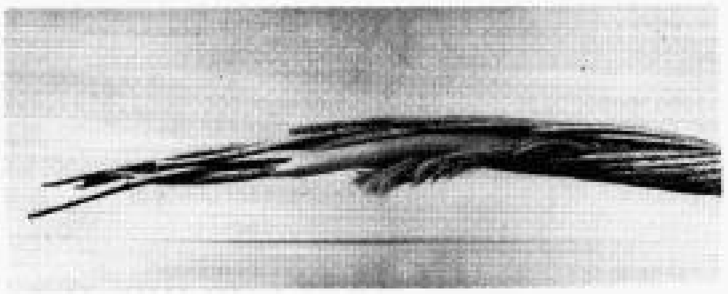


Figure 5. Cable broken under tension

gardless of whether a cable was the cause or whether the sacrifice had been deliberate, since his geographical position and the depth of water could be so stated readily as to place him over a cable if there were any in the vicinity, now that the routes are common knowledge.

As an example of what can happen, Western Union lost four transatlantic cables in twenty-six hours on February 24th and 25th, 1959, three days after the interruption of TAT 1, the telephone cable laid in 1956 between Canada and Scotland. Six days later (on March 3rd) Western Union lost still another. The damage to the telephone cable included a tensile break and a cut less than a mile apart. Damage to the five Western Union cables included ten tensile breaks (Figure 5) and two flush cuts (Figure 6). These cables are armored with No. 1 BWG galvanized steel wires which were in good condition. The depth of water ranged from 170 to 215 fathoms. The telephone cable was out of use for eight days. Western Union lost six days on each of two cables, seven on another, eight on another, and fifty-six on the last one due to an ice field (on the edge of which the trawler evidently had been working) moving over the cable, making it inaccessible for repair.

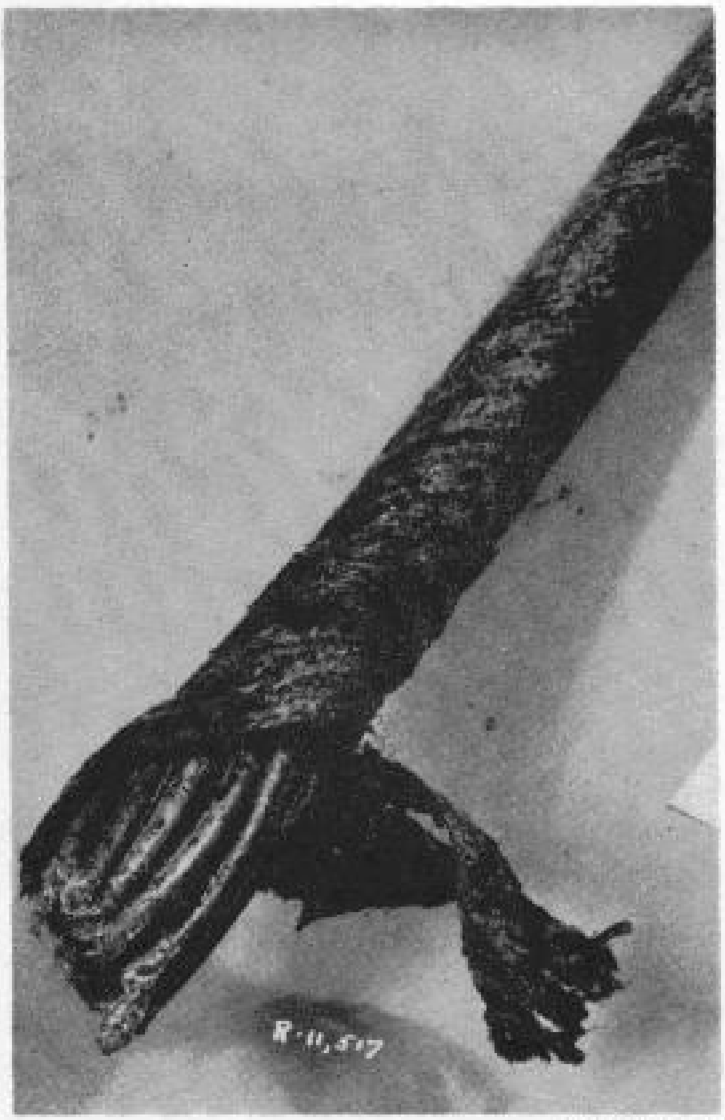


Photo R-11,517

Figure 6. Cable flush cut

The repairs required a total of 43 days of ships' time and necessitated the replacement of 19 miles of cable. The total cost to the cable operators for repairs on this occasion was about $120,000. This, of course, did not include the cost of traffic diversions and hire of alternate facilities where available, nor was this an isolated case.

There have been numerous other occasions recently on which multiple damage to several cables has occurred within short intervals of time. In the first ten months of 1960 Western Union cables were individually interrupted or made faulty by trawlers on forty-four occasions, and the telephone cables were broken on several occasions also.

High as is the cost of repairing cable damage, our greatest concern is with the serious effect upon the quality and continuity of service to the public. When cable interruptions come singly, suitable fallback arrangements can be made to overcome the loss but when several cables are broken within a matter of a few hours, such as has happened off Newfoundland repeatedly, there is bound to be disruption of service and long delays in its restoration.

Despite the international scope of the problems and the best efforts of those engaged in telecommunications, neither of the two recent international conferences on the Law of the Sea have been able to cope with it, having been too deeply absorbed in the controversy over the width of the Territorial Sea. On the other hand, it must be clear to any serious student of the matter that the provisions of the 1884 Convention are ineffectual in dealing with the situation which confronts us today.

In the early days of radio it was the hope of the fishing fraternity that this invention would spell the end of cables and the annoyance which went with them. No doubt they are pinning their present hope on the development of communication satellites, but from the amount of money now being invested in new cable projects and the extent of these projects it seems like a forlorn hope for the indulgence of this generation of fishermen.

A biographical sketch of the author appears in the April 1959 issue of TECHNICAL REVIEW.

WILLIAM V. JOHNSON attended Illinois Institute of Technology and Newark College of Engineering, receiving the degree of Bachelor of Science in Mechanical Engineering from the latter. He served with the U. S. Naval Reserve as an Ensign in World War II. Mr. Johnson joined the staff of the Engineering Department of Western Union in 1946 and since then has been actively engaged in the design of domestic telegraph and ocean cable equipment, and in improving the design of existing equipment. He has also been responsible for writing many of the operation and maintenance specifications associated with the various units of telegraph equipment.

WILLIAM V. JOHNSON, Senior Project Engineer, Telegraph Equipment

A Tape Rewinder for the Telecommunications Industry

PERFORATED paper tape is still the standard medium for the interim storage of messages in the telegraph industry. As speedier and more elaborate message switching systems are designed and installed which handle larger volumes of messages and tape, it becomes expedient to handle the tape with a minimum of effort and time. Tape storage begins when the tape is wound upon the reels of the tape winders. Most message centers then store these full reels of tape for a period of time varying with the routine employed at the centers.

For various reasons it is often necessary to find a particular message located on one of the stored reels. Western Union Tape Rewinder 7650-A, which was developed to facilitate the unwinding of a stored-tape reel to locate a particular message, requires only 115-volt a-c power for operation.

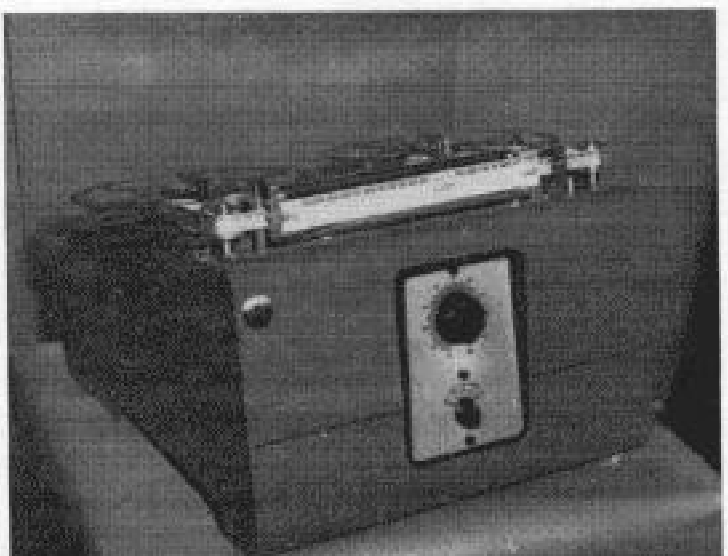


Photo H-2677

Figure 1.

This rewinder makes it possible to search rapidly through a reel of perforated tape while visually scanning the tape for the desired message. The rewinder is motor driven and is capable of rewinding tape from one reel to another, in either direction, at speeds which are continuously variable from 0 to 250 rpm, producing linear tape speeds up to 680 feet per minute. The tape can be stopped quickly at any point and at any speed for examination. Visual scanning of the tape is made easier by a magnifying lens which is placed in front of the tape path.

Photo H-2709

Figure 2.

Tape Rewinder 7650-A is a table top unit shown in Figure 1. A rewinder is usually associated with a distributor-transmitter for retransmission of any message which has been located by use of the rewinder. Figure 2 shows a Tape Rewinder 7650-A mounted on an Operating Table 7878-A. This operating table includes a distributor-transmitter for the retransmission of a length of tape without necessitating removal of the tape from the reels.

The tape reel to be searched is placed on the left-hand shaft and the tape is then threaded onto the empty reel located on the right, as shown in Figure 3. The right-hand reel serves as a temporary storage reel for the tape and is part of the tape rewinder. This reel is larger in diameter than the standard reel placed on the left-hand shaft, so that it will accommodate all of the tape from a tightly wound reel which has been removed from a tape winder.

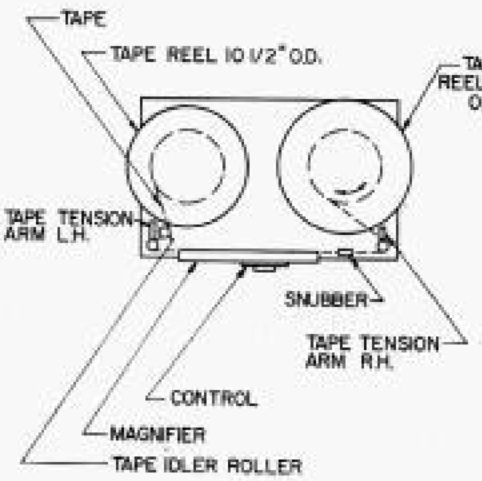


Figure 3.

There are only two control knobs associated with the tape rewinder. The larger knob controls the speed and the smaller knob, located below the large knob, controls the direction of tape motion and dynamic braking. This lower control is a 5-position switch. The center position is the off position which removes all power from the drive mechanism. The remaining four positions are oriented two to the right and two to the left for dynamic braking and tape transport from left to right and right to left, respectively.

Drive Mechanism

The tape rewinder, shown diagrammatically in Figure 4, consists of a variable speed reversible d-c motor which drives, by means of a rubber timing belt, the right and left pulley shafts. The upper sections of the two shafts which carry the two tape reels are coupled to the driving pulley shafts by magnetic clutches controlled by the lower control knob. When this lower control knob is moved fully clockwise to the forward "run" position the right-hand magnetic clutch will be energized causing the motor to drive the right-hand reel. Tape will now be pulled from the left-hand reel, since the left magnetic clutch is not energized, and wound upon the right-hand reel. The reverse of the above will be true when the control switch is moved counterclockwise to the reverse "run" position which actuates the transport of tape from right to left. The first switch positions to either the right or left of center are dynamic brake

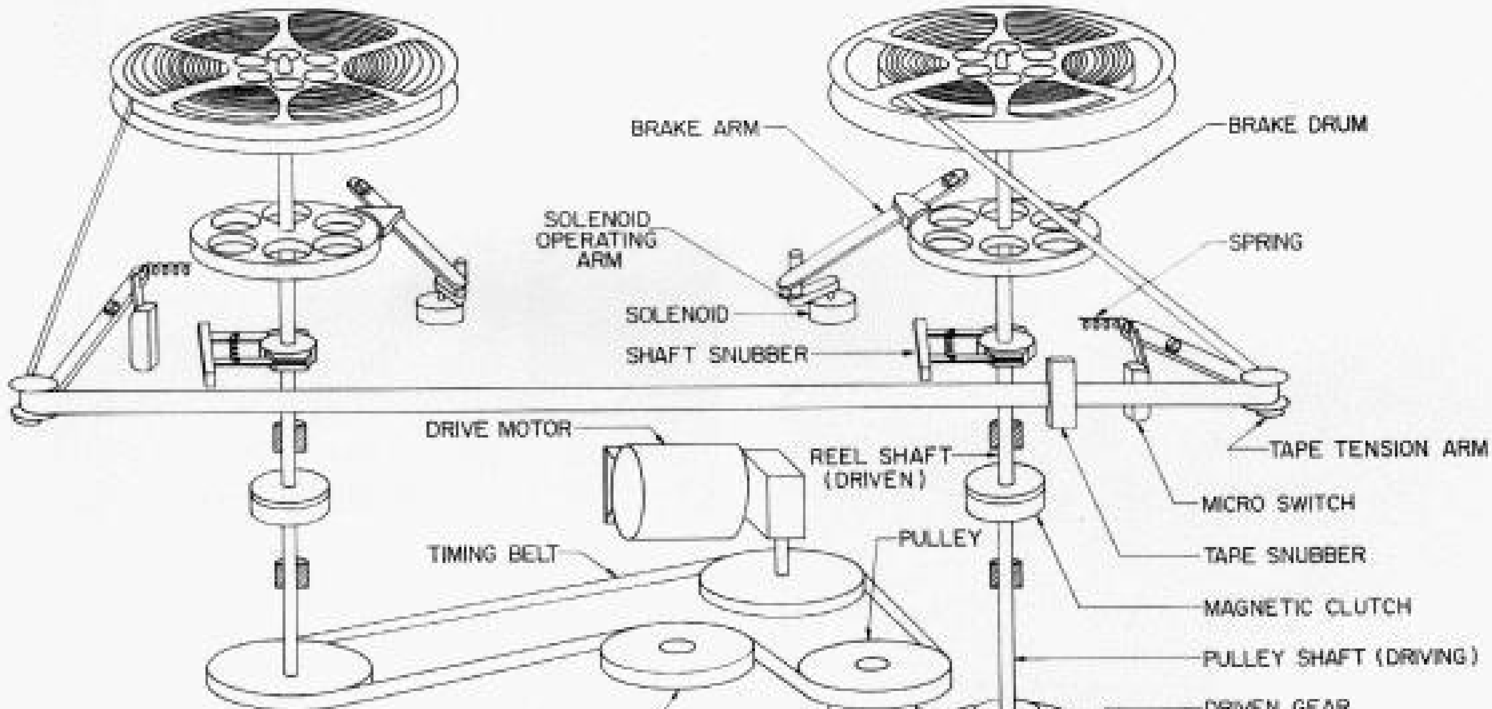


Figure 4.

positions for the drive motor. In addition to braking the motor dynamically, this position also energizes both magnetic clutches. By this means the rotation of both shafts is rapidly and smoothly stopped by the motor.

Figure 5 is a schematic wiring of the tape rewinder. The heavy lines denote the current path when the control switch is in the forward run position. The current path, when the control switch is in the forward dynamic brake position, is shown in Figure 6.

Mechanical Brake Mechanism

The rewinder includes a mechanical brake mechanism as a separate and complete braking system to overcome the inertia of the free-running reel when the winding speed of the motor is rapidly reduced. When in the process of operating the rewinder it becomes necessary rapidly to reduce the winding speed, for example, to scan the tape closely, a slack tape loop will be formed between the driving and idling reels. This slack tape loop is formed due to the abrupt reduction in speed of the driving reel while the inertia of the idling reel causes it to continue rotating at a higher speed. As the slack tape loop is formed, the tape tension arms associated with each tape reel will rotate outward under action of their respective spring tensions. As the tape tension arms move outward they actuate microswitches associated with each arm. Referring to Figure 5, it will be seen that power will be applied only to the left microswitch when the control switch is in the forward run position. Conversely, power will be applied only to the right microswitch when the control switch is in the reverse run position. Closure of the left microswitch energizes the left brake solenoid, slowing the idling reel until the slack tape loop has diminished sufficiently again to restore the tape tension arms to their normal running position.

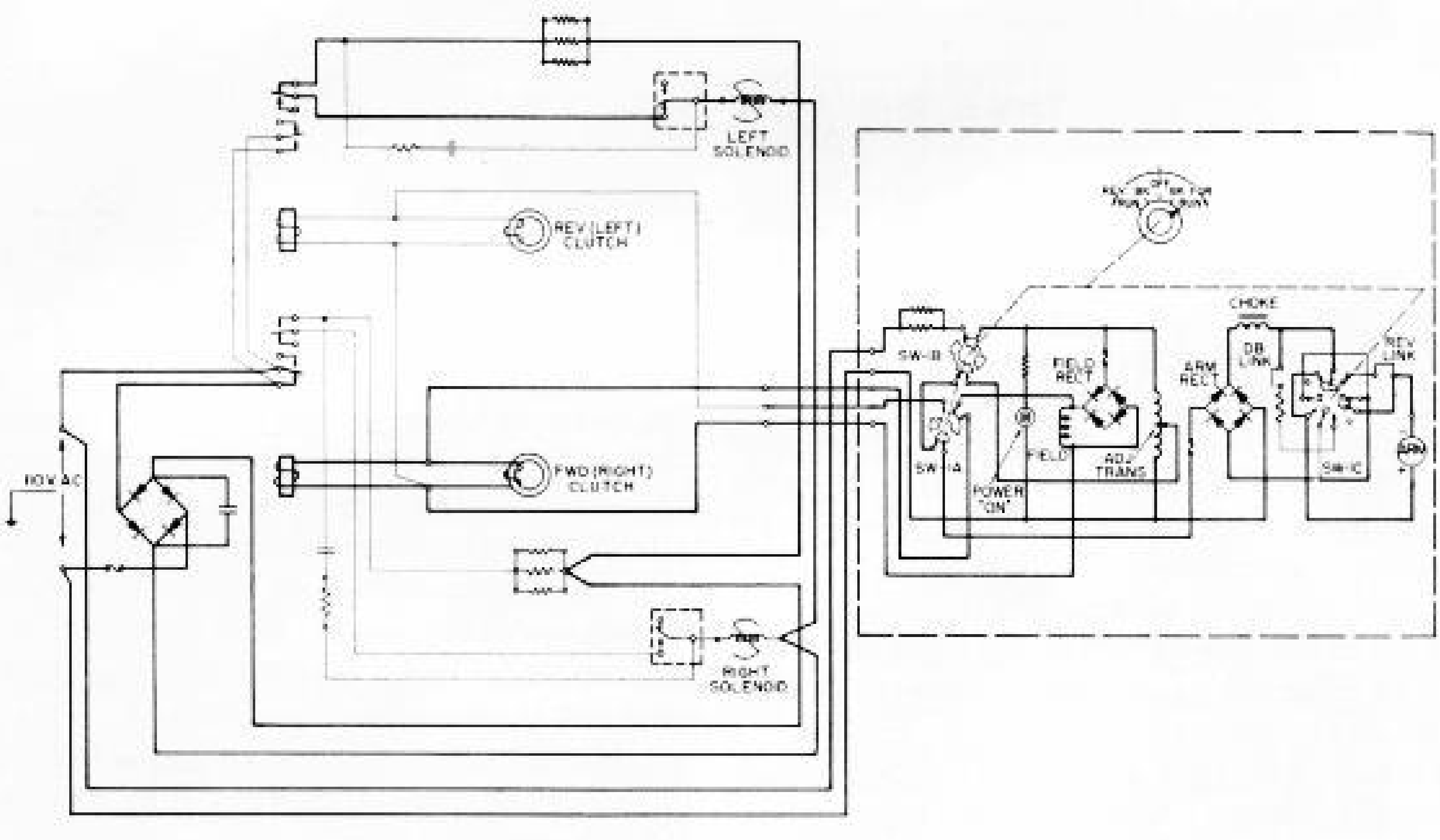


Figure 5. Control switch in forward run position

The brake solenoids are under control of two relays and are energized from a separate power supply. The d-c power for the solenoids is supplied through the normally closed contacts, and the a-c power to the rectifier is supplied through the normally open contacts of the relays. The operating winding of each relay is paralleled with the right and left magnetic clutches respectively. The power to energize the relays and magnetic clutches is

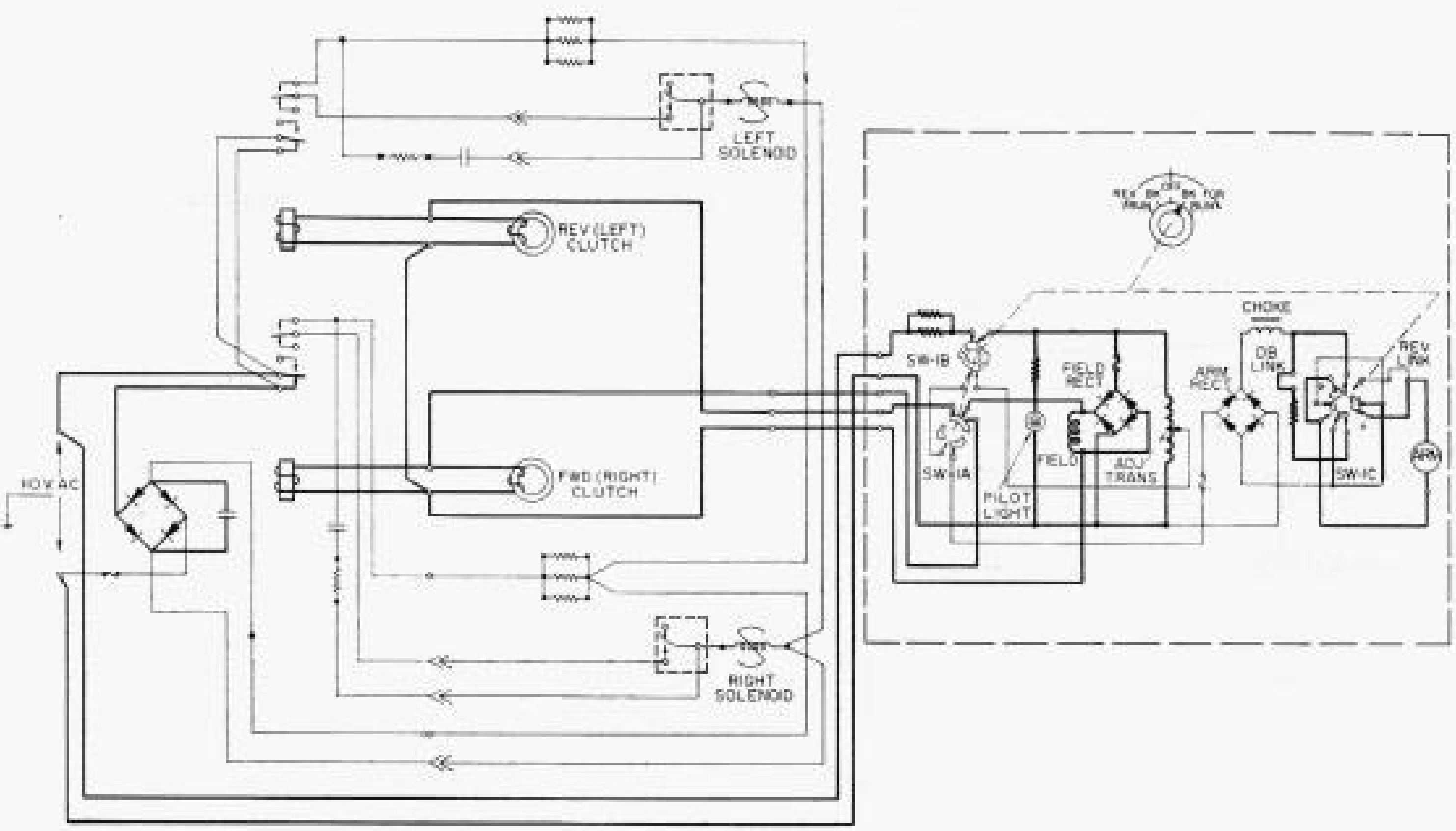


Figure 6. Control switch in forward "brake" position

obtained from the field 100-volt d-c power supply for the drive motor.

With the control switch in the forward run position, the right-hand magnetic clutch and associated relay will be energized. Operation of the relay will supply a-c power to the rectifier through the normally open contacts. The rectified alternating current for operation of the left solenoid is supplied through the normally closed contacts of the left (unoperated) relay to the microswitch and solenoid. The right solenoid cannot be energized as the circuit is open at the normally closed contacts of the right (operated) relay. Conversely, when transporting tape from right to left the left magnetic clutch and relay will be operated, providing a circuit for operation of only the right solenoid.

Referring to Figure 6 it can be seen that when the control switch is in a dynamic brake position both relays will be actuated preventing operation of the brake solenoids. This feature permits the reels to be smoothly brought to a stop solely by the motor.

A shaft snubber has been provided on each upper reel assembly. The function of the shaft snubber is to provide a small friction drag on each reel shaft, which introduces into the tape a tension sufficient to overcome the forces of the two tape tension arms, rotating them inward to their normal operating position.

A tape snubber located in the tape path adjacent to the magnifier creates a tape snubber action to provide a compact wind on each reel. Tape, of course, may be run through this snubber in either direction.

This tape rewinder will accommodate chad or chadless tape and models are available for use with 11/16-, 7/8- or 1-inch wide paper tape. The winder will continuously wind up to 1000 feet of tape on either reel.

JOHN J. McMANUS, Project Engineer

Investigation of Electrical Contacts in Low Power Level Circuits

THE use of transistors in Western Union's switching systems and elsewhere has resulted in frequent use of electrical contacts working into low voltage and low current circuits. This two-part report covers first, a survey of the history, literature and industry opinions concerning electrical contact performance in low level circuits; the second section concerns recommendations and means to prevent electrical contact failure in these circuits.

PART I

"THE electro-magnetic relay is probably the least understood, least standardized, and most abused of all components used in electronic equipment," says one authority.[1] This statement certainly seems to be true when one considers the subject of this report and the relation of contacts working into transistor circuits. Before proceeding to the relationship between mechanical contacts and transistor circuits it would be well to review previous work done in this area in the telephone and telegraph art.

Early Experience

The telephone industry by the very nature of its normal transmission of small a-c speech signals, encountered very early the problem of failure of relay contacts in such circuits. It was found that relay contacts which did not carry direct current signalling currents tended to develop high resistances to a-c speech signals of small magnitude. Investigation revealed, "that exposed metal surfaces are very seldom chemically clean and have substances with poor electrical conductivity which contaminate the surfaces."[2] This surface contamination, it was found, took the form of extremely thin surface films (perhaps a few molecules thick) which are produced by tarnish, grease, water or gases. Furthermore, it was found that very small speech voltages were often incapable of breaking down these thin films of insulating or semi-conducting material.

It was found that if the voltage applied to the contacts was above a certain critical level, the film breaks down in a manner analogous to the breakdown of a dielectric material. The collapse of the dielectric film provides a metallic path through the rupture to establish a metal connection.

A paragraph in reference[2] indicates that in modern circuit design it is the practice to supply a d-c potential to all contacts which are required to carry only speech currents. In the case of a typical telephone circuit shown in Figure 1, it will be observed that the breakthrough potential is usually obtained by shunting d-c blocking condensers with a resistance of 40,000 ohms. The process of passing a small d-c current through the voice signal contacts

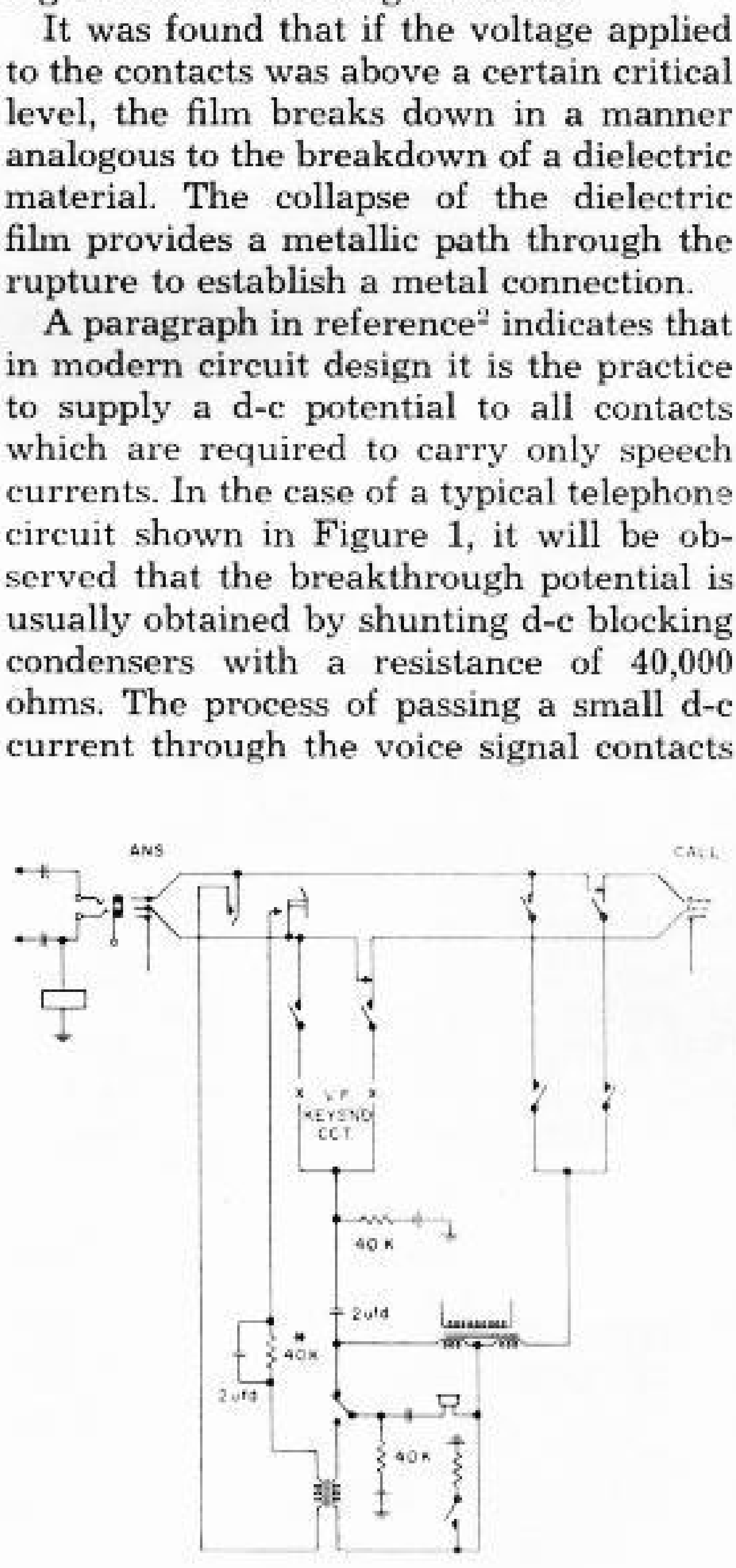


Figure 1. Section of Position and Cord Circuits taken from Reference 2 showing wetting * Resistor

is often referred to as the "wetting" of speech contacts. The value of the wetting resistance is so chosen that the potential difference across the contact is adequate to ensure the breakdown of the contact film but the resulting current after breakdown produces only a very small drop at the contacts.[3]

The switching circuits normally used in the telegraph and teleprinter systems of Western Union have been, until comparatively recent times, of the high level type. The potentials applied across relay and switch contacts have been 120 volts and over, well above the breakdown strength of any contamination films that might appear on the contact surfaces. Relays and switch contacts interrupted power levels in the order of 120 volts and 50 ma. The applied voltage was more than enough to break through the surface oxide films and the current through the rupture was sufficient to insure continued reduction of the contact resistance.

"Wetting" Potentials

With the advent of facsimile circuits, the power level through the switching relay contacts was down to a much lower level than that found in the telegraph and teletype circuits previously employed. Signal levels on a facsimile line can be found having maximum values of 5 db (with respect to a reference level of approximately 1 milliwatt) approximately 3 mw. Since these levels are comparable to those found in telephone voice circuits, it was found necessary to employ circuit "wetting" to break down films on contacts to avoid failure. A typical wetting circuit applied to rotary switch contacts is shown in Figure 2. The total voltage of 240 volts applied across the base metal contacts of the rotary switch insures adequate breakdown of contact contaminants. In applying wetting potentials care must be exercised to prevent these potentials from feeding back into low voltage parts of the circuit where damage could occur.

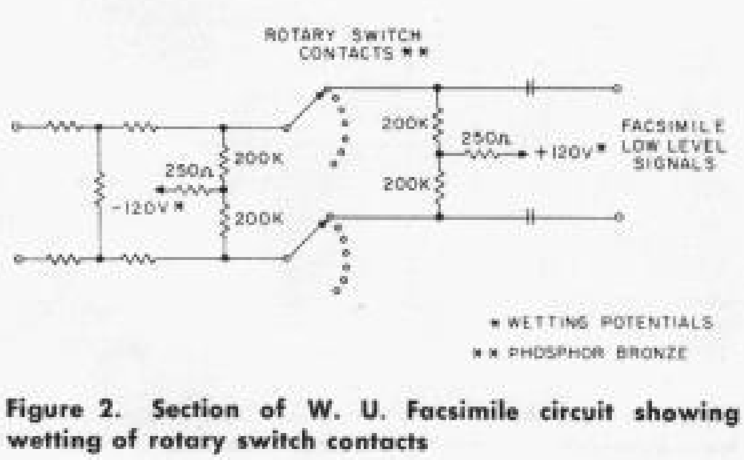


Figure 2. Section of W. U. Facsimile circuit showing wetting of rotary switch contacts

The recent widespread use of transistor circuits in conjunction with electromechanical devices such as relays and rotary switches has again emphasized the problem of contact failure in low level circuits.

A circuit difficulty was recently experienced due to the failure of refractory metal contacts in a polar relay used to drive a transistorized receiver-distributor. Figure 3 shows a typical polar relay with tungsten-carbide contacts which caused the circuit failure.

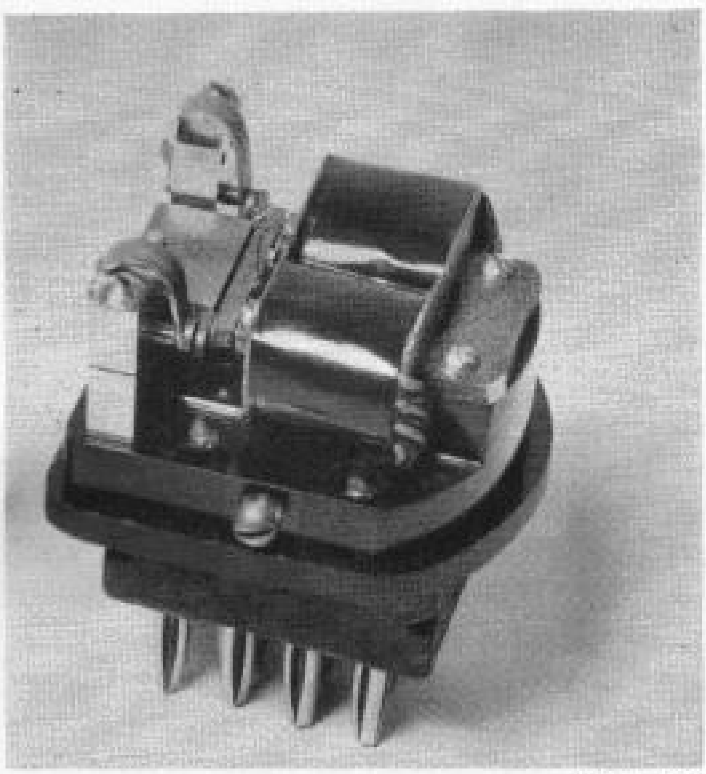


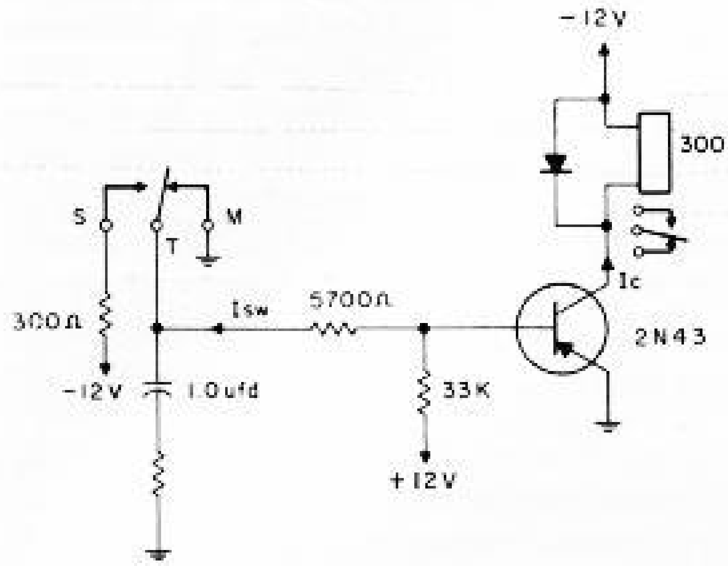
Photo R-8968

Figure 3. Polar relay with tungsten-carbide contacts

Transistor circuits are characterized by the low voltages and currents employed, in fact the power input to a typical switching circuit shown in Figure 4 compares with telephone system voice power levels.

Because of the low power levels required to switch transistor circuits, care must be exercised in the selection of the electromechanical contacts which may be employed in conjunction with the transistor circuit. Furthermore, circuits should be designed to provide adequate "wetting" currents by providing corrosive film breakdown voltages.

Data from field failures, laboratory evaluations and engineering estimates have shown that approximately 75 per cent of



Ic	.7 MA.	SWITCH	MARKING
Ic	40 MA	"	SPACING
Isw	.31 MA	"	MARKING
Isw	2 MA.	"	SPACING
INPUT POWER	3.7 MW.	"	MARKING
" "	24 MW.	"	SPACING
OUTPUT POWER	8.4 M W.	"	MARKING
" "	480 M W.	"	SPACING

Figure 4. Polar relay input to transistor circuit

relay failures encountered in the equipment of a prominent electrical concern can be charged directly to contact failure.[4]

Some of the most prevalent factors which cause contact failure can be summarized as follows:

(a) Contact contamination which results in:
1. Excess contact resistance.
2. Electrical contact wear.
3. Mechanical contact wear.

(b) Contact welding caused by:
1. Insufficient contact gap, excessive contact pressure, and overtravel.
2. Contact overload.

Contamination can be introduced in a relay in a number of ways:

1. Dust from manufacturing plants.
2. Organic material within the relay itself.
3. Transfer of iron and copper to the contacts during normal handling at the factory.
4. Other lesser known contaminants including the so-called frictional polymer, a brown or black powder which is noticed with the platinum family during contact with other metals in presence of some organic vapor.

Adhesion films are produced when a clean contact is exposed to air. Oxygen is deposited on its surfaces as physically absorbed molecules. These are the thin surface films of molecular thickness mentioned earlier.

Contact Resistance

Failure of contacts to satisfactorily complete a circuit is the result of the appearance of a resistance at the contacts that is above a specified or prescribed value. It has been shown that this resistance is due to combinations of the factors mentioned above. Two of these factors are:

1. Constriction resistance or that due to the restricted area through which the contact current must flow at the interface of the contacts.
2. Contamination resistance due to film or particle contaminants between the contacting surfaces.

Constriction resistance has been found to be directly proportional to the square root of the metal hardness.[5] When the noble metals and their alloys are used, because their hardness is generally lower than the base metal materials, the constriction resistance may be omitted from contact failure consideration at low levels. The following elements are found in the noble metal group:[6]

Gold	Rhodium	Silver
	Platinum	Palladium

The noble metals and their alloys are resistant to tarnish and are generally used at low contact pressures. They have low contact resistance.

Base metals such as copper and copper alloys, and refractory contact materials such as tungsten and molybdenum, have high contact resistance, oxidize and tarnish, and require higher contact pressures to break through tarnish films. Tarnish or oxide films can develop to a point on these materials that the contact resistance in low voltage circuits can be so high that a normally closed contact will appear to be open. The high melting point of the refractory metals make them resistant to electrical erosion and contact welding. Figure 5 shows a typical Western Union tape transmitter with contacts which can tarnish and oxidize.

Photo M-2950

Figure 5. Tape Transmitter

Constriction resistance could play a large part in the role of contact failure with base metals. A study of relay contact failure at low level shows that the generally accepted opinion is that contact contamination either by film or particle is the cause of failures.

The two distinct types of contaminants, film and particle, generally produce different magnitudes of contact resistance. The first is proportional to the thickness of the absorbed film on a given metal. The second will exhibit resistances of many megohms and is not related to the size of the particle until its diameter approaches the dimension which will allow tunnel conduction, bridging, or arcing between the contacts depending on the value of the open circuit voltage. It would appear logical that, while particle contaminants are a factor in the causes of low level misses, they exhibit approximately the same influence at higher voltage levels. Therefore, the major difference between high level and low level phenomena is film contamination.[7]

Low Level Circuits

The question of what constitutes a low level or dry circuit as contrasted with a high level or wet circuit seems to be divided by expert opinion into many areas for open circuit voltage; that from zero to 100 millivolts and a second area of 150 millivolts to about 15 volts. One authority places the dry circuit area up to 15 volts. The dry area is indicated as the area below the voltage at which the contaminants break down.[7] Opinions vary as to what constitutes the threshold of film breakdown voltage.

Industry Observations

In a discussion with a representative of a relay manufacturing concern the following points about relay contact operation in low level circuits were elicited:

1. Relay contacts with precious metals have been found to have a threshold voltage (the voltage below which the contaminant films generally will not break down) of approximately 32 volts.[8]
2. Gold is about the only contact material that can be trusted when you want to be sure of completing an electrical circuit on the first contact closure. When contacts are "to sit around" for a long time without any exercise at all and then suddenly be required to operate once or twice or three times, then gold plating at least could be justified, irrespective of the load conditions.
3. Where low level circuits are encountered wetting plus precious metal contacts should be used for absolute safety with respect to contact corrosion failure.

Base metals are usually employed in plugs, jacks, wipers and contacts of automatic switches, all examples illustrating the fact that, under conditions of proper pressure, relative sliding action, and frequent use, these contacts can be employed for reliable functions. Most of these devices were designed to work into high level circuits before the advent of transistor circuits. The results of this survey indicate, however, that contacts of relays, rotary switches, and other devices used in conjunction with transistor switching circuits which operate with lower potentials than those found in the usual telegraph circuits should be carefully designed to mitigate film contamination troubles. Where possible noble metal contact flashing such as gold should be used especially where small currents are involved.

Switching relay contacts used to drive transistor circuits should be made of a precious metal such as palladium and in addition, as a double precaution, wetting voltages certainly up to the highest available in telegraph circuits, i.e. 120 volts should be considered. When base metals are specified because of contact life considerations, as with polar relays, wetting voltages adequate to break the oxide films appear to be mandatory and should be incorporated in the circuit. Polar relays with contacts of precious or other nontarnishing metals, suitably wear resistant, seem to be desirable when transistor circuits are to be driven by these devices. Wetting voltages across the contacts should be used also as a precaution even though low-tarnish metals are used.

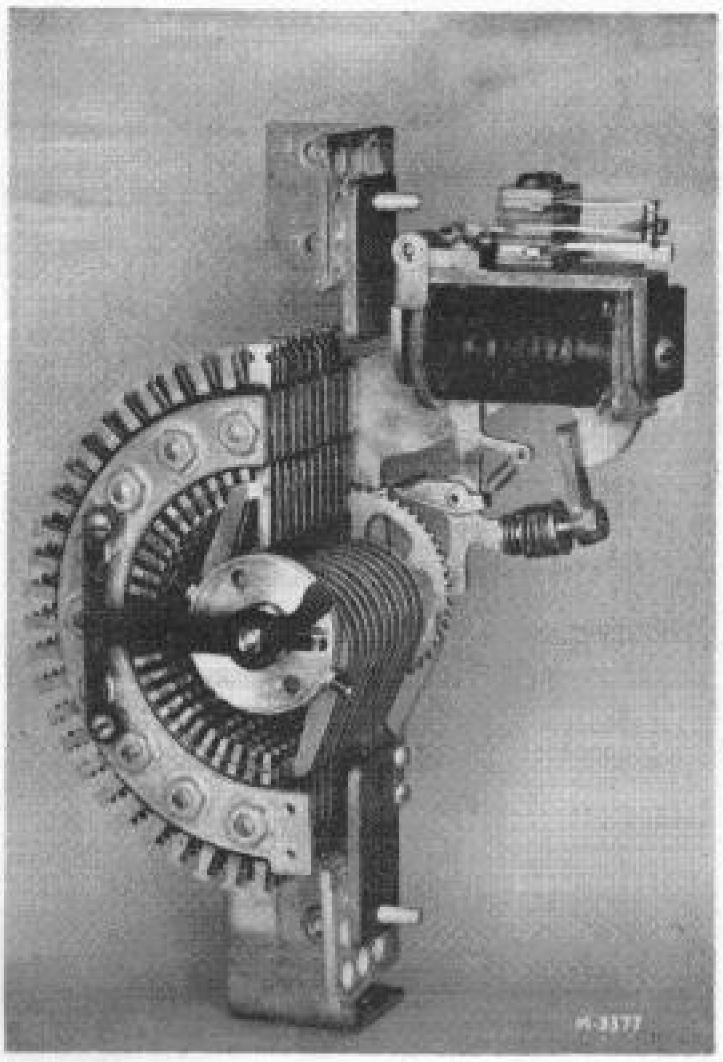


Photo M-3377

Figure 6. Rotary Switch with phosphor bronze contacts

Rotary Switches

Rotary switches using base metal wipers and studs, such as phosphor bronze, although usually less subject to film contamination because of high contact pressure and constant wiping, should be supplied with wetting voltages as an insurance factor against misses in low level circuits. In cases where rotary switches are allowed to stand over protracted periods and circuit contact misses on dry circuits cannot be tolerated, gold-plated contacts in addition to wetting potentials should be specified. Figure 6 shows a typical rotary switch with phosphor bronze contacts.

Conclusions from Survey

One overriding conclusion has been reached as the result of this survey of contact failure and it is the need to carefully specify the contact material of all contacts used in circuits which are in the low level or dry circuit category. Noble metal contacts are desirable in order to avoid resistive contact films on all contacts used in these circuits whether relays, switches, pin jacks etc. Where base metals must be used, adequate potentials should be supplied to break down the resistive films.

To supplement the observations given in the foregoing, one has only to peruse the current relay, switching and connector manufacturers' literature to see the frequent references to noble metal flashing recommended for critical contacts in low-level circuits. One manufacturer of communication equipment[9] making a study of electronic equipment, indicates that the hesitation felt with regard to electronic systems is "probably due to a large extent to inefficient contacts in soldered joints and jacks. Electronic systems are vulnerable to this type of fault owing to the low power levels passing the contacts." This opinion of the role of the contact in the marriage of electromechanical devices and electronic equipment, especially transistor devices, shows the need for care in the choice of materials and design of the contact circuits.

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PART II

The results of the survey of electrical contact performance in low level circuits summarized in Part I indicate the need for careful choice of contact metals and circuit means for preventing failure due to contact contamination.

Surface Film Threshold Voltages

The survey of Part I was reviewed and additional sources consulted with respect to the range of threshold voltages required to break down the surface films. Besides the voltages indicated in Part I; additional references cited figures of 20 volts,[1] 27 volts,[2] and 270 volts respectively. Table I, below, summarizes the range of voltages found in the survey.

Table I

Source	Threshold Voltage	Remarks
A	15	Reference 5, Part I (Results of survey of relay manufacturers and users)
B	20	Reference 1, Part II (Statement from patch-cord manufacturers literature)
C	27	Reference 2, Part II (Figures derived from statement in reference 2)
D	32	Reference 8, Part I (Dr. A. B. Smith, Automatic Electric Co.)
E	270	Bibliography, Ref. 12 Part I

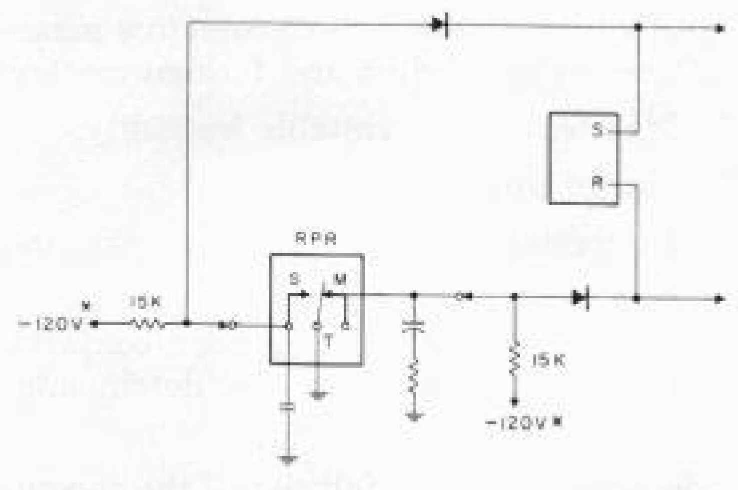
The voltage indicated in (E) was found in a BSTJ article, reference[12] of the bibliography, Part I. This article indicated that the polymers found on palladium contacts, under certain conditions, had a resistance of many megohms and required as much as 270 volts to break through the insulating film. Despite this one reference to such a high voltage, a thorough reading of the technical magazines and literature of the telephone industries, both domestic and foreign, one cannot find wetting voltages over the standard telephone battery, which in most cases is not higher than 50 volts. Furthermore, concerning the high polymer breakthrough voltage of source E, reference[2] Part II has this observation; "For contacts which do not arc and operate fairly slow, with comparatively light impact, the result (of polymer powdering) is complete contact failure. With arcing or heavy impact contacts, a lower and more variable resistance may develop, thought to result from a partial carbonizing of the polymer. Under ordinary conditions such failures are very rare less than one per ten million contact operations." In the light of this reference it is felt that with the avoidance of organic vapor sources and with the normal contact pressures found in the Western Union Telegraph Company's switching relays the polymer powder contact failure problem can be minimized.

It is evident from this survey that the telephone industry uses the highest battery voltage available as a wetting voltage across the speech or low level circuit contacts and is careful to limit the energy level below the destructive arcing point.

Specific Recommendations

In view of the data shown in Part I of this report and the foregoing paragraphs the following recommendations are made to cover electromechanical and other contacts working into transistor and other low level circuits used by Western Union.

1. All contacts using metals such as tungsten, tungsten carbide, phosphor bronze, etc. not including studs and wipers of rotary switches in motion shall have a wetting voltage of 120 volts d-c supplied through the contacts. This voltage shall be applied to the contacts with a series resistance sufficient to limit the current so that the energy supplied for wetting does not exceed approximately 1 watt. See Figure 7 for a typical field application.



* WETTING VOLTAGES

NOTE: BLOCKING DIODES USED TO PROTECT TRANSISTOR CIRCUITS.

Figure 7. Section of circuit using polar relay (W. U. Type 202) with tungsten carbide contacts driving a transistorized receiver distributor

2. Contacts of switching relays either single or twin using palladium, palladium silver, platinum-ruthenium, etc. shall have a wetting voltage of 120 volts d-c supplied through a resistor to limit the wetting energy to a maximum of approximately 0.25 watt. Figure 8 shows a spring-leaf relay with palladium contacts.

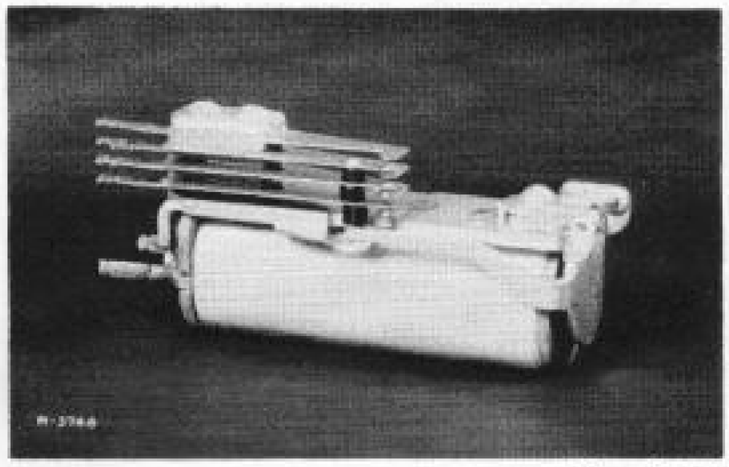


Photo M-3748

Figure 8. Relay with palladium contacts

3. Electromechanical or mechanical devices having gold plating either over base or other metals shall be used where low level circuits are switched and contact tarnish films are to be avoided. Contacts not used frequently where contact contamination could occur, such as with base metals, should be plated or flashed with gold.

4. In cases where gold-plated contacts are used and maximum certainty of contact operation is desired, for example, where contacts are lying idle and upon suddenly being activated, could possibly fail, due to a possible contaminant on the noble metal, wetting energy should be supplied. This energy should be limited to approximately 25 milliwatts by means of a suitable series resistor and a supply voltage of ± 120 volts d-c.

5. Rotary switch wipers and studs made of phosphor bronze which work into low level switching circuits, such as transistors, and which are required to

stand still for protracted periods should be gold plated or flashed. The wetting energy specified in paragraph 4 above would apply, if film breakdown voltage is also required, for maximum contact assurance.

6. Rotary switch wipers and studs made of phosphor bronze, carefully maintained as to contact pressure and lubrication, in continuous use (frequently rotated), and yet used in low level circuits, should have a wetting energy limited to 25 milliwatts at ± 120 volts d-c supplied through the contacts.

Table II shown below summarizes the recommended contact wetting energies at ± 120 volts d-c for various contact materials mentioned in paragraphs 1 through 6. The table shows the series resistance and current at the specified power level.

Table II

Material	Specified Wetting Power— Watts (NI)	Wetting Current at 120V.—MA.	Series Resistance Ohms
Tungsten	0.96	8	15K
Palladium	0.25	2	56K
Gold	0.025	0.2	620K
Phosphor Bronze	0.025	0.2	620K*

* For rotary switches frequently in motion, other phosphor bronze devices use same values as for tungsten.

Method of Developing Standards

These recommended standards are based in one case on one empirical value; for example, that for tungsten is in an actual working circuit in the field. The remaining standards are derived from this empirical data and ratios were applied to the other contact materials shown in the table. The wetting energy was taken as a fixed percentage (0.2 of 1 percent) of the manufacturer's recommended values for normal noninductive break or make d-c load for the contact metal under consideration.[3] Furthermore, an endeavor was made to keep the total contact load i.e., normal contact plus wetting load, below the minimum arcing watts for the various materials as outlined in reference[1] of the Bibliography of Part I. Particular care was applied to the figure for gold because of the inherent tendency of gold to weld at low currents.

In the case of polar relays working into transistor circuits it may be necessary, where circuits are critical, and contact failure cannot be tolerated, to employ tungsten carbide in combination with noble alloys or all palladium besides the recommended wetting energy specified in this report.

General Recommendations for Contact Reliability

Besides the methods specified in the foregoing paragraphs to mitigate contact failure in low level circuits, the following well known methods can be used for improving the reliability of contacts in these circuits.

1. Use of precious metals such as platinum, palladium, gold, silver or alloys of these metals where enough contact pressure cannot be provided or it is not desirable to "wet" the contacts.
2. Use of high contact pressure.
3. Double or twin contacts.
4. Lubrication of nonprecious metal contacts in the case of sliding contacts (e.g. wipers).
5. Air filtration or other protective measures to avoid dust and foreign matter.
6. Maintenance of suitable humidity.
7. Use of protective covers.
8. Protection against fumes, vapors and gases.
9. Avoidance of the use, near contacts, of materials likely to be detrimental to the contacts.

In conclusion it is felt that if the recommendations specified in this section of the report are carried out, the probability of contact failure will be considerably reduced when electromechanical or mechanical devices are working with low level circuits such as transistors.

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The End of an Era

"Editorial Note" — While there are no Western Union Camp Car complete outfits remaining in the United States there are some material cars still in service. There is, however, one camp car complete outfit north of the Border in the Canadian Maritime provinces where Western Union maintains pole lines along the Canadian National R.R. Here the country is sparsely settled and suitable boarding accommodations difficult to find.

IN 1960, the last of the Western Union owned railway camp car outfits in the United States was sold by the Pacific Division to a junk dealer in Portland, Oregon. Thus an era covering almost half a century came to an end, the era of the Western Union owned railway camp car outfits. The very important part these outfits played in the growth of The Western Union Telegraph Company is little known today. Only the "graybeards" who regarded them as a way of life during the era just passed are familiar with the contribution camp car outfits have made, and whenever they get together they recall the interesting events and incidents that had their origin in and around these outfits.

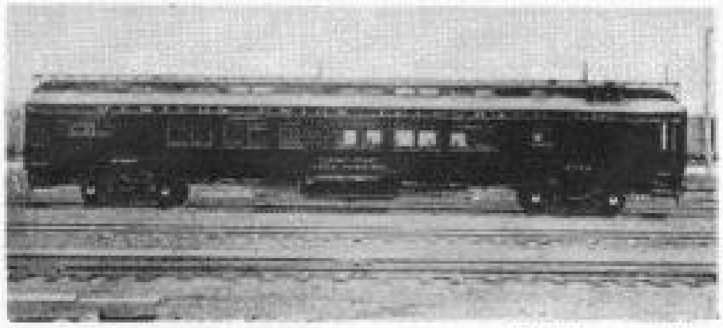
Prior to 1914, "line gangs," as they were called, were housed either in hotels or in railroad owned boxcar outfits that were equipped with such bare necessities as double-deck bunks, pot-bellied stoves, wash bowls, oil lamps, and other appointments in keeping with the time.

By 1914, many of the original pole lines were in need of repair because of deterioration or because the ever increasing wire load had become too great for the older pole lines to carry. Thus was undertaken the beginning of a heavy reconstruction program that was to last until the latter part of the 1920's and the start of the depression. The program reached its peak between 1925 and 1930.

At the start of this program, The Western Union Telegraph Company foresaw the benefits that could be derived from having the line gangs housed in outfits that could be set out at any location at any time or that could be moved to emergency areas quickly, at a much lower cost than if they were housed in hotels, some of which might be long distances from the jobsites.

It was decided to place many of these outfits in operation and, by purchasing the necessary cars where available and equipping them in railroad shops, to place them in operation as fast as they could be made available. This arrangement proved to be neither practical nor economical. In order to correct this situation, a camp car shop was established at Chattanooga, Tennessee as a headquarters for all outfit remodeling, maintenance, and supplies. This shop flourished and was busy continually until about 1930, when it entered upon a decline in activity that continued until a few years ago when the servicing of outfits was no longer required. (The camp car shop was then converted into a shop for manufacturing and assembling equipment to meet other and present day requirements.)

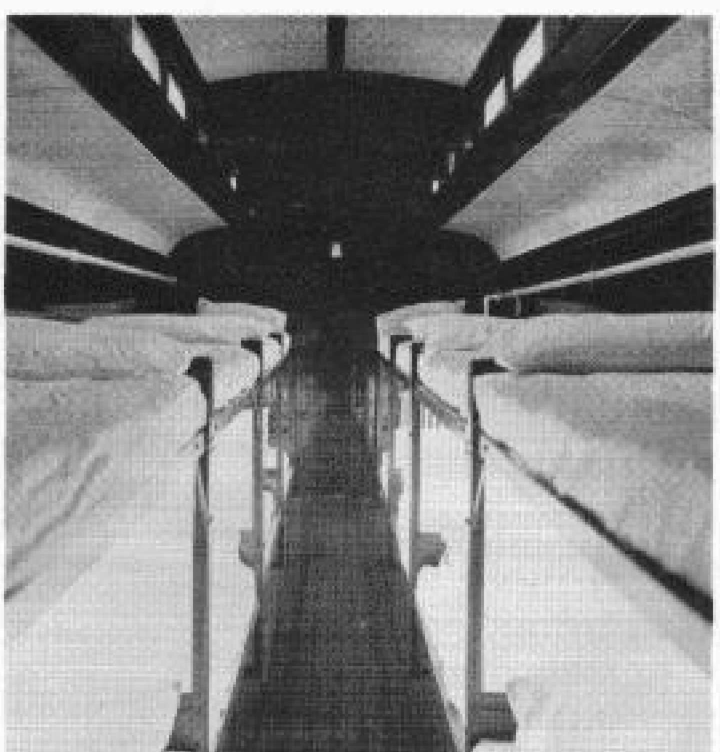
By the end of 1914, twelve such outfits had been placed in service. These represented a great improvement over the earlier railroad bunk cars. They were lighted with individual Coleman gasoline lamps and were equipped with hot water and shower bath facilities. A hand-operated pressure pump, located behind the kitchen stove, supplied the water pressure for the wash basins, shower baths, and kitchen. (The first rule of the water system in those days was that anyone desiring a shower must first pump the water pressure up to sixty pounds. As the cooks were required to pump their own water for kitchen use, they were the ones who saw to it that everyone pumped his own water.) As the processing of these outfit units progressed, many improvements were made in the equipment. For example, the individual Coleman gasoline lamps were replaced with a series of lights that had their fuel supplied from a centralized pressure tank.



Chattanooga Photo

Pullman Coach

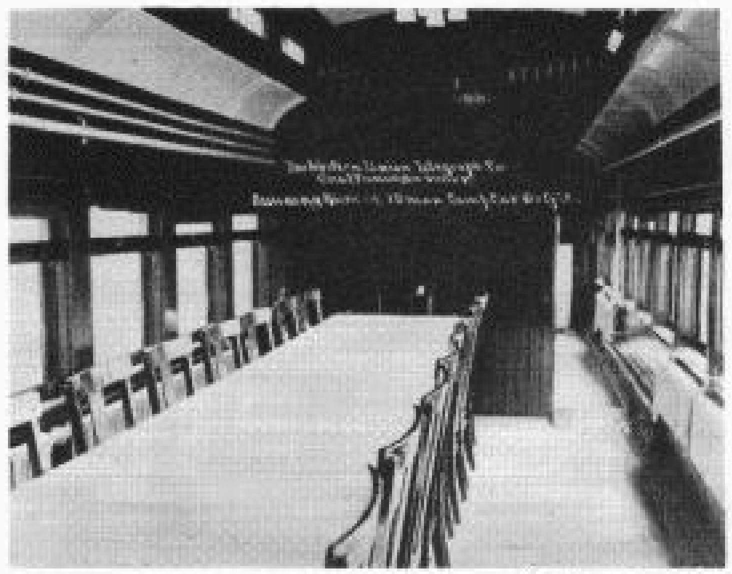
At the peak of the heavy reconstruction period, between 1925 and 1930, there were about 120 of these outfits scattered throughout the United States. By that time, the type of railroad cars used and the arrangement of the associated equipment had been fairly well standardized. These later models consisted of two Pullman cars about seventy feet in length (one sleeping car and one dining car), two boxcars (one tool car and one material car), and a steel tank car (water car). In fact, No. 10 recently sold at Portland consisted of two Pullman coaches, two boxcars, one tank car, and associated equipment.



Chattanooga Photo

Sleeping Quarters

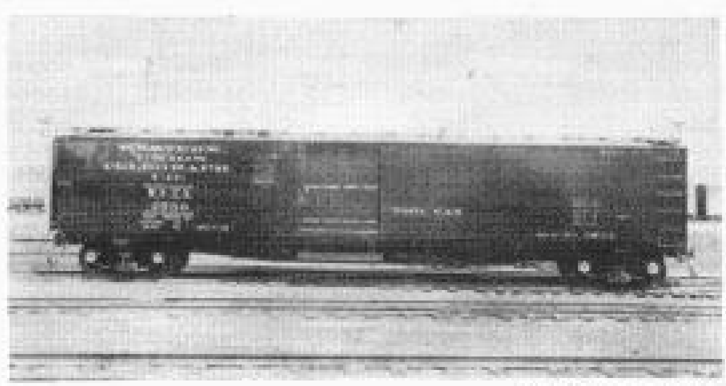
The sleeping car was partitioned into three sections or rooms. The foreman had small private quarters at the end of the car, equipped with bed, lockers, chairs, desk, and wash basin. Adjacent to this room was the men's dormitory, which was equipped with two rows of double-deck bunks that would accommodate sixteen men. These two sections covered a little more than half the coach. The remaining section was used as the men's recreation room and for locker space.



Chattanooga Photo

Dining Room

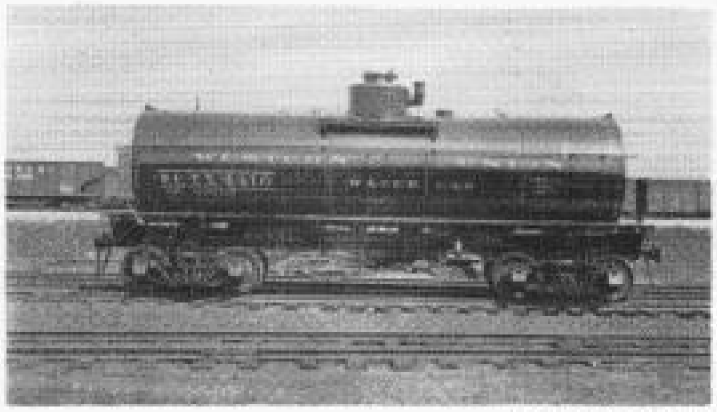
The second coach or dining car had living quarters to accommodate the man and his wife who were the cooks, a shower room and wash room for the men, and the dining room and kitchen.



Chattanooga Photo

Tool Car

The tool car housed the tools, Delco light plant and battery bank, coal bin, icebox, and storage space for vegetables. The Delco plant furnished power for the operation of all lights. The electrical system was 32 volts d-c. The automatic water pressure pump supplied water pressure for the dining car only. The tank car (water car) which carried the water supply was adjacent to the tool car. Water was carried from the tank to two auxiliary "possum belly" tanks located under the dining car; from these it was pumped out by the automatic pump as required.



Chattanooga Photo

Tank Car

In the early days, the outfit cooks consisted of two men, a "Bull Cook" and a "Flunky." This arrangement was not a reliable one, especially if the outfit happened to be located near a bootlegger or a saloon and the cooks happened to be fond of drink. By 1918 a more dependable arrangement had been found; a man and his wife were being hired as cooks for each outfit.

By 1943, Republic Pictures rented one of these outfits at Cedar City, Utah for use in portraying an early-day passenger train. It "starred" in the film "in Old Oklahoma" and "co-starred" John Wayne and Martha Scott. The studio repainted the exterior of the coaches with water colors for the filming and paid the expenses of the Western Union crew at a local hotel while the cars were in use. This is one of the favorite reminiscences of the men who used to work in the gangs, along with other such highly personal remembrances as the time a gang foreman tried to make homemade elderberry wine secretly and it foamed out of his locker because he did not allow for expansion in the container during fermentation.

There were several contributing factors that forced the discontinuance of the use of this last representative outfit of the camp car era. The reduction in the size of line crews from the original sixteen men to an average of about eight made the operation of an outfit more expensive than hotel accommodations would have been. Because western railroads had discontinued the use of their own camp car outfits wherever possible and had removed storage tracks in a majority of the small towns, it became necessary for Western Union to construct temporary spur tracks for the outfit at a cost of about $700.00 per location. Also, the repair parts for the Delco lighting, the water pressure system, the Arcola heating system, and the coal-burning cook stove were no longer available from any source. At the end, the outfit was kept in operation for several years for the sole purpose of handling projects located in the mountain and desert regions of the Pacific Division where hotel accommodations are few.

With the sale of outfit No. 10, the graybeards mourn the passing of an era that began in the days when the line gangs were paid their earnings in gold coins sent to the foreman by way of American Railway Express and has ended in these days when line crews are paid by machine-punched checks.

Nell Organ Ramhorst

Miss Nell Organ, Secretary to the Committee on Technical Publication, retired from Western Union June 30, 1961 after 31 years of service. Miss Organ joined the Engineering Department after having studied at West Virginia University and the University of Pittsburgh for two years, and having worked for several years for the New York Consolidated Edison Company's engineering department. She later continued her studies at New York University, specializing in English composition and short-story writing, and acquiring proficiency in the French language.

Miss Organ came to Western Union as secretary to the Assistant Chief Engineer Mr. Paul J. Howe. As Chairman of the Committee on Technical Publication, Mr. Howe started the WESTERN UNION TECHNICAL REVIEW in 1947. Upon his retirement in 1949, Miss Organ took over the editorial duties, and continued to handle distribution and the accounting records for the REVIEW. She continued these duties up to her retirement, in addition to acting as Secretary for the Technical Publication and d'Humy Award committees.

She will best be remembered for the outstanding work she has done as Editorial Secretary of the TECHNICAL REVIEW for the past 14 years. She offered a helping hand to many of the engineers who so generously contributed to the success of the REVIEW. Due to her long experience with the diverse technical subjects she so ably handled, she became a most proficient technical adviser. She herself wrote a valuable article on Central Office Engineering of Modern Telegraph Offices which appeared in the REVIEW.

The many readers of the TECHNICAL REVIEW join in wishing for Miss Organ, who is Mrs. W. J. Ramhorst in private life, health and happiness in her well-earned retirement.

Patents Recently Issued to Western Union

Facsimile Scanner

D. M. Zabriskie, A. Hofer
2,978,288—April 4, 1961

In a facsimile recorder employing a flexible nonconducting stylus belt with stylus holders mounted thereon adapted to slide under magnetic attraction in electrical contact with a pair of grouping bars, the bearing surfaces of both the holders and bars are provided with sintered metal carbide inserts which are conductive, resist wear, and also introduce a gap into the magnetic path thereby to reduce the nonuniformity of the attractive force consequent upon the intermittent spacing of the attracting magnets.

Error Detection in Telegraph Switching Systems

R. Steeneck, D. J. Walker, R. H. Leonard
2,978,541—April 4, 1961

In a transistorized error detecting transmitting and receiving system for 5-level perforated tape the original message tape is read twice by a dual pin transmitter which passes the signals respectively to a reperforator for preparing the final sending tape and to an error check apparatus which includes an 8-stage binary counter which determines a count for the marking pulses occurring within a block of the tape. The count is made in accordance with a special weighting system based upon the differing error susceptibilities of the five levels of perforations. A 2-character symbol representing the complement of the count is then sent to the reperforator for incorporation into the message block. In preparing the original message or data tape it is divided into standard blocks, usually of 72 characters each, the first block of the message prefaced by a 3-character code and subsequent ones by a line feed, LF. All blocks end in a carriage return, CR, except the final block of the message which ends in a 4-character code. These characters are read in a reading matrix and serve respectively to start, reset, and finally to deenergize the counter. Routing and end-of-message characters remain outside the blocks. The error check characters use only four levels of the code, leaving the third level always marking so as to prevent interference with the regular functional characters. The double reading transmitter guards against tape reading errors, a "long block" indicator guards against omissions of the CR terminating characters, and further provision is made for checking the entire reconstituted tape before sending. The receiving equipment is somewhat similar but operates in complementary fashion to identify the blocks, count the marking pulses, compare with the transmitted check characters, and in the event of a wrong comparison to operate an alarm and mark the block of tape with a red stripe.

Telegraph Way Station System

G. G. Light, W. J. Wichtendahl
2,982,809—May 2, 1961

A way station selection system in which the way stations are invited sequentially by the terminal station to send traffic and, to expedite the sequencing process, the last invited station, when it has finished sending, itself sends the invitation character to the next succeeding station. The way stations include keysets for sending prepared or coded data, a tape transmitter and a receiving printer all connected individually to line via a control apparatus. Whenever transmission from any station stops, the control apparatus of all stations automatically cuts in, and upon resumption of transmission a selected control character is automatically transmitted to restore the former condition. The control apparatus distinguishes between keyset and teleprinter traffic, and control signals, and is the seat of various circuit and traffic safeguards. It also converts the binary coded signals of the keyset into telegraph permutation code and vice versa.

Facsimile Transmitter

W. D. Buckingham, N. R. Lane, G. H. Ridge, F. T. Turner
2,982,815—May 2, 1961

A flat-bed oscillating mirror type of facsimile scanner as described in Patent No. 2,903,512 with added manual settings which provide for advancing nonmessage areas at a faster than normal rate, with blanking of these areas. Blanking of the nonmessage areas of narrow width messages is also provided for. The scanner includes an improved light collection system which intercepts light formerly wasted and directs it to the photocell.

Tape Winder

W. V. Johnson

2,993,659—July 25, 1961

A winder for perforated telegraph tape which provides a tight even wind of tape from beginning to outer periphery of the roll so as to always secure the maximum capacity of the reel. The tape incoming to the reel forms a loop from which is suspended the outer extremity of a switch lever so arranged that the switch is closed to operate the motor while the loop length lies between limits of two and five inches. After traversing the loop the tape is restrained by a snubber pivotally supported so as to maintain a constant alignment and uniform tension on the tape from beginning to finish of the roll.

Error Detecting System for Telegraph Transmission

R. Steeneck

2,993,956—July 25, 1961

An error detecting system illustrated for 5-level code but not limited thereto in which the number of marks (or spaces) in a line of type are counted according to a system of numbering in which the levels are weighted according to their susceptibility to error and the sum for any number of levels cannot equal the number for any single level. The level numbers 1, 2, 4, 8, 16 to give a modulus of 256 and an 8-stage binary counter are illustrated. At the beginning of a line, counting is initiated at both the transmitter and receiver by a "carriage return" signal and at the end of the line the next CR signal causes transmission of two check characters to the receiver, the first representing the "0" condition of the first four stages of the counter and the second representing likewise the last four stages, thus indicating the complement of the binary total. The code used omits the third level but substitutes a mark therefor so that these check characters cannot falsely simulate any susceptible regular alphanumeric or function characters. This complement, when added to the count total stored in the receiver counter will set each stage to its "1" position if there are no errors. Appearance of an "0" indicates an error and sounds an alarm. As modifications, the binary total instead of the complement may be transmitted and the checking functions of transmitter and receiver may be reversed.

INDEX

JANUARY 1960 (Vol. 14, No. 1) — OCTOBER 1961 (Vol. 15, No. 4)

SUBJECT

INDEX (Continued)

SUBJECT

AUTHORS

INDEX (Continued)

AUTHORS