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

CONTENTS FOR JANUARY 1960

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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

W/U

Cooperation for Progress

RAY HOOVER
Vice President
Plant Department

Another year has ended and we are now on the threshold of a new one. We can be proud of our accomplishments during the year 1959 and I feel quite sure the experience gained will be of invaluable assistance in our efforts in 1960.

We have a large program planned for 1960 and it will take a lot of effort to obtain the objective end result. A continued spirit of cooperation among the employees and teamwork between the various departments is bound to carry to a conclusion all facets of the program.

We have a live, wide-awake company which is well regarded in the eyes of the users of all phases of the written communication field. Let's make our progress in the year 1960 the best yet.

A Happy and Prosperous New Year to all of you!

Ray Hoover

January 1, 1960

ROBERT STEENECK, Assistant to Automation Engineer

HAROLD F. CALEY, Assistant Automation Engineer

Detection of Transmission Errors in 5-Level Punched Tape

It is often desirable for data transmission systems to incorporate some form of error detection. Employment of transistorized telegraph circuitry which includes simple 8-stage computers or binary counters offers an advantageous means of detecting data transmission errors which may appear in received 5-level perforated tape.

BUSINESS concerns in this age of automation are making steadily increasing use of their leased telegraph systems for the transmission of data in 5-level tape form. The number of errors introduced in the data by transmission over high-grade facilities is relatively small and can be tolerated in many business applications. In some situations, however, the error frequency must be reduced to the lowest possible rate. For these situations the Telegraph Company has developed equipment which will incorporate redundant check characters in the data at the transmitting end of the circuit, perform the check and delete the check characters at the receiving end.

Error-Checking Principle

The first problem which must be resolved in the design of an error-detecting system is which of the many possible error-detecting codes will be used. As this system had to be compatible with conventional 5-level telegraph switching equipment, use of any of the simple vertical parity checks was ruled out because they require at least six levels. In addition, extensive tests showed that vertical parity checks are relatively ineffective when the bits making up a character are transmitted serially as they are on a telegraph circuit. Approximately 10 percent of the errors encountered in telegraphic communica-

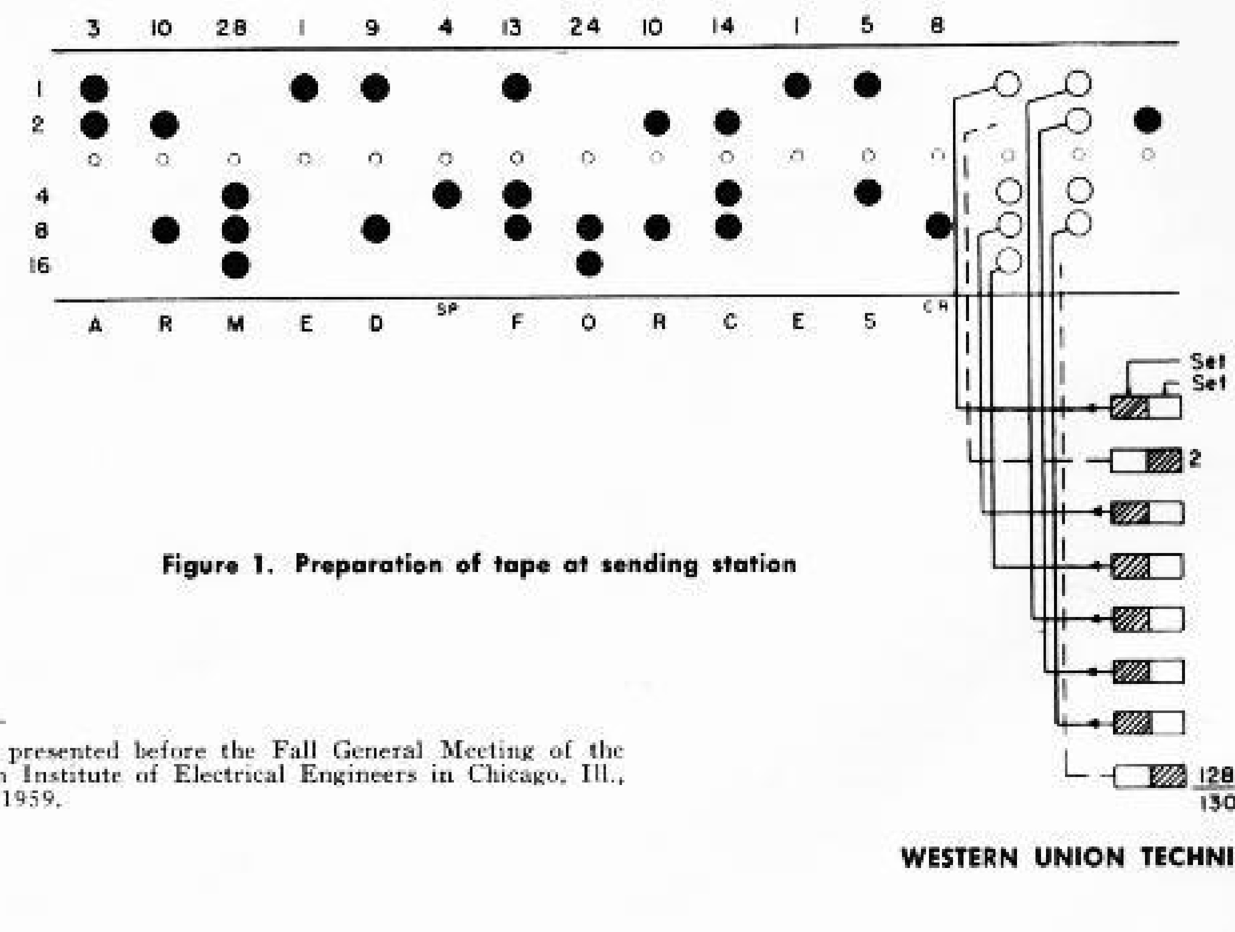


Figure 1. Preparation of tape at sending station

A paper presented before the Fall General Meeting of the American Institute of Electrical Engineers in Chicago, Ill., October 1959.

tions affect two bits in the same character and the resulting errors are not detected by the simple vertical odd or even parity check. The information which can be transmitted in any given time is also reduced by 16-2/3 percent. More complex vertical parity checks have been devised which lower the 10-percent undetected error rate but they further decrease the rate of transmission.

Attention was, therefore, directed to the horizontal-type checks and tests were made of the effectiveness of a single horizontal parity character at the end of each line (maximum of 72 characters) and a 2-character binary total at the end of each line. Both of these checks proved superior to the vertical parity checks with the 2-character binary total being the more effective of the two. It had the further advantage of reducing transmitted information per unit time by less than 5 percent. Accordingly, this system was adopted.

Figures 1 and 2 illustrate the basic features of the 2-character binary total error-detection system. Each character is considered a 5-digit binary number with levels 1 through 5 having weights 1, 2, 4, 8 and 16, respectively. The characters in a variable-length line which does not exceed 72 characters are totaled up to and including the carriage return.

The simple computer used has 8 stages and can therefore total from 0 to 255. As the total for a line of 72 characters can be as high as 2,232 the counter will cycle a number of times in totaling an average line. This raises the possibility that equipment troubles in switching centers such as sticking pins on transmitters will consistently add or drop a number of pulses in one of the levels which may be sufficient exactly to cycle the counter and cause the errors to be undetected. This cannot occur in levels 1 and 2 when the block length is limited to 72 characters because 256 pulses must be lost or gained in level 1 and 128 pulses lost or gained in level 2. However, the possibility does exist in levels 3, 4 and 5 where gaining or losing 64, 32 and 16 pulses, respectively, will cycle the counter.

A simple modification which causes the computer to cycle on a count of 255 instead of 256 greatly improves this situation and requires that 255 pulses be added or lost in any one of the 5 levels before a computer cycle can be gained or lost. This, of course, cannot occur in 72-character groups.

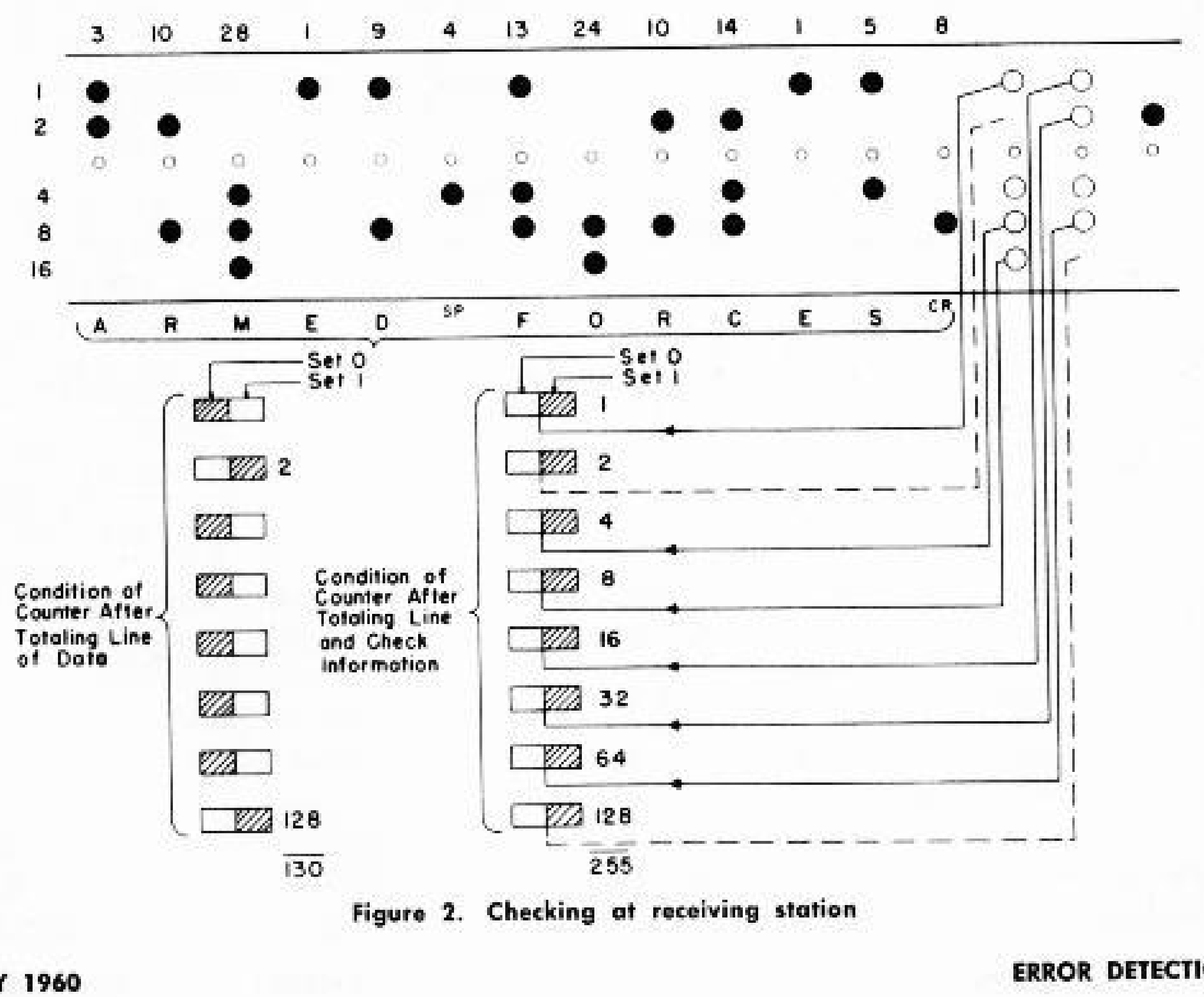


Figure 2. Checking at receiving station

At the end of the group the complement of the 8-digit binary total in the computer is punched in the tape as levels 1, 2, 4 and 5 in two characters. The third level of each of these characters is always punched to avoid the formation of control-character combinations such as FIGS, H and CR, CR used in switching systems. The checking process at the receiving station consists of again totaling the characters in the group in a computer very similar to the one in the sending unit. The eight binary digits in the two check characters are also totaled and if no errors were introduced in transmission this results in all eight stages of the computer being set on 1. The binary additions in Table I illustrate the processes taking place in the sending and receiving computers for the short blocks of data shown on Figures 1 and 2.

same block of data. This condition, fortunately, is quite rare on high-grade land lines. Much more frequent is the mutilation of several successive bits by one "hit" on the line or the shifting of a marking bit from one level to the next and this system prevents such errors from being compensating.

System Design

Both sending and receiving units operate at 200 words per minute and are, therefore, capable of handling up to three 65-word-per-minute transmission circuits.

The equipment can be packaged in different ways depending on whether data will flow in only one direction or in both directions. The simplest system for checking data flowing in one direction will be described but it will be noticed that sending and receiving station equipments are very similar and with only minor additions and modifications could serve both functions.

TABLE I. COMPUTATIONS AT SENDING AND RECEIVING STATIONS

Sending Station			Receiving Station		
Character	Binary Number	Decimal Number	Character	Binary Number	Decimal Number
A	00011	3	A	00011	3
R	01010	10	R	01010	10
M	11100	28	M	11100	28
E	00001	1	E	00001	1
D	01001	9	D	01001	9
Space	00100	4	Space	00100	4
F	01101	13	F	01101	13
O	11000	24	O	11000	24
R	01010	10	R	01010	10
C	01110	14	C	01110	14
E	00001	1	E	00001	1
S	00101	5	S	00101	5
CR	01000	8	CR	01000	8
TOTAL	10000010	130		10000010	130
COMPLEMENT	01111101	125	COMPLEMENT	01111101	125
			TOTAL	11111111	255

If any of the bits in the block were reversed during transmission it can be seen that the foregoing process would result in at least one of the stages in the receiving computer being set on zero.

With this checking system errors occurring in one character can be compensated for by equal and opposite errors in the same level in another character in the

The checking equipment at the sending station is illustrated in Figure 3 and a block diagram is shown in Figure 4.

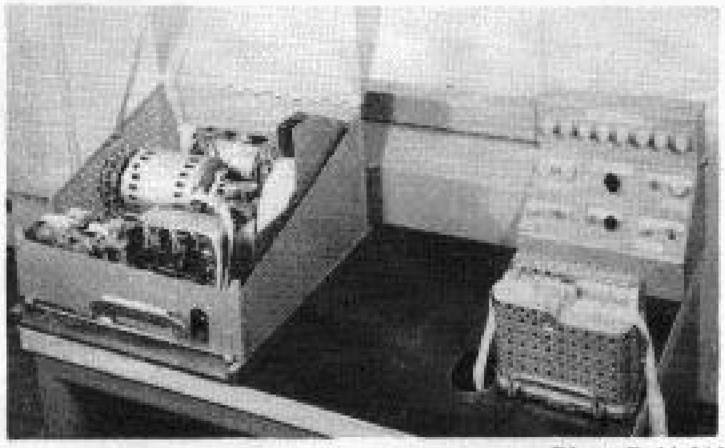


Photo R-11,503

Figure 3. Sending station equipment

Sending Station Operation

The sending end equipment is primarily designed to produce from the data tape a new tape incorporating check characters at the end of each line of data. To start this process the selector switch is set to the "Generate Tape" position and the data tape without check characters which has been prepared on a Type 19 set or other tape producing equipment is fed through the special dual reading transmitter. This transmitter has two sets of reading pins 0.1 inch apart which is the distance between characters on the tape. The first set feeds the computer and the second set feeds the reperforator through the check character switch and the character-reading matrix. Routing information at the beginning of the tape for the control of switching centers is transmitted to the reperforator but is not sent to the computer which is turned off at this time. At the end of the routing information a special 3-character code which has been inserted in data preparation is read indicating the beginning of the data. At this point the computer is turned on automatically and set to zero count. In the block diagram the starting 3-character code is shown as FIGS, A, LTRS; however, any combination could be used.

The entire first block of data ending with CR is sent to both the reperforator and the computer. When CR is read by the matrix the transmitter is stopped, the two check characters are transmitted from the computer to the reperforator and the computer is reset to zero. This process is repeated for the next data block beginning with LF and ending with CR, and for succeeding data blocks until the end-of-data characters FIGS, A, F, LTRS are read. This combination turns off the computer and allows the message terminating characters to be transmitted only to the reperforator. By using two sets of reading pins in the transmitter, one to transmit to the computer and one to the reperforator, the pos-

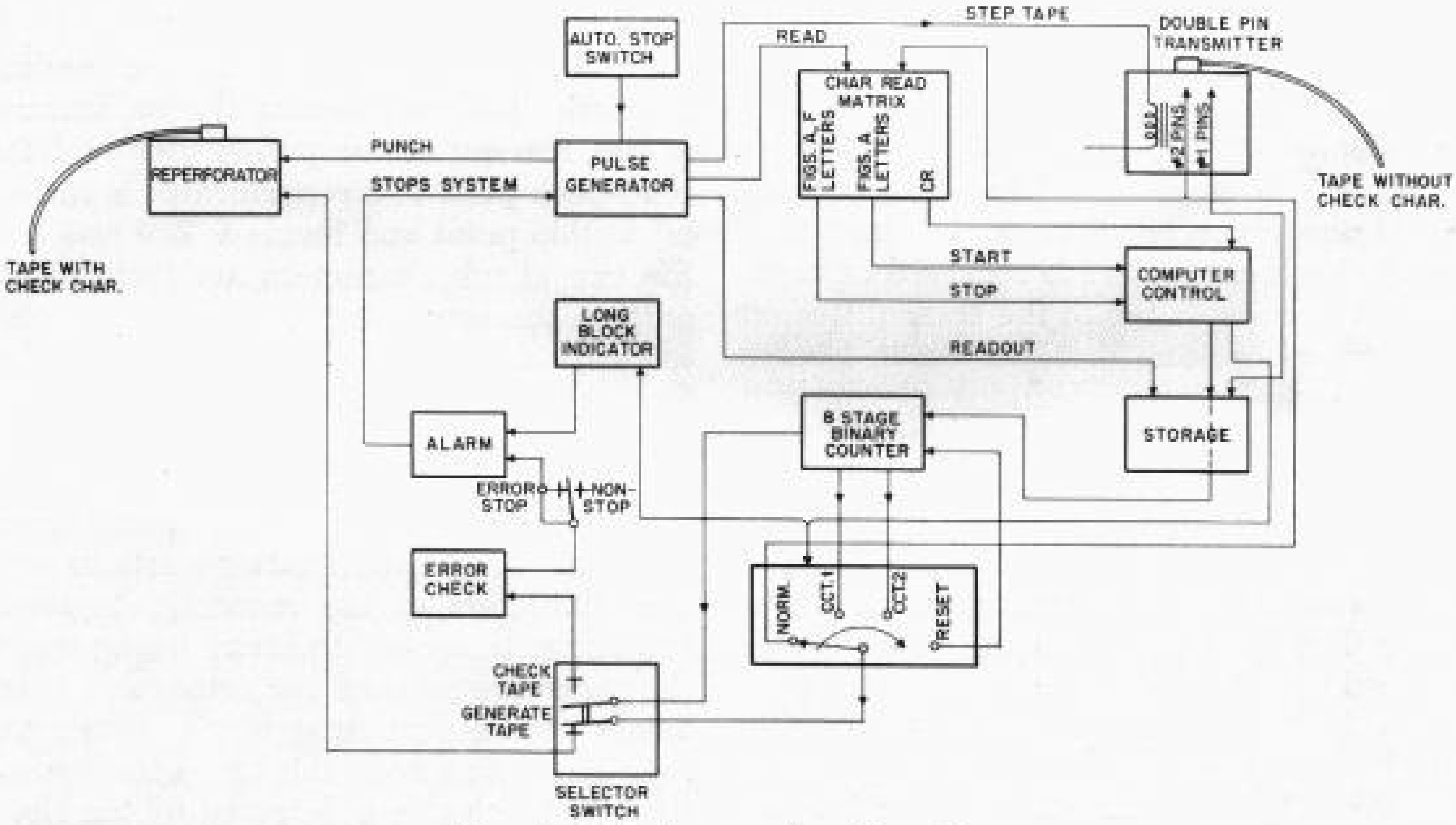


Figure 4. Block diagram of sending station

sibility of reading errors being undetected is practically eliminated. The possibility of both sets of pins making the same error is extremely small and any difference will be detected in the check at the receiving station.

The tape that has been produced in the reperforator contains check characters for each block of data and may be transmitted over any conventional switching system or leased circuit.

If it is desired to check the tape locally before transmitting it the selector switch is thrown to "Check Tape" which disconnects the reperforator and connects checking units. The tape is fed through the dual-pin transmitter and each block is checked for punching errors in a manner which will be described in succeeding sections covering the receiving station unit. If an error is detected an alarm is sounded and the tape stops until the reset switch is operated which silences the alarm and causes checking to continue.

Receiving

At the receiving station the data tape with check characters is received on a reperforator and is fed to the transmitter on the error-checking unit, shown in Figure 5. A block diagram of this receiving unit indicating the functions of the various components is shown in Figure 6.

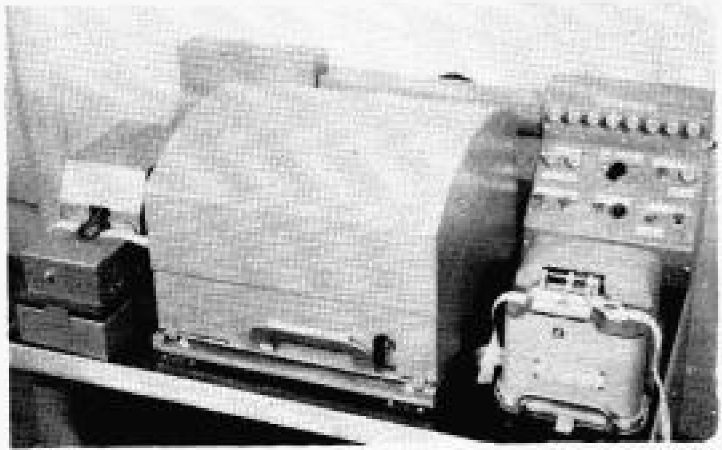


Photo R-11,502

Figure 5. Receiving station equipment

The transmitter sends to a reperforator through the reperforator control switching unit which is in the normal position at this time. Read-back pins on the reperforator spaced five characters after the punch pins read the final tape and feed the characters to the computer and the character-reading matrix. The computer is turned off while the routing information at the beginning of the tape is passing over the read-back pins. When the characters FIGS, A, LETTERS are read by the matrix associated with the reperforator the computer is turned on and totaling of the characters in the first data block starts.

The checking process is done in two different ways depending on whether the selector switch is in "Delete" or "Non-Delete" position. If it is desired that check characters shall not be punched in the final tape the selector switch is thrown to "Delete" and checking proceeds in the following manner.

The first data block continues to be sent from the transmitter to the reperforator until the matrix associated with the transmitter reads the CR at the end of the block. It should be remembered that the read-back pins on the reperforator are reading the fifth character before the CR because of the spacing of the punch pins and the read-back pins. The reperforator is turned off at this point and levels 1, 2, 4 and 5 of the two check characters are transmitted only to the computer. The computer control unit directs the four elements of the first character to stages 1 to 4 of the computer, and the four elements of the second check character to stages 5 to 8 of the computer. The reperforator is then turned on again and the transmitter starts to send the characters of the second data block starting with LF, and the read-back pins on the reperforator read the remaining characters of the first data block. When the read-back pins read the CR at the end of the first block this is detected by the character-reading matrix associated with the reperforator. After the CR character is totaled a check is made to see if all stages of the counter are set to 1 and the counter is reset. If this check is satisfied the block is marked in black by the tape marker and checking of the second block proceeds without interruption. If any counter stage is set to 0 the system is stopped, an alarm is sounded and the errored block is marked in red. The reset switch must be operated before checking will proceed. However, if the error switch is thrown to "Non-Stop" detection of an error will only cause red marking of the block. Checking of succeeding blocks will be continued and no alarm will be sounded.

Conclusions

At the present time only empirical figures can be given on the effectiveness of this system in detecting transmission errors. A calculated figure based on an

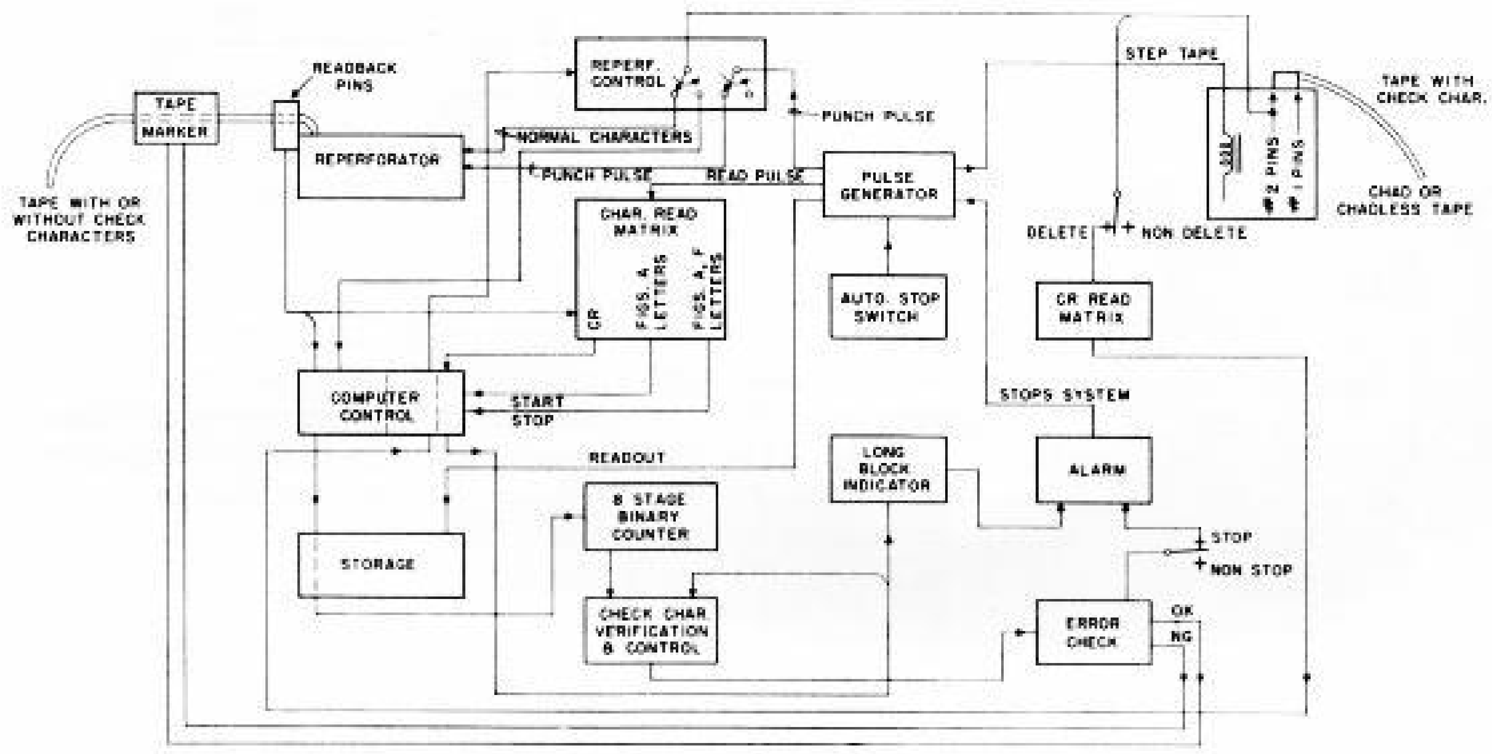


Figure 6. Block diagram of receiving station

This checking process proceeds until the reading matrix associated with the reperforator detects FIGS, A, F, LETTERS after the check characters at the end of the last data block. The computer is turned off and any further characters in the received tape are punched but not checked.

To safeguard against improper operation of the checking circuitry a long-block indicator is provided to detect the absence of a check cycle within the maximum block length of 72 characters. This condition stops the equipment and sounds an alarm indicating that an end-of-block signal and a check cycle have been missed. Action can then be taken to recheck and if necessary rerun the skipped block.

Because a low error rate is anticipated on normal facilities and an inexpensive system was desired automatic error correction is not provided. When an error is detected the block must be identified and a rerun requested from the sending station.

assumption of a random distribution of single-bit errors throughout the levels and blocks would be meaningless as errors introduced in switching equipment have a different distribution from those introduced on the lines and neither appears to be randomly distributed single-bit errors. A mathematical analysis of effectiveness will have to await the results of tests now under way to determine the rate, nature and distribution of errors introduced by lines and equipment. However, while the precise distribution of errors is not yet known, experience and tests to date have given an indication of the general pattern of equipment and line errors.

This system has been designed to be particularly effective in detecting both of these types of errors while at the same time requiring a low degree of redundancy. Operational tests on typical switching systems and FM telegraph circuits indicate that when the telegraph system error rate is one errored character per 50,000 characters transmitted, the undetected error rate will be in the order of one undetected error per 100,000,000 characters transmitted.

Reference

1. SOME ASPECTS OF TELEGRAPHIC DATA PREPARATION AND TRANSMISSION, WILLIAM B. BLANTON, *Western Union Technical Review*, Vol. 11, No. 4, October 1957.

A biographical sketch of MR. STEENECK appeared in the January 1957 issue of TECHNICAL REVIEW.

HAROLD F. CALEY graduated from Pennsylvania State College in 1942 and after completing military service joined the Plant and Engineering Department of Western Union in 1946. His activities there included preparation of installation specifications for Plan 21 switching centers and supervision of radio beam equipment installation. In 1951 he joined Ebasco Services, Inc., where he was concerned with communication and control systems for power plants and pipe-lines. In 1956 he returned to Western Union in the Research and Development Department where he has taken an active part in the development of data equipment and services. Mr. Caley is Chairman of the Electronic Industries Association Committee for Data Transmission Equipment and is Vice Chairman of the AIEE Data Communication Committee.

HARRY F. BURROUGHS, Project Engineer, Electronic Components

Eddy Current Speed Control for Facsimile Telegraph Apparatus

Operation of transmitters and recorders "in phase" is requisite in design of facsimile systems. An economically made, compactly packaged eddy current brake with continuous servo loop speed correction and low over-all heat dissipation can assure efficient synchronization.

FOR ANY facsimile circuit, it is necessary that the transmitting and recording devices maintain a fixed phase relationship. Over the years of facsimile development, this requirement has been met for the most part through the use of synchronous motors.

The speed at which a given synchronous motor will operate is dependent only upon the frequency of the supply voltage and, except for momentary fluctuations, is independent of its magnitude. Two synchronous motors will operate together and maintain an unvarying phase relationship only if the supply voltages of each also maintain a constant unvarying phase relationship. Hence, for any facsimile circuit having commercial power sources with constant phase angle at both the transmitter and receiver ends, the motors may take their power directly from the line. For this type of service the synchronous motor performs satisfactorily.

Synchronous Power Amplifier

For many intracity and for almost all intercity facsimile circuits, phase-common commercial power sources are not available. For these circuits, recourse is made to an independent frequency standard of known accuracy coupled with amplifiers having sufficient power to drive the synchronous motors. For a typical 1/30-horsepower motor, an amplifier having a power capability of 75 watts is necessary.

While such a system is practical and is being used extensively there are certain inherent disadvantages. The number of components and general complexity of a conventional high-quality power amplifier and its associated regulated power supply result in a somewhat high cost of manufacture and maintenance. In addition, the equipment is bulky and dissipates considerable heat which is deleterious to the operation of other circuit elements such as modulators and other low-level networks usually housed in the same console.

It is the purpose of this paper to present the principles of an alternative drive system which generally eliminates the disadvantages of the system outlined above. The device is referred to as the eddy current brake speed control system.

Figure 1 diagrammatically indicates the arrangement of components. The system is driven by an induction motor which always takes its power from the commercial line. The speed of the induction motor is less than synchronous by an amount dependent upon the magnitude of the load and, to a lesser extent, of the supply voltage. The motor drives an auxiliary shaft above synchronous speed through a step-up gear train. Coupling to the auxiliary shaft could also be done with smooth pulleys and a flat belt. The latter method, while somewhat cheaper, requires more space. It will be shown that neither the gears nor the pulleys need be of high precision.

Mounted on the driven shaft is a tone wheel having evenly spaced holes or slots which, in conjunction with the optical pickup, will generate an alternating voltage, the frequency of which is dependent

A paper presented before the Fall General Meeting of the American Institute of Electrical Engineers in Chicago, Ill., October 1959.

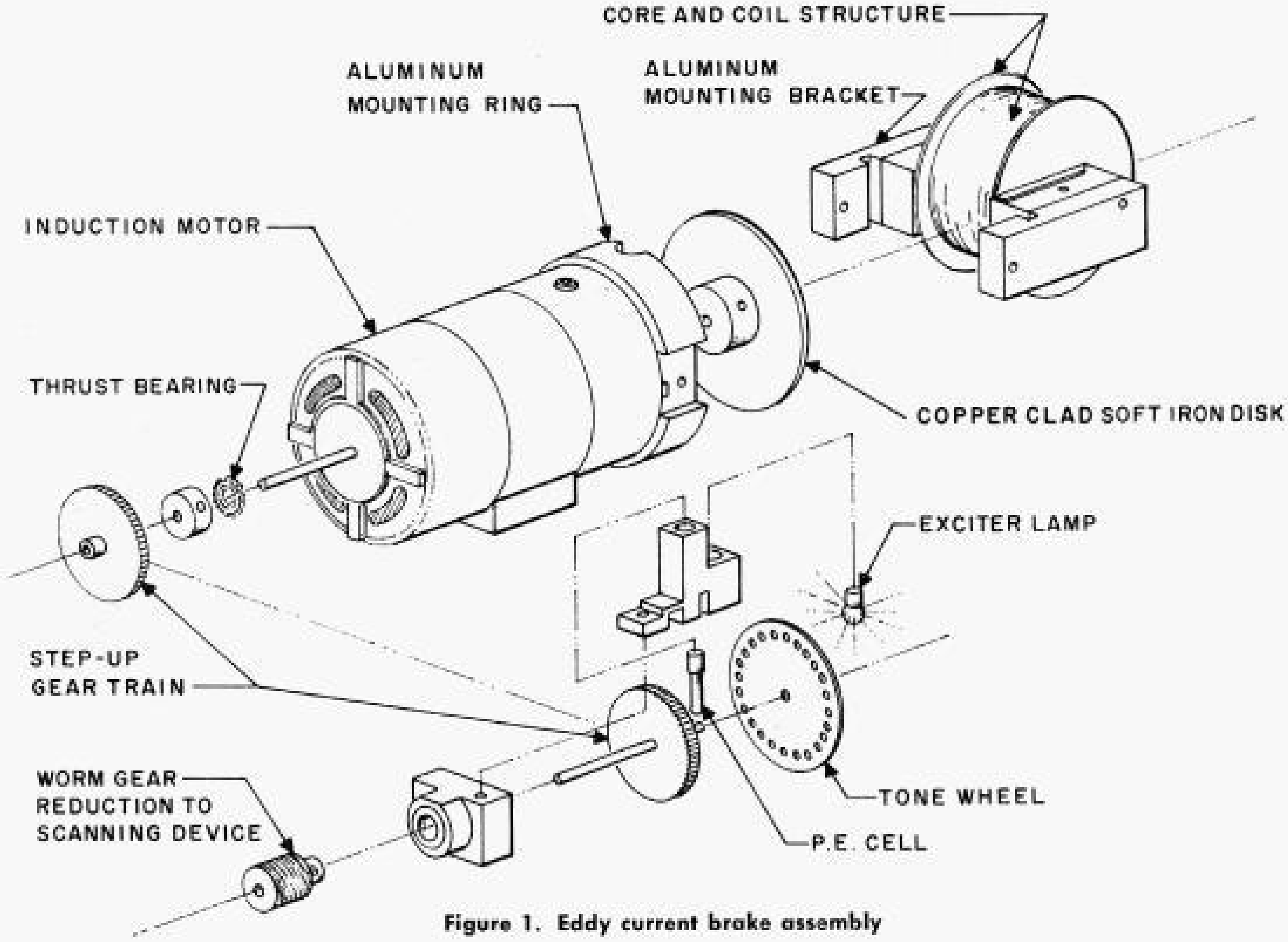


Figure 1. Eddy current brake assembly

upon the number of holes or slots and the speed of the shaft. The tone wheel provides a signal for the servo circuit as explained below. Also mounted on the driven shaft is a worm gear reduction drive which causes the scanning device to operate at a repetitive increment of the shaft speed. Reductions of 20:1, 10:1 and 5:1 are commonly used.

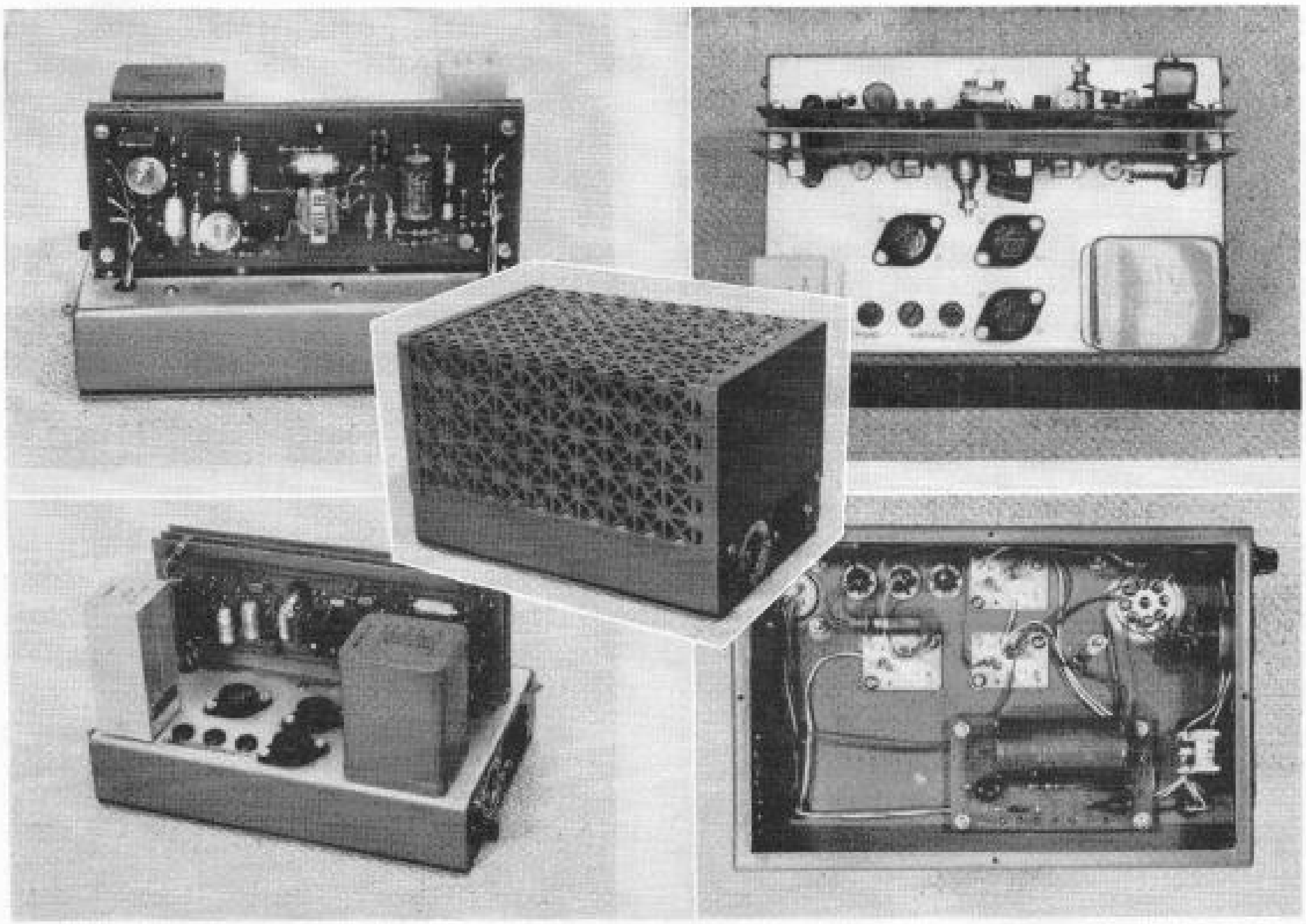
Eddy Current Brake

Mounted integrally with the motor and of the same diameter is the eddy current brake structure. In essence, the unwanted eddy or random currents induced in motor armatures and transformer cores are here used to advantage to impose a controllable load on the motor. As shown, the brake consists of a U-shaped iron core of square cross section on which is wound a coil of wire. The assembly is rigidly affixed to the motor frame. Mounted on the motor shaft and rotating in a plane perpendicular to the axis of the pole pieces is a soft iron disk covered with a thin sheet of copper. The copper face of the disk may be accurately spaced from the pole pieces by sliding it axially along the motor shaft.

This particular configuration represents a departure from a patented eddy current brake design used successfully by the Telegraph Company for several years.[1] The earlier design consists of a coil wound on a core composed of U-I laminations. The coil structure is offset from the motor axis in a position such that the periphery of a copper disk mounted on the motor shaft will rotate through a slot cut transversely in the coil core.

The present design is more compact, thus requiring less space, and is also more efficient. Moreover, the brake structure together with the motor forms an integral unit which may be moved about and mounted in any position, without realignment, using the motor mounting screws.

For ease and economy of manufacture, the core may be made of soft iron bar stock screwed together. The disk is easily turned on a lathe and the copper is soldered directly to the face of the disk under pressure. The copper is not necessary for operation of the brake but improves the



Photos WM 419-5 to 9

Eddy current brake control unit (center); cover removed (lower left); side view (upper left); top view (upper right); bottom view (lower right)

efficiency due to its higher conductivity. Addition of the copper also increases the total effective air gap with consequent reduction in the amount of magnetic end thrust. The mounting brackets and ring are of aluminum.

The magnetic circuit is from either pole piece through the air gap, copper and soft iron disk and back through the copper and air gap to the other pole piece. The strength of the magnetic field and hence the flux is dependent upon the core material, the number of turns in the coil, the amount of direct current passing through

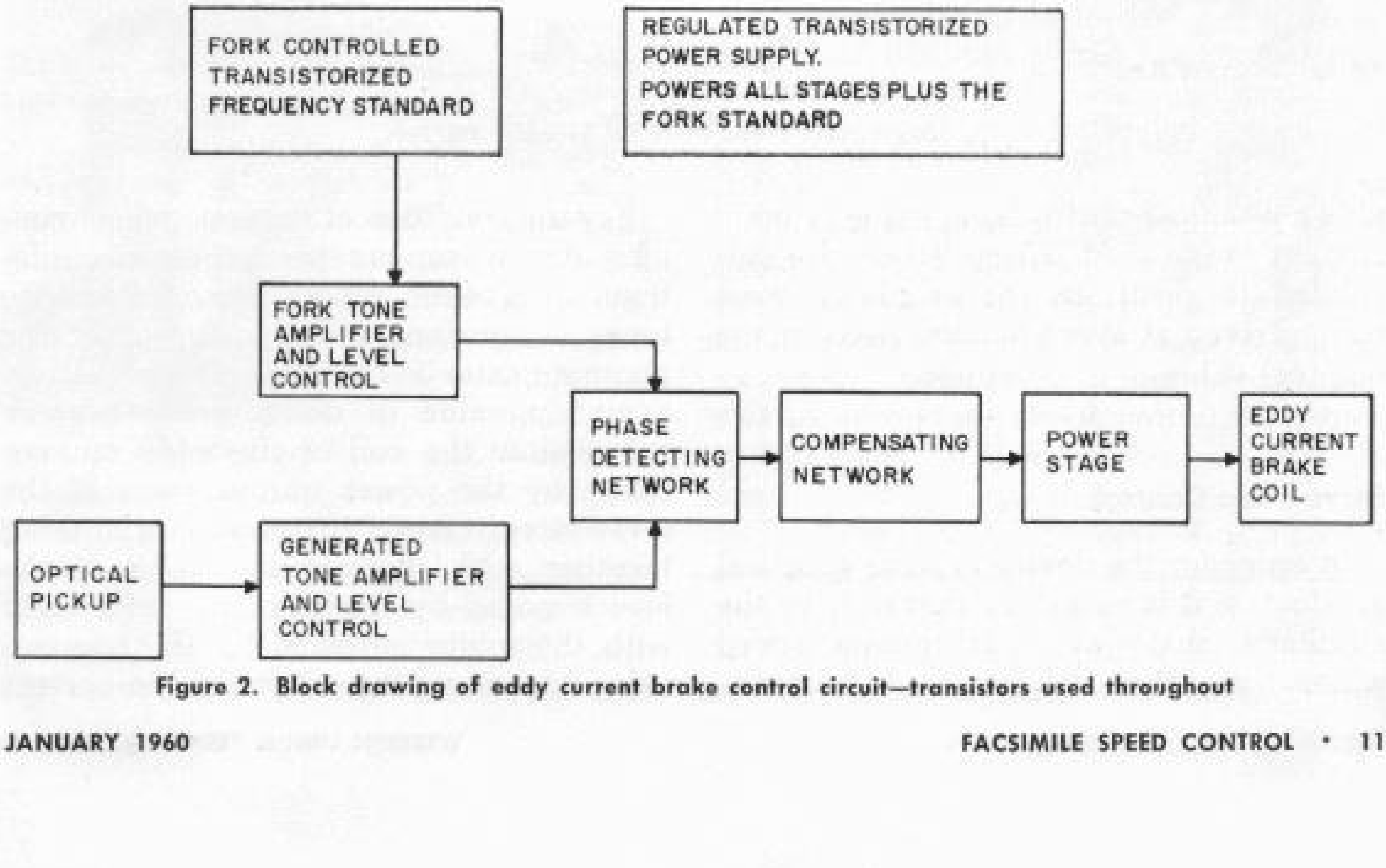


Figure 2. Block drawing of eddy current brake control circuit—transistors used throughout

the coil, and the width of the air gap. The magnitude of the induced currents in the disk, and hence the braking force, is proportional to the square of both flux and disk speed. The undesirable magnetic end thrust exerted on the motor armature is counteracted at the opposite end of the motor by a collar attached to the motor shaft which turns against bearings supported by the motor frame. The total loading of the motor is the sum of the fixed load imposed by the scanning device plus a variable portion induced by the eddy current brake.

It is desirable that the motor operate at a favorable point in its torque-speed characteristic. This is achieved by the selection of an appropriate gear train ratio based upon the magnitude of the mechanical load plus a practical controllable value of eddy current brake load. These values are calculated to result in the auxiliary shaft being driven at synchronous speed at the nominal value of line voltage.

Servo Loop Control

In order for the device to have practical application it is necessary that it drive the auxiliary shaft at synchronous speed without deviation. Therefore, to compensate for variations in line voltage and in the mechanical load of the scanning device, a servo loop is incorporated into the system. The operation is as shown in the diagram of Figure 2.

So long as the driven shaft revolves at exactly synchronous speed, the frequency of the voltage generated by the tone wheel will remain constant. If the shaft speed decreases or increases for any reason, the frequency of the generated tone will decrease or increase accordingly.

The generated tone is amplified and fed into a phase-detecting network together with a tone obtained from a fork-controlled frequency standard. The frequency of the fork tone is equal to that frequency which is generated by the tone wheel at exactly synchronous speed.

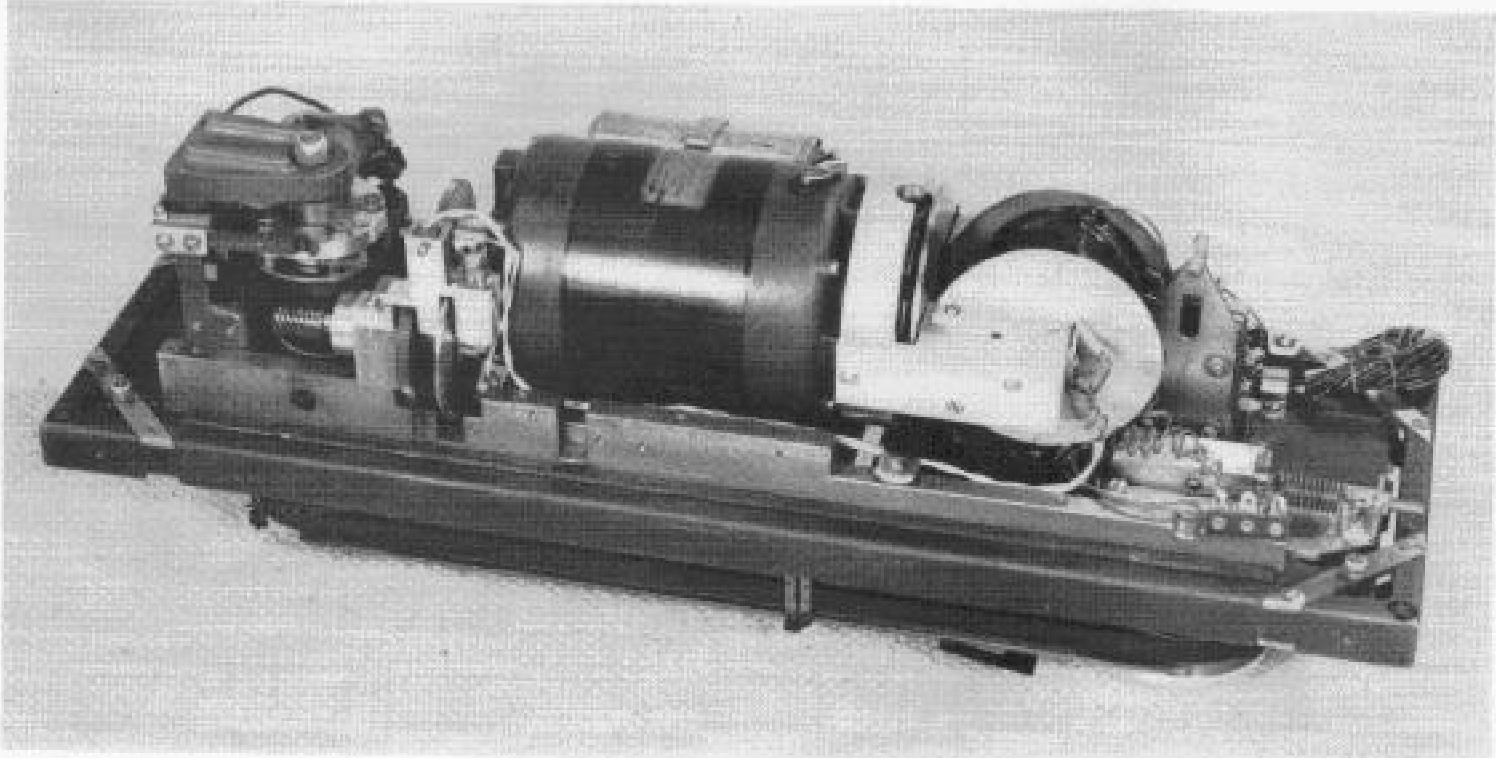


Photo WM 419-3

Eddy current brake drive for Recorder EM7219

For the condition of the tone wheel running at synchronous speed, the phase relationship between generated and reference tones is constant and the output of the phase detector is constant. This results in a steady value of direct current being supplied to the coil of the eddy current brake by the power output stage of the servo circuit. Also, this amount of braking together with the nominal value of the load imposed by the scanning device and with the motor supplied by the nominal value of line voltage, dictates the correct step-up gear or pulley ratio to cause the motor to operate at a favorable point in its torque-speed characteristic as mentioned previously.

For any change in the speed of the motor brought about by a shift in the value of the line voltage or from a change in the mechanical loading of the scanning device, there is a phase change between the generated and reference tones which appears as an increase or decrease in output of the phase detector and hence as an increase or decrease of coil current and of braking force. The servo loop thus continuously samples the speed of the driven shaft and instantly corrects for speed changes by a proportional change in the amount of eddy current braking.

Conclusions

The circuit will compensate for line voltage variations of at least plus or minus ten percent of the nominal value, in addition to changes in the mechanical loading of the scanning device such as friction changes in bearings and gears and higher order abrupt changes sometimes present in multistyli recording belts. In addition, since the tone wheel is mounted on the driven shaft after the gear train, the spur gears need not be of high precision. The frequency of the most common gear faults such as run-out and flat spots falls well within the compensating range of the servo loop. Also, for the case of the flat belt and pulley combination, in addition to run-out, momentary belt slippage is also compensated for.

The control circuit, regulated power supply and frequency standard, all transistorized, can be conveniently packaged in a volume of approximately one-eighth of a cubic foot. The heat dissipation of only a few watts is but a small fraction of the dissipation found in the conventional power amplifier system. This, together with small size plus ease and economy of manufacture, makes the device a very useful tool for controlling the speed of commercial facsimile telegraph apparatus.

The system has received extensive testing in the laboratory and has operated satisfactorily for extended periods of time.

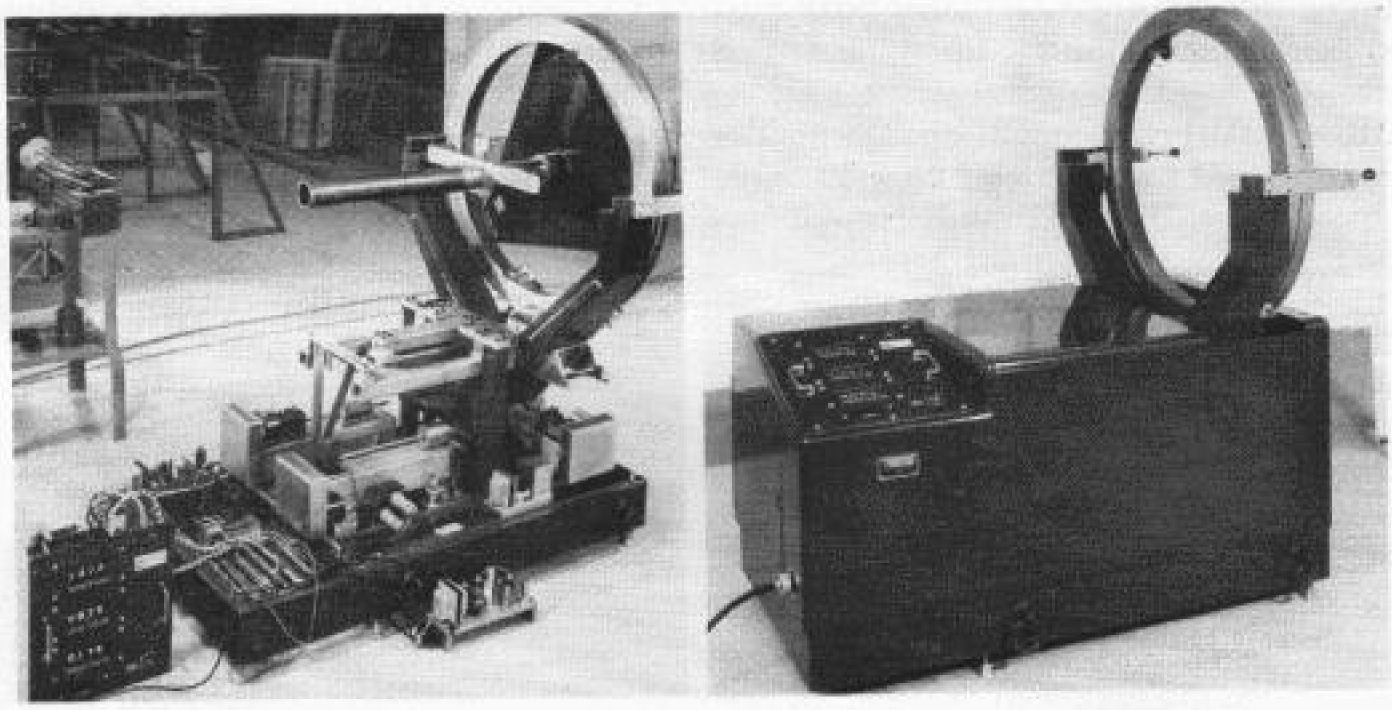
Reference

1. Patent No. 2715202–Issued August 9, 1955–F.T. Turner, L. G. Pollard, C. R. Deibert

HARRY F. BURROUGHS was graduated from Brown University in 1950 with the degree of Bachelor of Science in Electrical Engineering. He then joined the staff of the Electronics Research Engineer at the Telegraph Company's Water Mill Laboratories, where he contributed toward the design of the high-speed facsimile apparatus and its improvement during extensive field trials on the Washington, D. C., congressional circuits. Mr. Burroughs was associated with the design and initial production of Telegraph Terminal AN/FGC-29 for the Signal Corps, and with the development and field trials of the flying-spot facsimile transmitter. More recently he has been concerned with the design of the eddy current brake speed control described in the accompanying article.

Technical Associates of Western Union — I
Dynametrics Corporation

As of late 1959 The Western Union Telegraph Company had established close business relations through various mutually advantageous arrangements with seven technical organizations. Considered in alphabetical sequence, the first of these is Dynametrics Corporation at Burlington, Massachusetts.



One model of Dynametrics' Weight and C.G. Locator which is used for precise determination of weight of missiles and missile components and location of the center of gravity along the three geometric axes of pitch, yaw, and roll. Successful flight of space vehicles is determined by trajectory and velocity. Precise knowledge of the location of the center of gravity aids trajectory calculations, and the known weight is a major consideration in determination of burn-out velocity. Of particular significance is the re-entry attitude of a missile. An ICBM nose cone will disintegrate from violent shock and 15,000 degrees (F) heating as it plunges back into earth's atmosphere unless re-entry is made at the most favorable angle.

Instrumentation problems associated with aeronautical research and development are the primary targets of Dynametrics' broad design, engineering, manufacturing, assembly and testing ability. Development of quasi-static, high-accuracy force and pressure measuring devices is one of the company's basic interests. Examples are precision weight and center of gravity locators for missiles and components; electromechanical calibration systems for jet engine and rocket test stands; also, aerodynamic design of wind tunnels from which comes Dynametrics' former name, Wind Tunnel Instrument Company. Dynametrics currently is completing development of a digital barometer for use in engine test cells as well as more generally in weather stations and air traffic control centers.

Specifically, among other items, the corporation now has in production pressure differential measuring manometers for laboratory and industrial use ranging from single-tube units to 50-tube photopanels for jet engine or wind tunnel tests. Dynametrics' weigh beam, a semistandard product, is the basic measuring element in wind tunnel balance systems, c.g. locators and industrial weighing and batching apparatus.

At last report, Western Union owned one-third of the outstanding shares of Dynametrics Corporation.

Western Union's Blueprint for Communications Progress

Excerpts from an address by RAY HOOVER, Vice President, Plant Department, at the F. E. d'Humy Award ceremonies in New York.

OUR EXPERIENCE shows that low cost maintenance and operations begin with engineering foresight, proper installation, and trained operating and maintenance personnel. In casting our blueprint, we recognize the need for highly trained engineers and nonengineering employees. It is our goal to train and supply such talent. Thus far more than 4000 maintainers and technicians have been given basic training in electronics, mechanics and on special devices at our Chattanooga school. As time permits, all maintainers and technicians assigned to the maintenance of the plant will attend this school. We are also maintaining classes for the benefit of engineers so they may become proficient in technological changes.

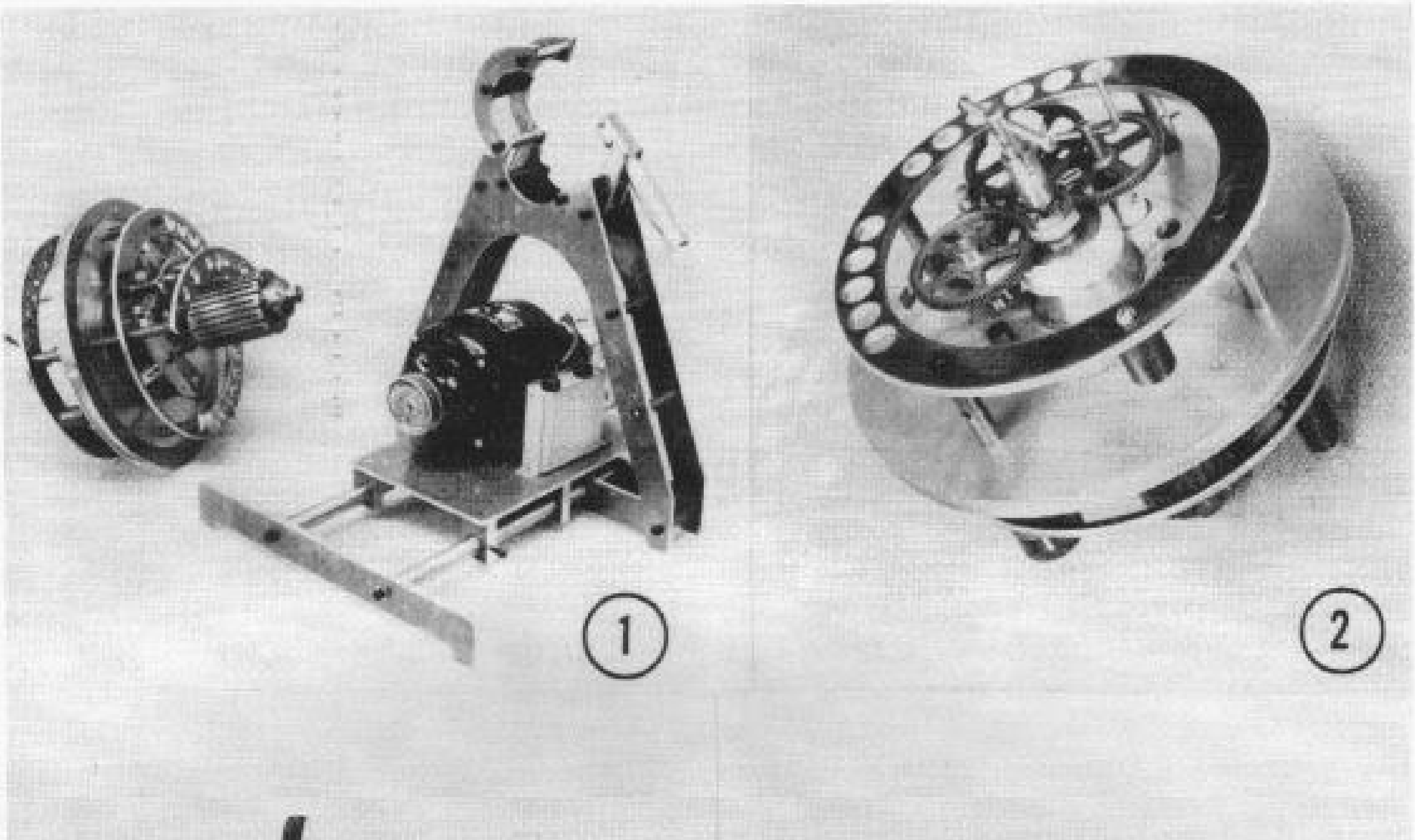
To design an item of equipment so it functions satisfactorily in the laboratory is only part of the engineer's responsibility. It is very important that there is free and easy accessibility to operational parts, so adjustments, parts replacements and lubrication can be effectuated with a minimum of effort. The selection of materials used in moving parts, the correct resistors, condensers, vacuum tubes, transistors, and so forth, are very important so that wear, breakage and deterioration will be kept to a minimum. In other words, I believe it is good engineering philosophy to strive toward dependability, long life and ease of operation. If this is done, recurring maintenance and operating charges will be at low level; the customer will be happy, and the company will receive the income to which it is entitled.

Weaknesses in apparatus design, marginal circuits, overloaded send-receive positions, and any number of other defects may be frequently the cause of unsatisfactory operating conditions which, of course, result in high-cost maintenance and operation. Most of these conditions will show up during the first few weeks of operation. The engineer can overcome many of these weaknesses quickly and effectively if he closely observes the overall performance during the initial operating period. In this connection, I believe each important project should have an assigned Project Engineer who is charged with the final operating performance as well as the initial engineering.

There are bound to be times when the customer, and consequently the salesman, will not have full information regarding operating requirements for a private wire system, and it is, of course, good judgement for our experts to step in and make a survey and offer suggestions. At this point the engineer should come into the picture so he can gain firsthand information *at the beginning* and thus be better equipped to carry out the final design. This approach has always appealed to me and I, therefore, strongly recommend its application to the fullest extent before the final agreement with the customer is consummated. Engineering changes after manufacture and installation are costly and often result in extraordinary expense that could make the installation a deficit instead of a profitable operation.

As we look into the future, we must be alert to find better ways to improve our position in the written communications field. Keeping abreast of and applying new techniques, which will result in better service to our customers at a cost in line with or lower than that offered by our competitors is, in my opinion, a "must" if we are to continue to be the leaders in the printed communications field.

UNIQUE LATHE WITH ROTARY CUTTING TOOL



Photos WM-407-53 to 56

(1) Special lathe designed to make precision joints for circular waveguide. (2) Cutting tool fixture which revolves around clamped end of waveguide. (3) With waveguide locked in position, outside shoulder is machined exactly to conform with inside dimension. (4) After mounting on waveguide, coupling flange is faced accurately in same device.

ELMER E. BEDELL, Project Engineer, Electronic Components

Precision Joints for Circular Waveguide

TRANSMISSION efficiency of waveguide applications is considerably improved when the waveguide is, in effect, one piece and since waveguide is normally used in sections the quality of the joints is of some significance. Joints usually consist of pairs of flanges that are bolted together, making an assembly.

A method to join sections of circular waveguide was developed at the Water Mill Laboratories that contains a relatively high order of precision and results in an accuracy that is within the tolerance allowed in waveguide manufacture. The method consists of using, as a reference, the first three to four inches of inside circumference of each end of a section. From this reference a shoulder, concentric with the reference axis, is machined to a precise diameter on the outside circumference. The purpose of this shoulder is to accept special flanges that are manufactured with matching precision.

The method was implemented by the design and construction of a special lathe in which the tool-bit orbits about the above-mentioned reference axis while the section of waveguide is held in a stationary clamp. This is in reverse principle to a conventional lathe. It would be impractical to employ a conventional lathe for this purpose because the waveguide sections are normally about ten feet long and in some applications may be 20 feet or over and always contain a variable amount of bow.

Photographic figures one through five display the operating characteristics. Figures 1 and 2 show a general view of the lathe and stand. It may be of interest to note that the lathe senses the axis of the waveguide by means of an integrant expansion chuck. Some detail of the method of clamping the waveguide section is also in view as a part of the stand.

Figure 3 pictures the lathe in the operating position of machining the shoulder on the waveguide. The normal length of shoulder is about 3/4 inch; the flange is placed upon it and attached to the waveguide by a soldering operation.

Figure 4 shows the shoulder-cutting assembly removed and the face of the flange about to be machined. A feature of this face-machining operation consists of a mechanism which automatically results in making the angle of the machined face less than 90 degrees with respect to the axis of the waveguide. The angular displacement is small and amounts to the outside edge of the flange being approximately 0.002 inch below the plane of the inside (waveguide) edge. This assures accurate butting of the waveguide when the flanged sections are bolted together. One end of a section of the finished product is also in view.

In Figure 5 the method of obtaining axial alignment between sections is shown.

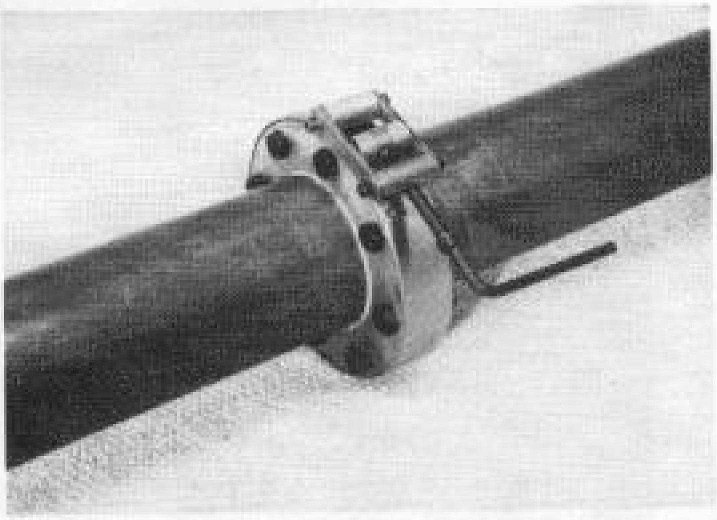


Photo WM-407-57

Figure 5. Temporary clamp holds flanges in alignment for bolting

It consists of a clamp that is similar to a type of hose clamp but tailored to satisfy the requirements of this particular application. In practice the flange bolt nuts remain hand-set until the clamp is tightened, then the nuts are wrench-set and the clamp is removed.

Another version (not shown) is a substitute for the clamp and consists of a step that is machined on the face of the flanges. The step is near the outside diameter and accepts a ring that is cut from commercial grade brass tubing. The inside diameter of the ring is machined by conventional methods to match the diameter of the step and thus functions in the same manner as the clamp except that it remains a part of the flange assembly. In some waveguide installations the ring may be a favorable adjunct, because of simplicity, although more costly to manufacture.

ELMER E. BEDELL, of the Electronic Components Division, Water Mill, L. I., entered the employ of Western Union in December 1940. For thirteen years prior to that time he had operated his own establishment that dealt with the design and production of a wide range of electromechanisms for special applications. He designed and constructed the projector which was a vital part of the wartime Western Union Flight Trainer (TECHNICAL REVIEW, Vol. 13, No. 3, July 1959, page 86). Recent contributions include the invention of the "quick-change" stylus for Desk-Fax, and design and construction of automatic machinery to produce the stylii in large quantities. Mr. Bedell is also responsible for the development of a new exhaust system currently being applied to Letterfax recorders.

Seven seconds after odd-lot orders are executed at the New York Stock Exchange, confirmations, transmitted from the Exchange floor by Western Union Brokerfax, arrive in the order room of Merrill Lynch, Pierce, Fenner & Smith, 70 Pine Street, New York, where facsimiles of the executed orders are passed to teleprinter operators as information to be telegraphed back to the originating branches.

ALDER F. CONNERY, Manager — Technical Control, Project Engineering

Neutralization of Static Electricity -- II

High-voltage a-c corona discharge from needle points is being employed to neutralize vexatious static electricity which develops with low humidity during mechanized handling of paper message blanks and tapes used in telegraphy. The background of this development is discussed in some detail in Part I of Neutralization of Static Electricity published in TECHNICAL REVIEW for July 1959.

ONE OF THE first field installations of the high-voltage ionizing needle system in Western Union service was in connection with "burster" teleprinters. During a period of cold weather in the month of December the relative humidity in the operating room reached a low level and a serious impairment of traffic movement was experienced due to strong static charges on the message paper. Many messages would not be discharged automatically from the burster printer but would cling to the paper guides at the rear of the printer.

Other telegrams would adhere to the metal sides of the V-belt structure. At the routing desk message blanks would cling to the table and when inserted in the routing slots leading to other belts would not fall by gravity but would stick to the sides of the chute.

Since it is essential that the static-neutralizing ionizing needles act upon the paper when it is reasonably remote from anything but air, as will be subsequently explained in more detail, it was decided to locate an ionizing needle at the rear of the burster printer where the message sheet drops by gravity guided only by wire guides. It was found that a single needle point was reasonably helpful but did not completely neutralize the charge. Two needles, however, were quite effective. In the final design a bracket that mounts four needles was used to insure complete neutralization under all conditions. When the system was placed in operation the messages fell upon the belt in a completely neutral condition and no further static trouble was noted.

Experience with electrified telegraph blanks indicates a compounding effect in the picking up of static charges. If, for example, a blank having a noticeable static charge is deposited on a belt the paper will tend to cling to the guides and the additional rubbing effect will quickly build up the total charge to the point where the blank may come to a complete stop at some point along the way. On the other hand, if the blank, when deposited on the belt, is in a neutral state it will pick up very little charge on the V-belt because it will have little tendency to cling to the sides of the belt structure.

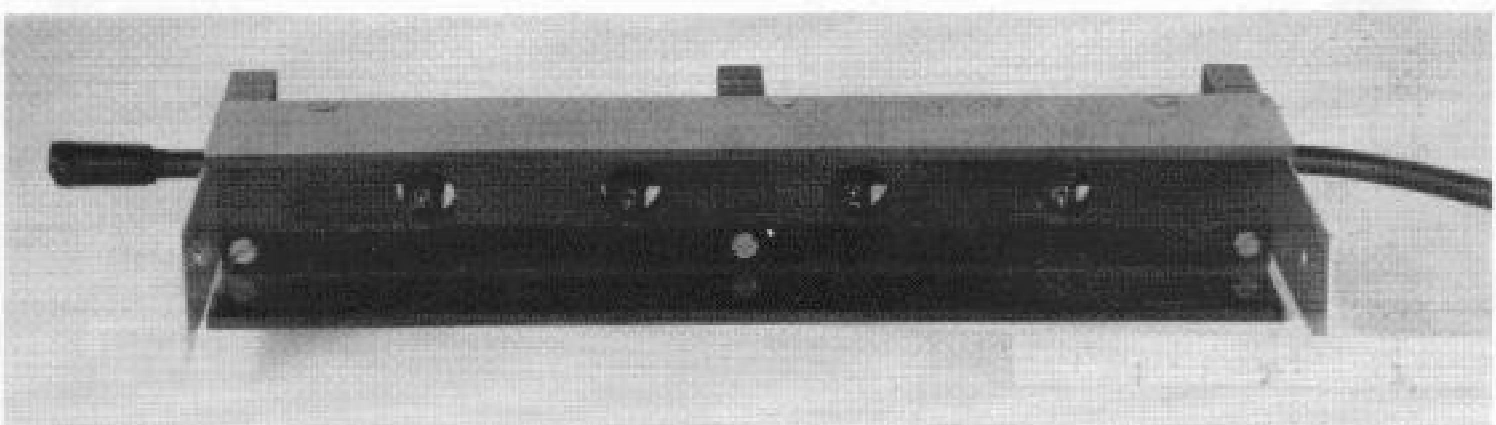


Photo M-4059

Figure 1. High-Voltage Static Eliminator 8143-A for burster printer

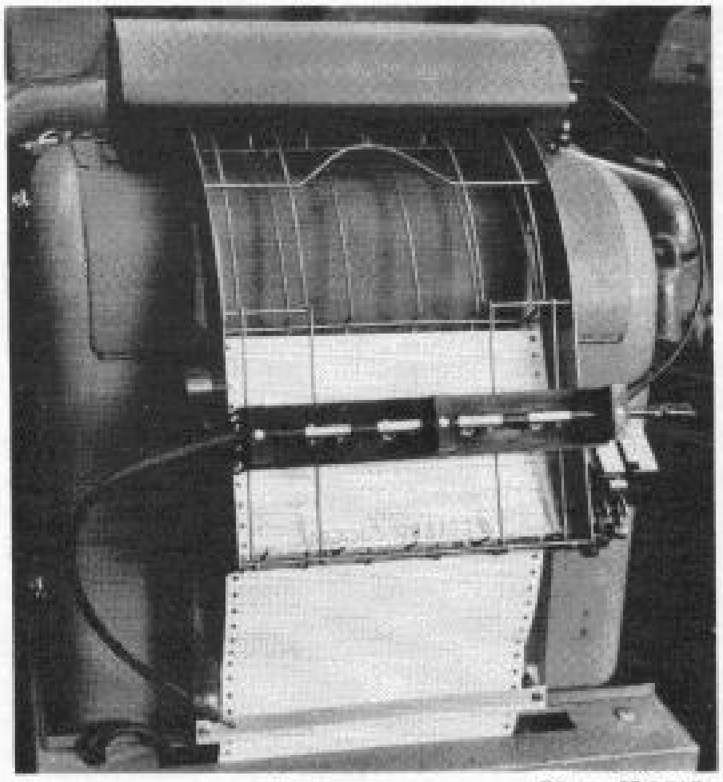


Photo H-2507-A

Figure 2. Four-needle static eliminator mounted on back of burster printer behind message receptacle

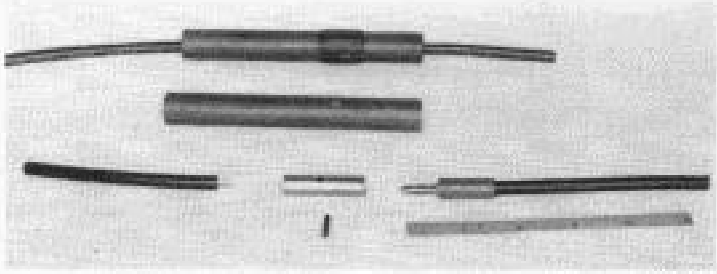


Photo M-4056

Figure 3. Receptacle 8146-A employed to join Static Eliminator Unit 8143-A at burster printer to energizing power supply wire. Assembled unit is shown at top

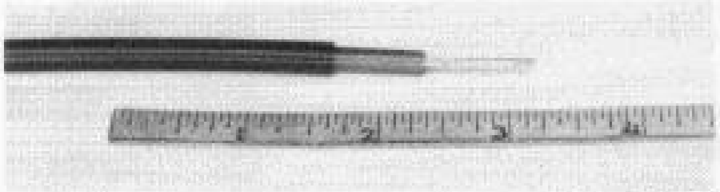


Photo M-4057

Figure 4. High-voltage energizing power supply wire consisting of No. 14 AWG 19-strand copper, insulated with polyethylene and covered with vinyl jacket

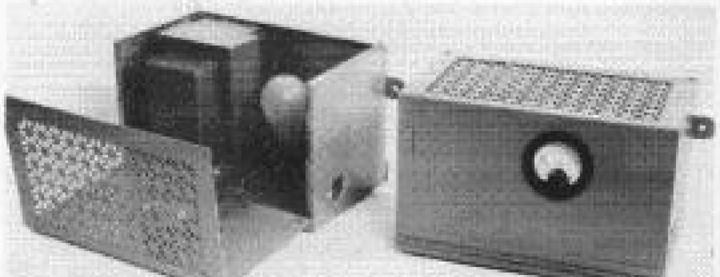


Photo R-11,668

Figure 5. Power Supply 9927-A for high-voltage static eliminator system. Meter winding with ratio of 1:100 records voltage in high-voltage power supply wire

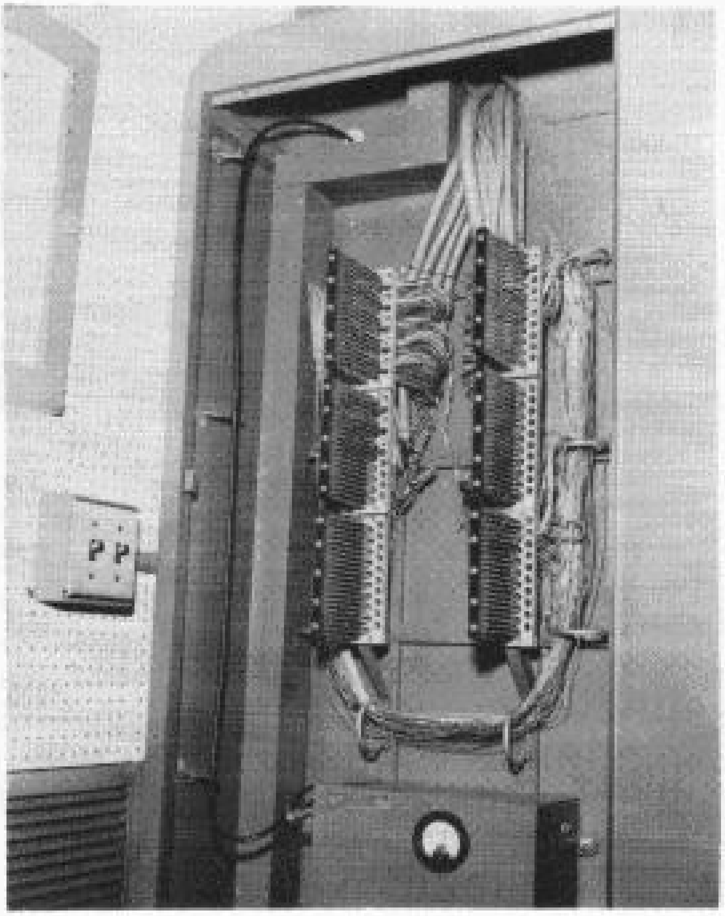


Photo H-2497

Figure 6. End panel of row of tape repeater and duplex way cabinets showing high-voltage power unit and power lead mounted on glass supports

The needle points of the burster printer installation are about an inch or so from the paper which, in most instances, falls by the points at a very rapid rate since considerable impetus is given to the blank by the rollers on the printer.

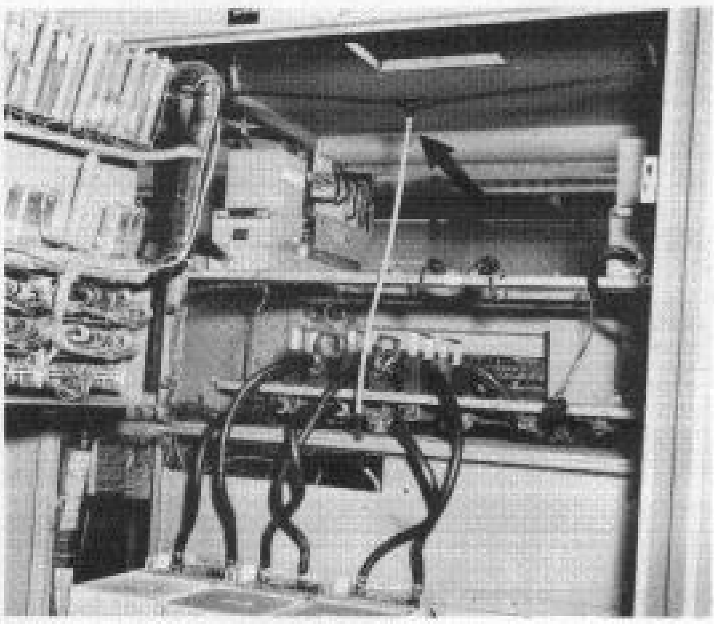


Photo H-2498

Figure 7. Rear view of Type 7000 tables showing joining of wire lead from eliminator to high-voltage power supply wire (arrow)

A single needle point was not fully effective for this reason. The paper was under the influence of the single ionizing point for only a very brief time interval and insufficient ions were generated for that period of time to neutralize all the excess ions on the paper. Doubling the number of points doubled the ion production and resulted in more complete neutralization. By using four points an abundance of ions is generated and complete neutralization is insured. It was not a problem of the ions getting to the paper quickly enough but rather a matter of an insufficient quantity being generated. Figure 1 shows the unit with the four needles that is used on burster printers. Each needle is mounted on a small spring and if the finger is placed on the needle point it will back away and reduce the possibility of a pricked finger. Plastic guards at the top and bottom also reduce the danger of a pin prick. The complete installation is shown in Figure 2. The high-voltage cord has a plug that permits disconnecting the printer from the high-voltage line when it must be removed for servicing.

A separate connector, as used in the high-voltage line and its components, is shown in Figures 3 and 4. When engaged, all line parts are contained within the fibre tubing.

The power supply unit is shown in Figure 5. This unit contains the high-voltage transformer, the protective primary lamps and the voltmeter. The transformer case is molded of epoxy resin which is a nonconductor and completely seals the winding from moisture and eliminates any tendency of the laminations to hum.

Figure 6 is the end cabinet with cover removed of a row of Type 7000 tables in the Plan 54 tape relay system. As a general rule, one high-voltage unit is provided for each row of tables. The high-voltage line plugs into the power unit. The high-voltage conductor is of the type designed for use in neon sign installations and consists of a No. 14 AWG, 19-strand copper conductor insulated with polyethylene and covered by a vinyl jacket 1/4 in. O.D. This conductor is U.L. approved for 15,000 volts working voltage. It is important that this line, although highly insulated, make no direct contact with metal or there will be a possibility of premature breakdown. Wherever possible, it is held at least a half inch from metal by the use of glass stand-off insulators and porcelain bushings, as may be seen in the figure.

Figure 7 shows the tapped overhead line, suspended by glass insulators. The tap wire is covered by a plastic spiral wrap as additional protection in case the wire is in contact with any other object.

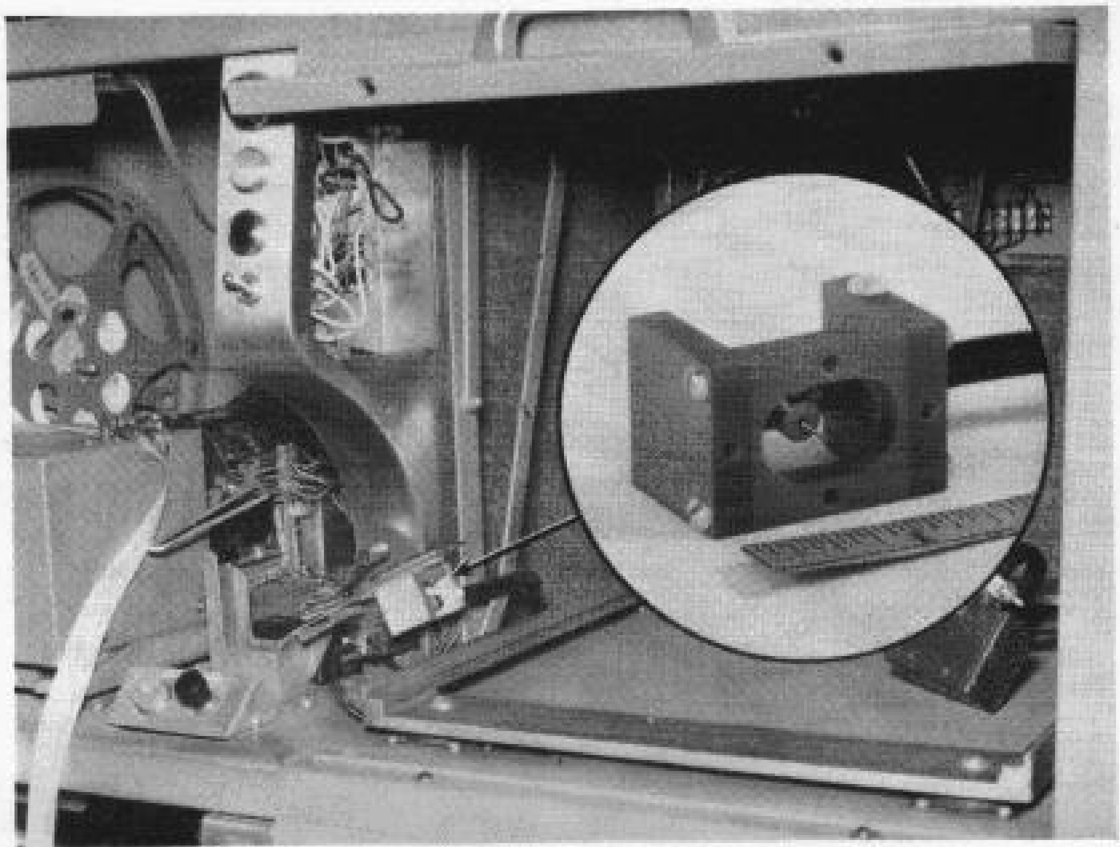
The amount of energy consumed by each ionizing point is negligible and many needles could be served by a single transformer were it not for the reactance current resulting from the electrostatic capacity of the high-voltage line which is necessarily quite close to grounded metal throughout its entire length. The charging current for this line is significant and that is one of the reasons for having a transformer for each row of cabinets. Under certain conditions a resonance condition can occur when the electrostatic capacity of the high-voltage line and the inductance of the transformer bear a certain relationship. The resistance lamps in the primary of the transformer, in addition to limiting the maximum current in the secondary circuit, provide sufficient damping to prevent any appreciable rise in voltage if resonance should exist.

The ionizing unit that acts upon the tape leaving the reperforator is shown in the insert in Figure 8. This unit consists of a plastic frame for holding and dead-ending the cable. A copper sleeve surrounds the cable and is slightly pinched to prevent it from turning. Attached to this sleeve is a mount and set screw for the needle. An ordinary fine steel sewing needle is used with the eye end broken off to give the required length. This ionizing unit is fastened to the underside of the tape chute between the reperforator and the tape accumulator. An oval-shaped hole is cut in this chute and corresponds to the oval hole in the ionizing unit. The needle point is positioned about a quarter of an inch from the tape.

Figure 8 shows the installation of an ionizing unit in an actual Plan 54 installation. The tape upon leaving this unit should be in a completely neutral condition.

There should be no difficulties in the accumulator attributable to static. Some charge, however, will be picked up by the tape during its passage through the accumulator and subsequent passage through the tape transmitter. This static accumulation is, of course, caused by the rubbing of the tape on the various surfaces. Since many of the positions are equipped with motor-driven tape winders no further precautions are necessary on tape that leaves the sending transmitter. At those positions where tape is expected to fall by gravity through a chute and into a container, trouble is likely to occur at times because of the tape sticking to the chute or container and then spewing out on the floor.

To correct this condition an ionizing unit has been designed to act upon the tape as it leaves the transmitter. The unit is shown in Figure 9 and consists basically of a pair of telescoping insulating tubes and the high-voltage wire which is dead-ended in the inner tube. There a few turns of wire encircle the high-voltage conductor and are soldered to the needle. Sufficient electrostatic capacity will exist between the copper high-voltage conductor and the encircling wire to bring the needle practically to line voltage. The complete unit is mounted on the side of the operating position. It points down at an angle of 45 degrees below horizontal and the needle will be a couple of inches from the tape. A telescoping cover guards the needle point and reduces the possibility of anyone getting pricked by the



Photos H-2503 and M-4058

Figure 8. Upper receiving position, Type 7000 table, printer-perforator removed, showing installation of Static Eliminator 8141-A (insert) adjacent to printer location

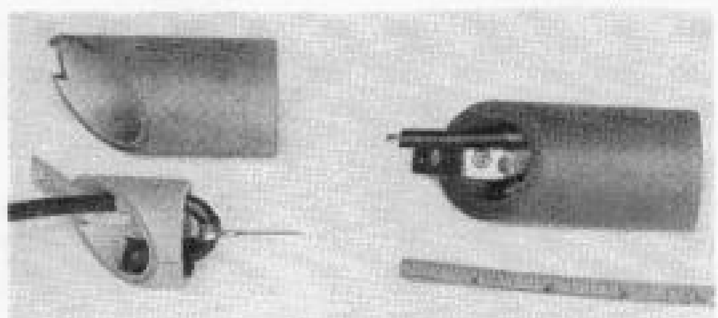


Photo M-4055

Figure 9. High-voltage Static Eliminator 8142-A for transmitter sending position

needle. As previously indicated, there will be no perceptible electric shock to anyone touching the needle.

This unit is very effective at a distance of a couple of inches because there are few nearby attracting surfaces and the tape upon leaving the transmitter is hanging free and is remote from any material. The neutralizing ions in the vicinity of the tape are therefore not likely to be attracted to other surfaces.

In applying the ionizing needle points certain general principles must be observed. The principal rule is that the paper, while being acted upon, must not be in intimate contact with any surface. The exception to this rule is that the paper can be in limited contact with guide wires as, for example, on the burster printer, provided the paper is moving while under the influence of the needle points. It is quite impossible to neutralize a piece of paper while it is lying on a surface, regardless of whether the surface is a conductor or an insulator.

Suppose, for example, a piece of charged paper is being carried on a flat belt and rides by some ionizing needles. The tendency of the ions will be to bring the combination of the belt and the paper into a neutral state. When the paper is removed from the belt it will be found, however, to have a static charge. Another example should be of interest. If two sheets of paper, in intimate contact, are rubbed and develop a charge, as evidenced by the tendency of the pair of sheets to cling to surfaces, and are then subjected to the influence of an ionizing needle the static charge on these sheets, in combination, will be completely neutralized. There will be no tendency of the pair of sheets to stick to other uncharged surfaces or metal. However, when the two sheets are separated from each other it will be found that each will be electrified and will tend to cling to other objects. The ionizing source acted on the pair of sheets until the positive and negative ions in any given small area were brought into a condition of numerical balance. When this balance was brought about there was then no tendency for any more ions to be attracted to the paper. It did not necessarily follow that each of the two sheets was separately in numerical balance and it is quite unlikely that they would be in such a state.

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

WILLIAM CORKUTT, Engineer, Switching Equipment & Systems

A Communication Power Supply Utilizing Transistors

Both theory and experience provide information by means of which power supply units may be designated to meet requirements of the particular developments with which the units are associated. A case history report helps make the theory more readily understood.

THE ADVENT of high-power, high-voltage germanium transistors, silicon rectifiers, and Zener reference diodes now makes it feasible to design high-power all-semiconductor power supplies. Among the advantages of semiconductors as regulating elements in voltage regulated power supplies are space saving, greater reliability, long life without maintenance, elimination of heater voltages, and circuit flexibility. In addition, a high degree of regulation and low ripple may be obtained without the necessity of bulky and expensive filter inductors.

Disadvantages exist, however, in that methods must be provided for protecting the supply during heavy current overloads and short circuits because ordinary electromechanical circuit breakers will not respond fast enough to prevent destruction of semiconductor components. Exceeding the voltage, current, or power capabilities of semiconductors will damage or destroy them even if this overload exists but for a brief time.

This article describes a 60-volt, 5-ampere voltage-regulated power supply originally designed to provide line battery potential in United States Air Force technical control centers. Specifications require that the regulation be better than 1.75 percent from no load to full load. In addition, the supply must also be capable of supplying the full output current for primary a-c line interruptions of five cycles and this requires additional circuitry, as the filter capacitor of the rectifier output would have to be exorbitantly large if it were to hold its charge during line interruptions.

Normally each USAF supply is backed up by an auxiliary stand-by supply so that in case of a power supply failure the auxiliary supply will carry the load without interruption.

Theory of Operation

There are two types of standard regulating circuits commonly in service — the shunt type and the series type. The shunt type of regulator is generally the least efficient, especially at low outputs, and this type will not be described here. In the series-type circuit the excess voltage, E_{in}-E_{out}, (see Figure 1) is dropped across the collector to the emitter of *T-1*.

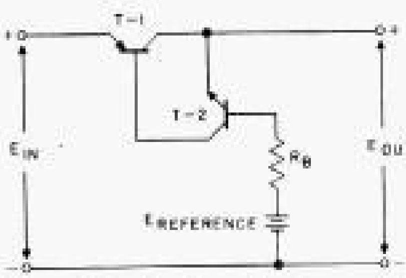


Figure 1. Basic series type voltage regulator

Increasing output voltage causes a compensating increase in collector to emitter voltage across *T-1*, due to the reduction in base current caused by the change in emitter to base voltage of *T-2*. The regulation characteristic of this circuit is:

$$\frac{\Delta E_o}{E_o} = \left(\frac{1}{1 + B_1 B_2 \dfrac{R_L}{R_B}} \right) \frac{\Delta R_L}{R_L}$$

B_1 and B_2 are the current gains of the transistors and it is seen that the regulation can be improved by increasing these gains. Additional stages may be added or the transistors may be cascaded for additional gain.

Figure 2 shows the schematic diagram of an improved and more sophisticated regulator.

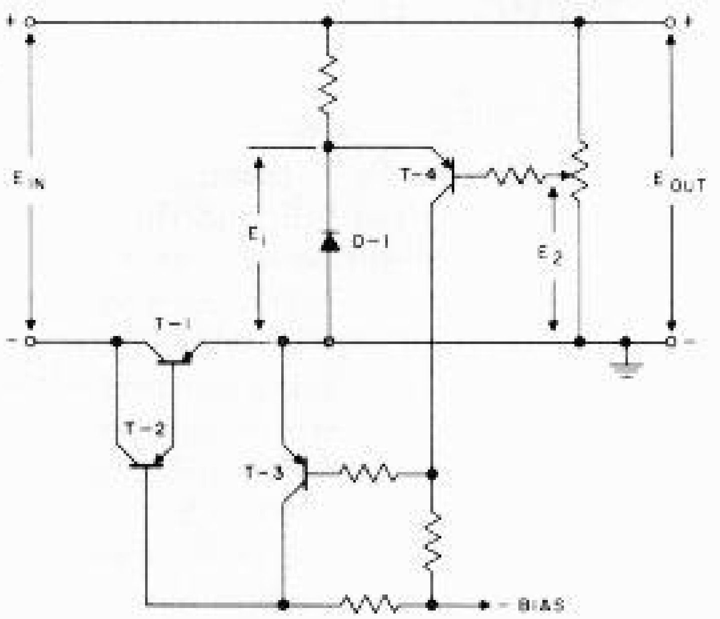


Figure 2. Improved series type voltage regulator

Here regulation is accomplished through variation of the collector to emitter voltage of transistor *T-1*, in response to any voltage change at the output of the supply. The voltage difference between E_1 and E_2 is used to bias the base of transistor *T-4*. E_1 is a reference voltage obtained from a Zener diode. A Zener diode is a diode biased into breakdown in the reverse direction. In this region the voltage drop across the diode is essentially constant for considerable variations of current and therefore it can be used as a reference voltage. By proper selection of the operating point of this diode a very stable reference source is obtained as a comparison voltage and this voltage is independent of the supply loading.

To understand the operation of the circuit (Figure 2), assume the output voltage E_o has increased due to a decrease in loading. This requires a compensating increase in the collector to emitter voltage of the regulating element *(T-1)* so that E_o will be restored to its normal value. With a rise of E_o the difference between E_1 and E_2 decreases, thereby decreasing the collector current of *T-4*. This results in a greater negative bias on the base of amplifier *T-3*. A larger negative bias on the base of *T-3* results in decrease in the emitter to collector voltage. The collector of *T-3* is coupled to the base of *T-2* which is cascaded with the regulating transistor *T-1*. The lower voltage of *T-3* results in a smaller base current in the regulating element and this causes a rise in the collector to emitter voltage which tends to keep the output voltage constant. Any decrease in the output potential will likewise decrease

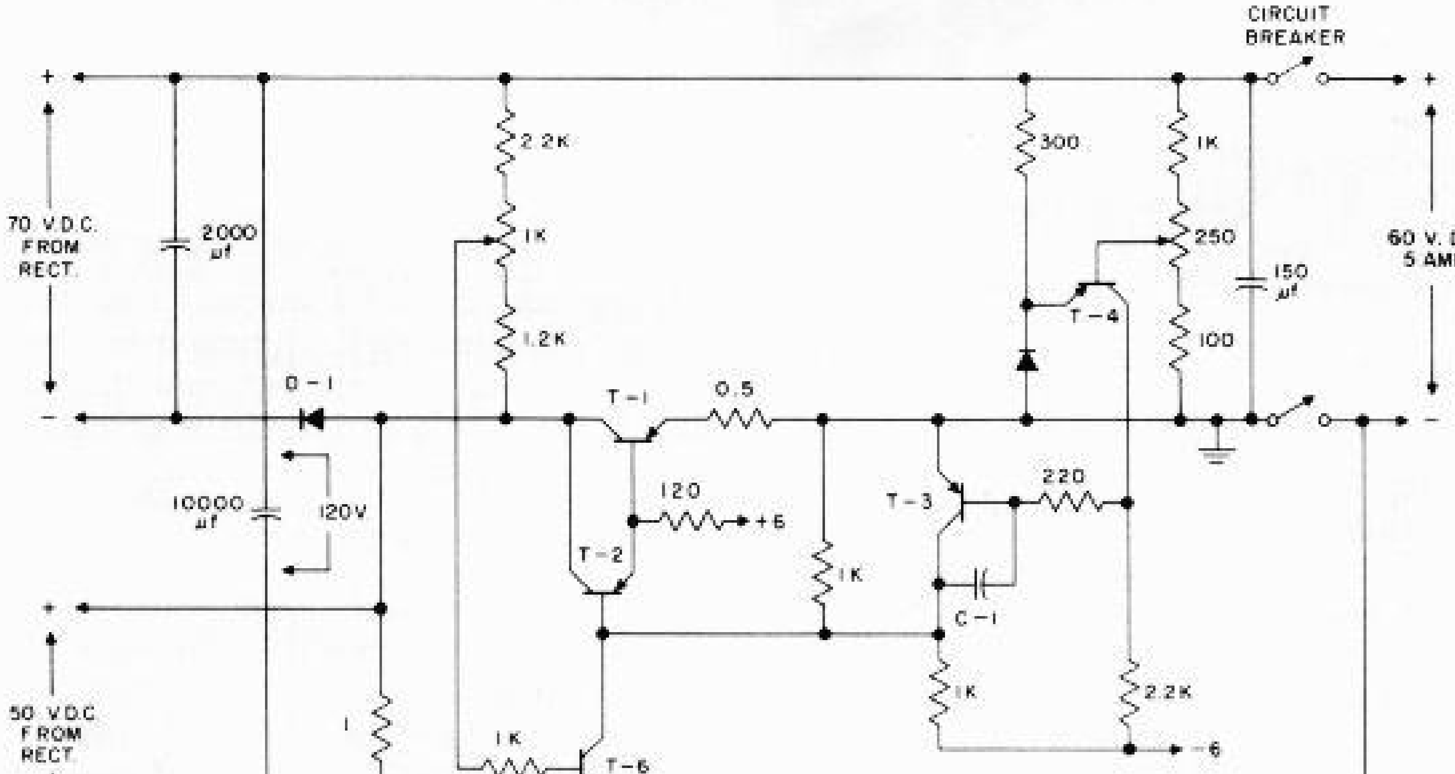


Figure 3. Complete regulating circuit

the emitter-collector voltage of the regulating transistor *T-4* and raise the output to its previous value. By adding amplifier *T-3* and cascading transistor *T-1* with *T-2* the current gain of the circuit has been increased so that improved regulation results.

Actual Supply Design

Figure 3 shows a diagram of the actual regulating circuit. Three single-phase transformers are delta connected and feed a 3-phase bridge-connected full-wave rectifier. The output of this rectifier is 70 volts at full load. A 3-phase rectifier is used because its reduced ripple factor is more easily filtered than rectified single-phase alternating current. By keeping the difference between the input and output voltages of the regulator at approximately ten volts the regulating element is required to dissipate less power than if a higher voltage were used, thereby increasing the efficiency of the power supply.

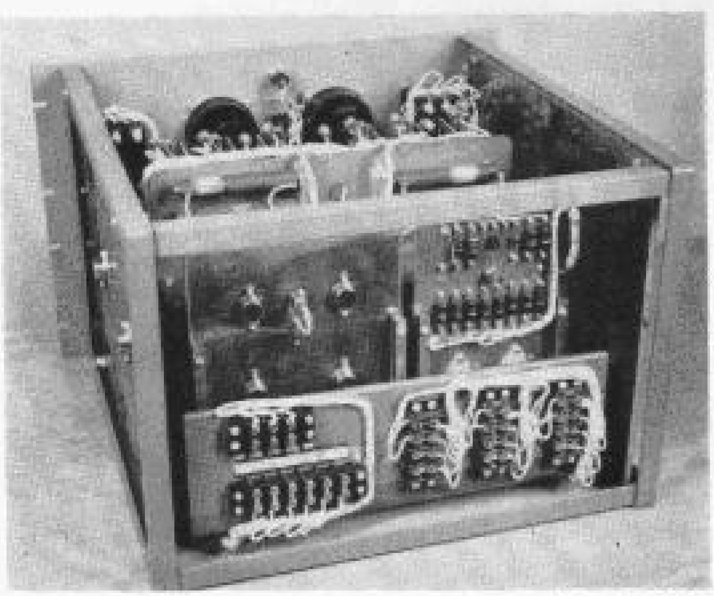


Photo R-11,691

Figure 4. Rear view of completed power supply

The regulation element *(T-1)* consists of four 2N630 power transistors connected in parallel. These transistors have 1/2-ohm equalizing resistors in their emitter which cause each transistor to carry an equal quantity of the load. A separate bias supply provides the required positive and negative bias voltages. A capacitor *(C-1)* connected from the base to collector of *T-3* eliminates any tendency of the regulator to oscillate by introducing degenerative feedback.

Diodes *D-1* and *D-2* are isolation diodes which protect the transistors from the high voltage required for the carry-over capacitor. Figure 4 shows the power supply from the rear.

Heat Dissipation

All load current flows through the regulating element and at full load this will be five amperes. The emitter-collector voltage across *T-1* at full load is ten volts and produces 50 watts of power which must be dissipated in the regulating element of the supply itself; therefore, adequate heat sinks must be provided. The junction temperature of the transistor itself prescribes the size of the heat sink to be used. The maximum allowable junction temperature is 90 degrees C for the 2N630 and this temperature must not be exceeded in operation. In order to determine the junction temperature it is necessary to know the ambient temperature, the rate of heat generation by the transistor, and the total thermal resistance from the transistor junction to the air. This relationship is indicated by the equation

$$T_J = T_a + \theta P$$

where T_J equals junction temperature in degrees centigrade

T_a equals ambient temperature in degrees centigrade

θ equals thermal resistance in degrees centigrade per watt

P equals heat generated in watts

θ represents the total thermal resistivity of the transistor itself (junction to case), any insulating washers between the base and the heat sink, and the heat sink itself.

A simpler and more practical relationship is:

$$T_J = T_b + \theta' P$$

where T_b is the case temperature of the transistor and θ' is the thermal resistivity of the transistor itself. If an intimate contact is made between the heat sink and the base this equation is the most practical to use since it is easier to measure the temperature of a metal plate which will equalize its surface temperature, if thick enough, rather than an ambient temperature which differs from spot to spot.

A rough estimate of the required size of the heat sink can be made from a knowledge of the thermal capacity of the material used and the volume required to hold the generated heat. Empirical curves have been prepared for the various sizes and orientation of flat plate heat sinks which indicate the capabilities for different conditions. It is then a simple matter to check the adequacy experimentally by measuring the heat sink temperature under normal operating conditions. If space permits a reasonable safety factor may be introduced by enlarging the size of plates used.

The heat sinks used are 1/4-inch aluminum plates. Their size is 15 by 11.5 inches and these plates form the sides of the supply itself.

Carry-Over Feature

To carry the load for five cycle interruptions of the a-c line, a bank of capacitors is charged to a potential of 120 volts and these capacitors are discharged into the regulating circuit and load during line interruption. The 120-volt potential is obtained by connecting a separate rectifier of 50 volts in series with the main rectifier. This 50-volt supply is formed by a separate winding on each transformer and an additional 3-phase full-wave bridge rectifier. The size of this storage capacitor may be determined by

$$E_o = E_m \epsilon^{-\frac{t}{RC}}$$

where E_o is equal to 60 volts, for when the capacitor falls below 60 volts the regulating circuit will no longer be able to maintain the output voltage

E_m equals the original voltage of the capacitor which is 120 volts

t is the time during which the capacitor discharges from 120 to 60 volts

R is the load impedance through which the capacitor discharges and at full load is equal to

$$\frac{60\ Volts}{5\ Amperes} = 12\ Ohms$$

C is the storage capacitor in farads

$$E_o = E_m \epsilon^{-\frac{t}{RC}}$$

$$60 = 120\, \epsilon^{-\frac{t}{RC}}$$

$$\frac{t}{RC} = 0.7$$

$$t = \frac{5\ Cycles}{60\ Cycles\ /\ Sec.} = 0.083\ Sec.$$

$$\therefore C = \frac{0.083}{0.7(12)} = 0.0099 = 0.01\ farad$$

Therefore, 10,000 microfarads are required to store the necessary power for five cycle line interruptions. This value could also be obtained from the energy storage relationships of a capacitor.

The discharge of this capacitor is performed in the following manner. During a line interruption the output voltage of the supply tends to fall and this reduces the collector-emitter voltage across the regulating element as has been previously explained. A group of three parallel transistors form a switch *(T-5)* which is ordinarily nonconducting. The base of *T-5* is biased to a minus 4-volt potential by a Zener diode and when the emitter of *T-5* (which is connected to the collector of *T-1)* becomes positive with respect to the minus 4 volts of the base, *T-5* will "close" allowing the capacitor to discharge into the load. The emitter to collector voltage of *T-5* will decay from 50 volts initially down to 0 volt at which time the output voltage of the supply begins to fall off. *T-5* must carry the full load current and must have a total thermal capacity capable of dissipating the full load output for the time of the line interruption.

Assuming the average value of the voltage across *T-5* to be half its maximum value or 25 volts, then the average dissipation for the 0.1-sec. carry-over is 5×25 or 125 watts. This 125 watts must be dissipated by the transistor itself during the short time of a line interruption and therefore the thermal capacity of the transistor becomes of importance, for during this time the junction temperature of the transistor must not rise above its rated value of 90 degrees C. The thermal capacity of the 2N630 is approximately 0.075 watt sec./degree C. Three transistors are paralleled and therefore the dissipation in each is equal to $\frac{125}{3}$ watts. The temperature rise of the junction is

$$\frac{125\ watt}{3} \times 0.1\ sec. = 4.2\ watt\ seconds$$

$$\therefore T_J = \frac{4.2\ watt\ secs.}{0.075\ watt\ secs./^{\circ}C} + T_a$$

$$= 60^{\circ}C + 21^{\circ}C = 81^{\circ}C$$

If two transistors were used the junction temperature would be 106 degrees C which exceeds the maximum allowable junction temperature.

Short Circuit Protection

A d-c breaker in the output protects the supply against overloads; however, on a short circuit this breaker will not respond fast enough to protect the regulating transistors from destruction due to high dissipation in these transistors. Therefore, an electronic circuit breaker has been provided to protect against short circuit damage. During short circuits the current through the regulating element is limited to approximately 12 amperes by the base impedances of *T-2* and the output voltage becomes zero. Therefore, the entire voltage from the rectifier appears across the regulating transistors. Transistor *T-6* acts as a switch and reduces the current flow of the supply to zero whenever the emitter-collector voltage of the regulating transistors exceeds 20 volts, so that the maximum power which need be dissipated is limited to approximately 240 watts for the short time it requires *T-6* to go to conduction. *T-6* prevents current flow in the supply by fully conducting and thereby clamping the base of *T-1* to ground. Manual opening of the d-c breaker resets the electronic circuit breaker.

Test Results

Four laboratory models of these rectifiers were built and tested. The average regulation was 0.63 percent from no load to a full load with a ripple of 0.03 rms volts at full load. The heat sinks with the supply operating at full load and an ambient temperature of approximately 21 degrees C, stabilized at a temperature of 53 degrees C, produce a junction temperature of 68 degrees which is well below the maximum allowable temperature of 90 degrees C. The supply will hold its regulation for the 0.1-sec. line interruption and requires a closed line for approximately two seconds to charge the carry-over capacitors before another interruption may occur. The output impedance is 0.076 ohm. For a full 300-watt output the input to the supply was 428 watts, giving an efficiency of 70.1 percent.

Control Panel and Alarm Circuitry

In field installations each power supply has an auxiliary supply paralleled to it which acts as a stand-by so that any failure of a supply will automatically transfer the load to the auxiliary without interruption of power. Alarm circuits are provided which remove a faulty power supply from service by opening its a-c circuit breaker.

A separate regulated reference power supply located on the control panel chassis provides two reference voltages of +65 and +55 volts. A constant check is made on the +60-volt output of each supply and if either rises above +65 volts or falls below +55 volts the supply will remove itself from the a-c line, thereby automatically transferring the load to the auxiliary supply. Alarm lamps light to indicate this condition. Figure 5 shows the alarm circuitry.

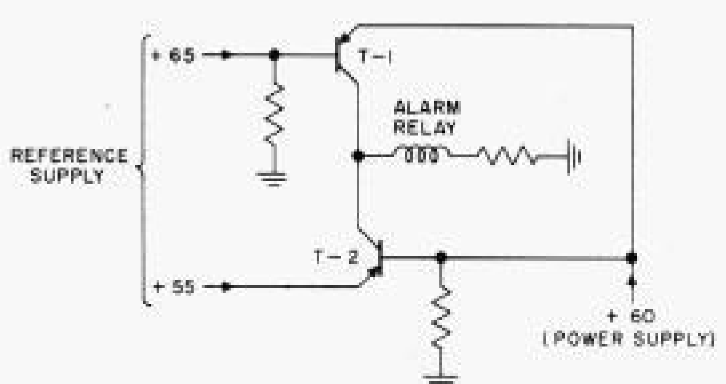


Figure 5. Alarm circuit

If the supply voltage exceeds +65 volts transistor *T-1* will conduct, or if the sup-

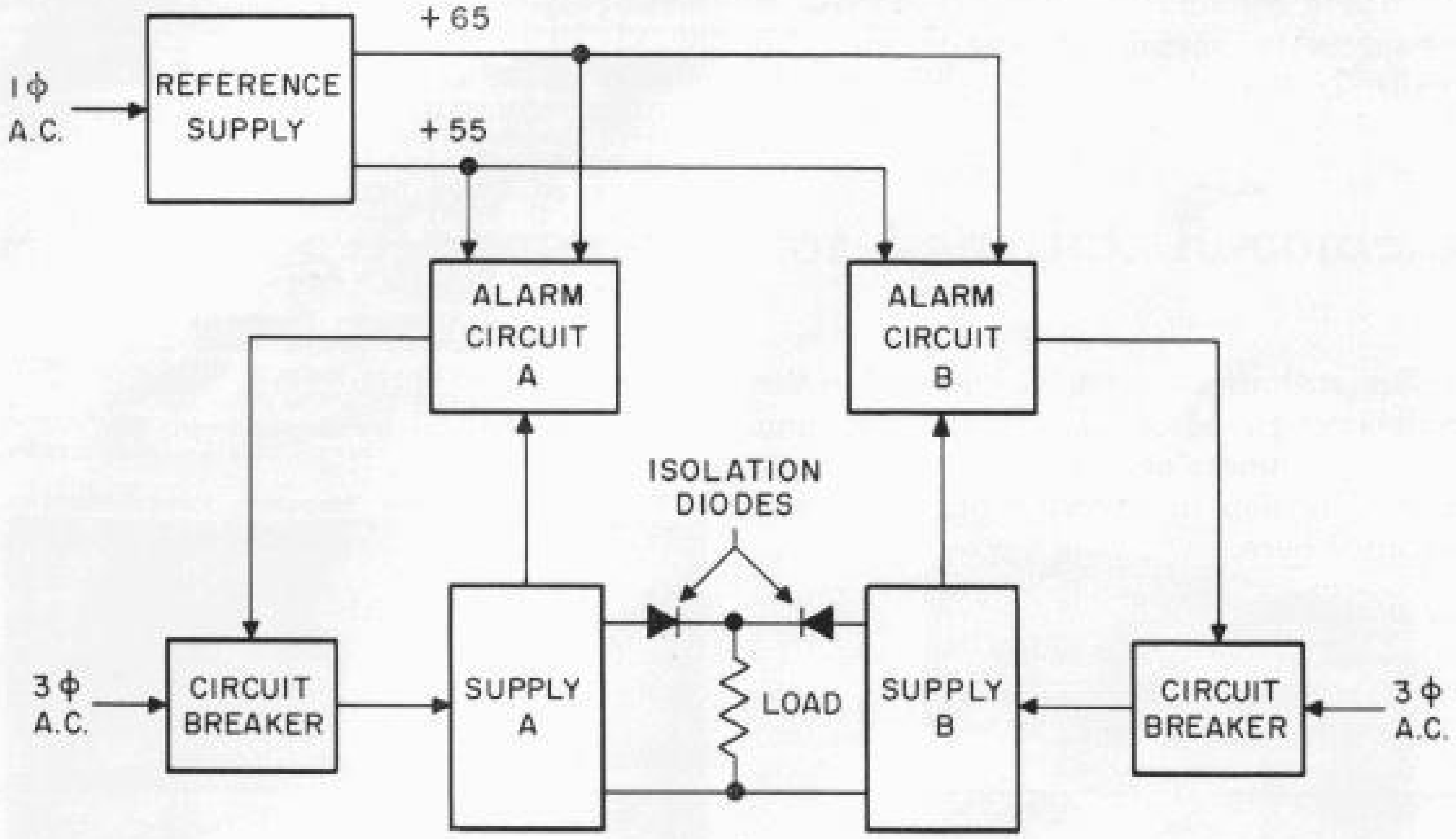


Figure 6. Connections between components

ply voltage falls below +55 volts transistor *T-2* will conduct. In either case the alarm relay will be energized. A circuit identical to that shown in Figure 5 is provided for each supply.

In case of a control panel failure the alarm lamps of both supplies will light; however, neither supply will be removed from the a-c line and no interruption of the d-c power will result.

A toggle switch included on the control panel allows manual switching between the supplies so that an operator may choose which supply will carry the load and which will act as the auxiliary. Manual switching between the supplies is accomplished by introducing a slight differential voltage between the paralleled supplies after their output voltages have been set equal. The supply having the higher voltage will assume the entire load. A germanium diode in the positive lead of each supply serves to isolate each from the other. Germanium is used because of its low-voltage drop at high currents, which in this application does not exceed 0.5 volt at full load.

Figure 6 is a block diagram showing the connections between the various components described here. Figure 7 shows the upper half of an installation of two supplies and an associated control panel providing positive or negative line battery. These power supplies are mounted on standard 12-inch rack panels; however, by a rearrangement of the components and

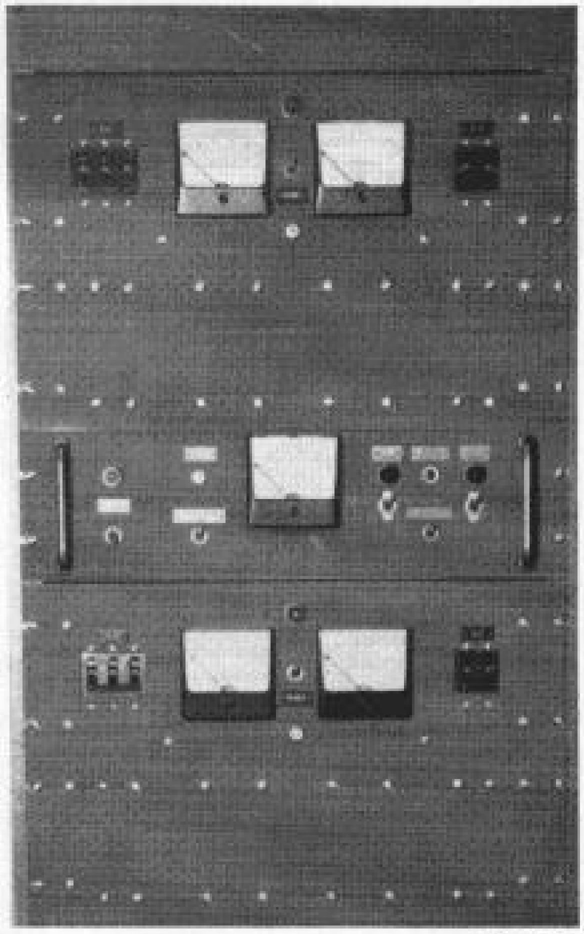


Photo R-11,618

Figure 7. Front view of supplies and control panel — upper half of 4-unit rack

the use of commercial finned heat sinks, a considerable saving of space can be realized.

★ ★ ★ ★ ★

The author wishes to acknowledge the collaboration of E. J. Chojnowski and A. A. Steinmetz of the Systems Development Division in carrying out the work outlined here.

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WILLIAM CORKUTT graduated from the Michigan College of Mining and Technology and joined the Research and Engineering Department of Western Union in 1957. Previous to college he served four years as a radio operator with the Signal Corps of the U. S. Army. He is an engineer in the systems development division, assigned to the electronics group. His activities include the design and application of electronic circuitry to automatic switching systems and telegraphic apparatus. Mr. Corkutt is a member of Eta Kappa Nu.

DOUGLAS M. ZABRISKIE, Assistant to Telefax Engineer

WILLIAM F. MOORE, Engineering Supervisory Assistant

A Message Accumulator for Letterfax Recorders

AN automatic accumulator has been designed to meet the need for assemblage of large numbers of recorded messages at unattended or occasionally attended Letterfax recorders. It is capable of stacking sheets, in the order received, cut into uniform or random lengths of from 1-5/8 to 15 inches from a whole roll of "Teledeltos"* (approximately 350 ft.).

Photo R-11,495

Modifications of laboratory models of Telefax apparatus are checked by authors Zabriskie (seated) and Moore

The time required to consume a roll of "Teledeltos" paper obviously represents the maximum interval of unattended operation possible. This would permit unattended operation of a 180-rpm circuit over a 64-hour week end for a comparatively heavy load averaging about six 11-inch-long messages per hour.

Figure 1 shows the accumulator in position on a recorder. It consists of a mechanism assembly (Figure 2), a message bar and a detachable transparent receptacle.

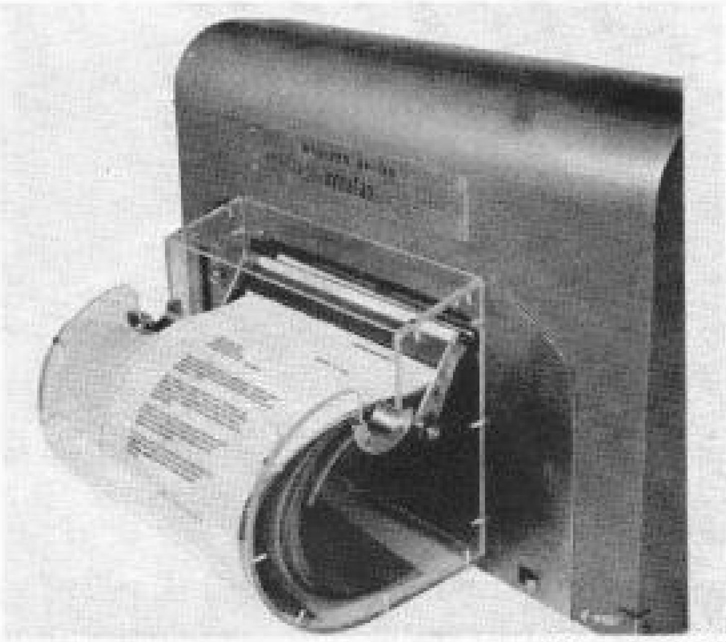


Photo R-11,421

Figure 1. Letterfax recorder with accumulator

Some of the features considered in its design were:

1. Prevent the accumulated stack from impeding the progress of an incoming sheet.
2. Remove the stacked sheets with no interference to incoming message.
3. Stack sheets of random length in the order received.
4. Avoid the difficulties incurred by free-falling sheets.

Description

The mechanism of the accumulator is actuated by a cam which is driven by the recorder knife motor. As the cam rotates, the cam follower and a sectional drum reciprocate, pulling a cable which, through a series of pulleys, drives the flapper lever.

Referring to Figure 3 a stationary message bar is seen attached to the recorder

* Registered Trademark, W. U. Tel. Co.

frame above the incoming sheet. It is equipped with a pivoted one-way latch protruding from the middle of the bar.

A clamping lever and a flapper lever are independently pivoted on a stationary shaft. The flapper is pivoted at the ends of the flapper lever which is actuated by the cable fastened to its hub.

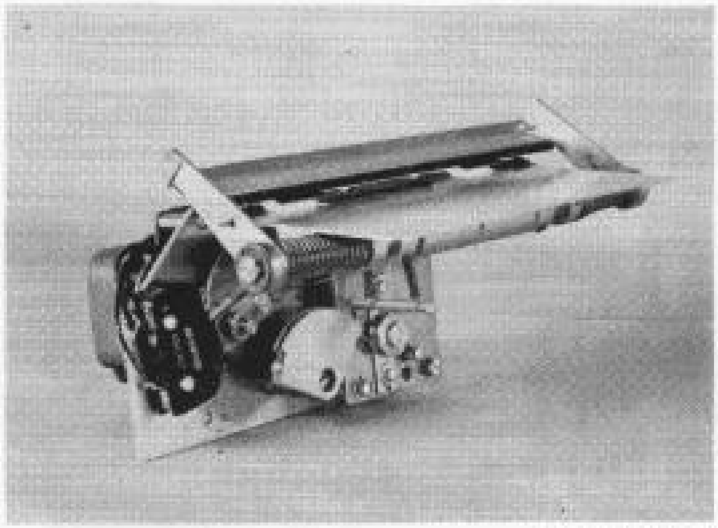


Photo R-11,570

Figure 2. Message accumulator mechanism

The clamping lever is forced against the message bar by adjustable torsion springs.

Fingers protrude inwardly from the sides of the transparent receptacle. They are located above the path of the emerging sheet and the space between them is less than the width of a sheet.

Operation

Refer to Figure 4 (A). The cam is timed so that just as the knife completes a cut the flapper lever rises to grip the cut sheet between the back end of the flapper and the unyielding one-way latch. Simultaneously, the resistance of the latch causes the flapper to rotate about its pivot, and to lift the leading end of the sheet above the receptacle fingers.

Refer to Figure 4 (B). When the flapper, in its continued upward movement, loses contact with the latch, the trailing end of the sheet then is gripped between the flapper and the clamping lever, at the same time the back end of the flapper falls and deposits the sheet upon the fingers.

Refer to Figure 4 (C). As the flapper and clamping levers continue to rise, the protruding, trailing end of the sheet is lifted above the message bar so that, upon

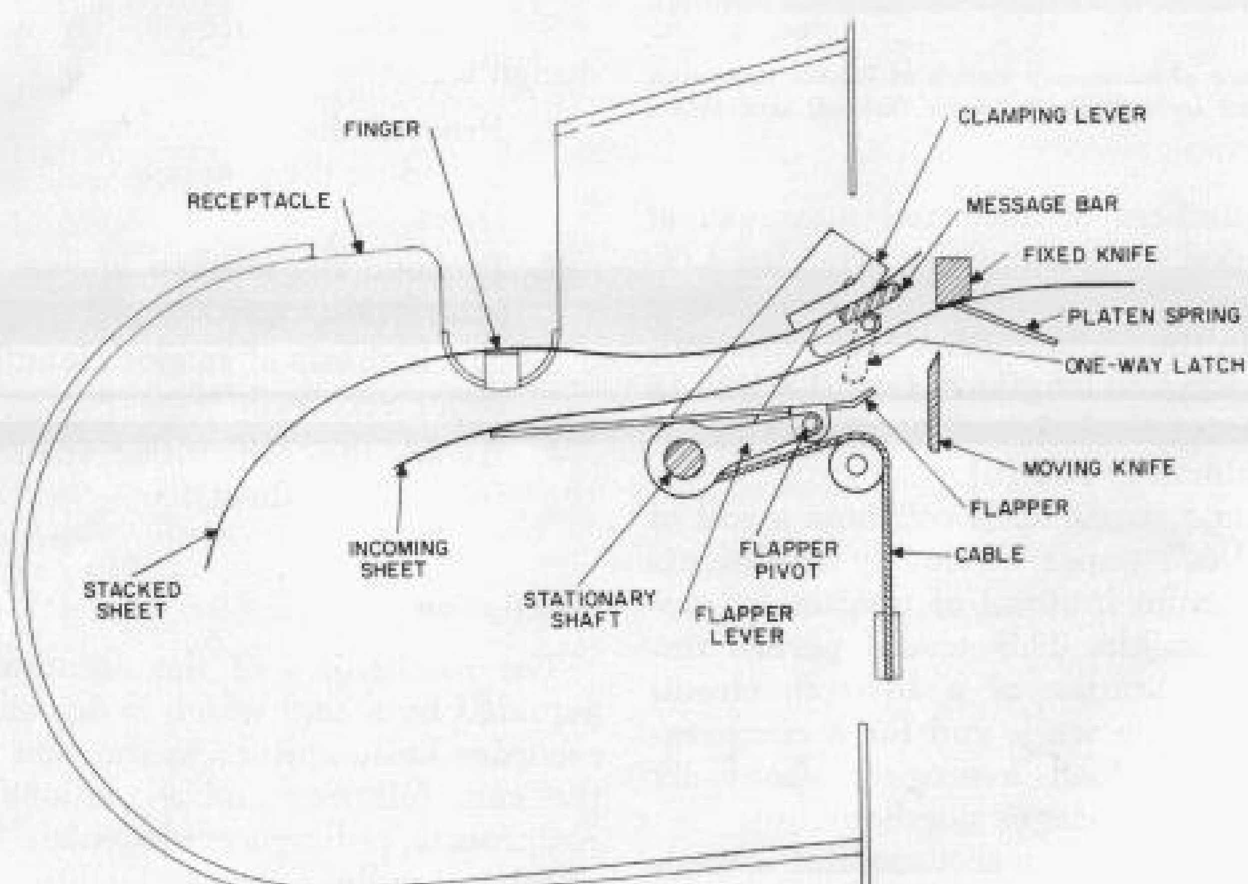


Figure 3.

descending, the trailing end of the sheet is deposited upon the message bar and held by the clamping lever, while the flapper continues to descend past the yielding latch to its rest position, clear of the next emerging sheet as in Figure 3.

A regulated tension upon the clamping lever permits only a limited number of sheets to remain between the message bar and the clamping lever. Agitation of the stack, by successive operations of the accumulator, causes sheets in the middle of the stack to slip from the grip and fall into the receptacle. In this manner the mechanism is not overloaded by excessive stack weight.

Inasmuch as the bottom sheet never falls, no obstacle is presented to the next emerging sheet.

The receptacle fingers are shaped so that the stack of messages resting upon them can be grasped and withdrawn at any time without disturbing an incoming recording.

Spring latches, applied to the recorder base, are used for convenient attachment and removal of the receptacle.

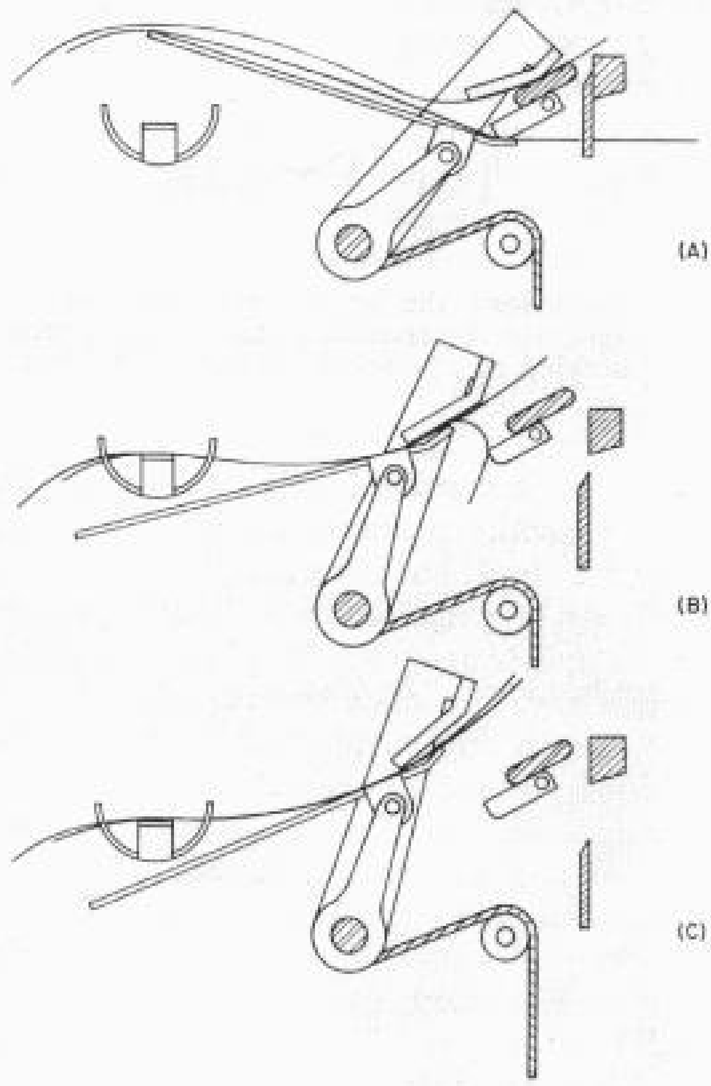


Figure 4.

A biographical sketch of MR. ZABRISKIE appears in the July 1955 issue of TECHNICAL REVIEW.

WILLIAM F. MOORE, of the Telefax Research Division, joined Western Union in 1941 as a draftsman in the former Engineering Department. During the war, after having studied at Iowa State College, he served in the U. S. Navy as an Electrician's Mate. He returned to the employ of the company in 1946, where he became associated with the activities of the Telefax Division in 1949, and assisted in the development of several facsimile applications. Since 1955 his work has been mainly concerned with the design of new facsimile equipment and the improvement and modification of existing facilities. Mr. Moore is coinventor on one patent issued and on two applied for.

NORMAN R. LANE, Engineer, Electronic Components

The Process of Silk-Screen Marking

Among the smaller accessories of laboratory and shop, silk-screen facilities are inexpensive and versatile. A time-tested process offers speed and simplicity for prototype panel marking or up-to-date refinements for exacting requirements in printed circuitry.

THE SILK SCREEN is perhaps one of the most versatile means of reproducing copy industrially. It has been adapted to various methods of printing from hand operated frame and squeegee to automatic printing machinery. The silk screen can be adapted to mark on any surface which can be developed from a flat plane; on practically any material including wood, metal, paper, textiles and other finishes; and in any of several media including glue, used in flocking; inks, used in poster and art work; dyes, used in textile printing; and enamels and lacquers, used for more permanent markings on metals, wood and over other finishes. Multicolor copy may be reproduced by the use of multiple screens and consecutive printing. In general it might be stated that anything which can be photographed can be reproduced with a silk screen, since by proper selection of screen material and printing media sufficient detail may be obtained for reproducing halftone copy.

There is a definite place in the laboratory and model shop for silk-screen marking methods. Dial calibrations, circuit labels, panel markings, chassis markings, component board designations, name plates, trademarks and printed circuits are all examples of work to which silk-screen printing methods may be applied. The versatility of the silk-screen technique in combining either complex detail with limited quantity or simplicity of detail with production quantities, emphasizes the wide range of application possible in pilot models and preproduction runs as well as straight quantity production operations.

A silk screen is essentially a stencil executed in fabric. Traditionally, as the name implies, the fabric is raw silk. This material was selected for its tensile strength, uniformity of mesh, and durability. More recently screen materials of nylon, dacron, cotton organdy, monel, phosphor bronze and stainless steel have come into use. All screen materials come in a wide variety of mesh and aperture sizes, and in taffeta or basket weave and leno or interlocked weave. The combination of mesh, aperture and weave used is dependent upon the printing media and detail requirements of the copy. For example, a thick marking fluid will require a larger aperture than a thin fluid for the same buildup of marking. However, the more detail required, the finer the mesh required, so a compromise must be reached which will give the desired result. Since weave is a factor in screen strength it must be considered with mesh and aperture. While there is some overlapping, it is generally true that the finer mesh is taffeta while the coarser mesh is leno.

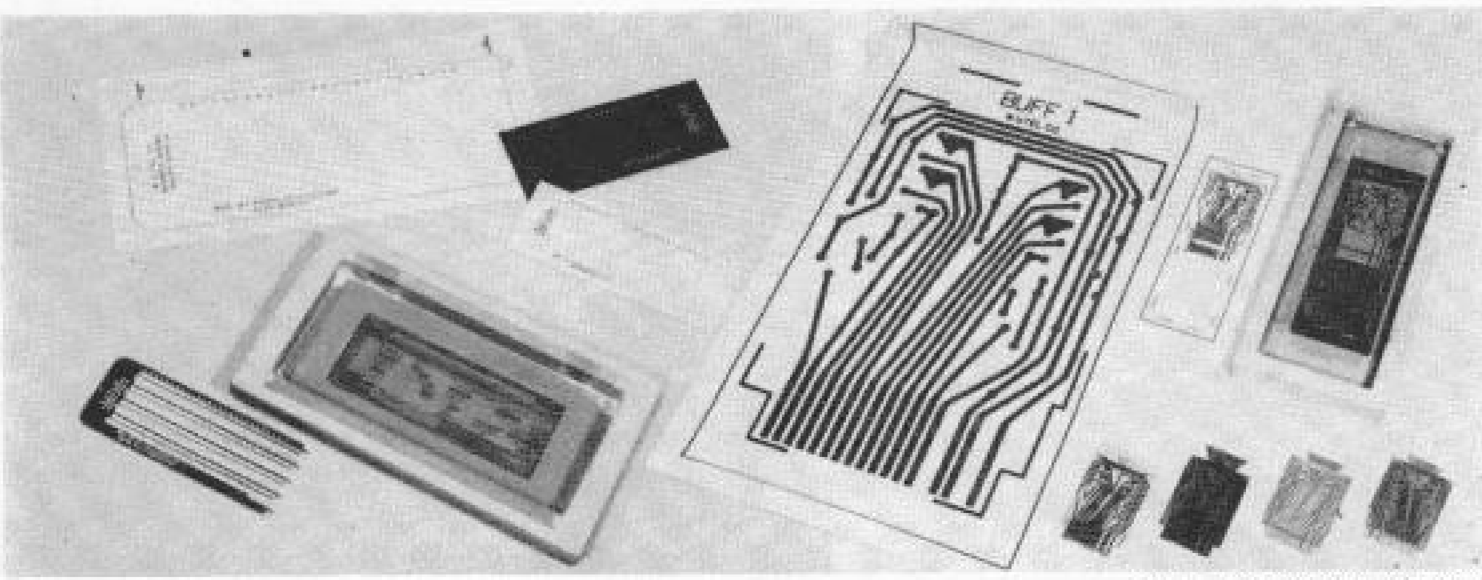
Screen Preparation

The preparation of a silk-screen stencil, simply stated, consists of selectively closing the apertures of the mesh with a suitable filler material to stop the passage of the printing medium through the stencil except in the desired copy pattern. This filling is generally prepared in one of two methods; namely, film cutting or photography. Cutting-films consist of a transparent backing of paper or plastic with a coating of tough durable lacquer temporarily held in place by an adhesive. This film is placed over a full-scale layout of the desired copy, lacquer side up. The lacquer coating over the copy is then carefully cut away, leaving in effect a lacquer stencil on the backing material. A silk-screen mesh, suitably stretched and mounted in a frame and moistened with a lacquer softening solvent, is gently pressed onto the lacquer surface. When the solvent has evaporated and the lacquer rehardened, the backing material is peeled off leaving the screen mesh completely filled in the desired pattern.

In one photographic process the copy is prepared several times full scale and reduced photographically to obtain a full-scale negative of the copy. This negative is then used to make a contact print on a photosensitive material with a peelable backing similar to cutting-film. The filler, or emulsion, is removed from the copy pattern in the developing process. A mounted silk-screen mesh is then gently pressed over the still damp, hence soft, emulsion stencil. When the emulsion is set the backing is peeled off, as with the cutting-film. When the original copy is of sufficient size and accuracy to get the detail desired, a negative may be prepared by means of contact printing, bypassing the camera work.

A second photographic technique, known as the direct method, uses an emulsion which, when dissolved in water and applied directly on the silk screen, becomes light-sensitive. The exposure is made directly on the screen and the image is washed out in the developing process.

Regardless of the method used or the pattern size, the final silk screen must always be somewhat larger than the printing portion to provide working space when the screen is in use. This additional space need not be included in the film stencil but may be filled in with a block-out solution applied with a brush. This solution may also be used for touch-up work in the copy portion of the screen if needed.



Photos WM 404-29 and 404-30

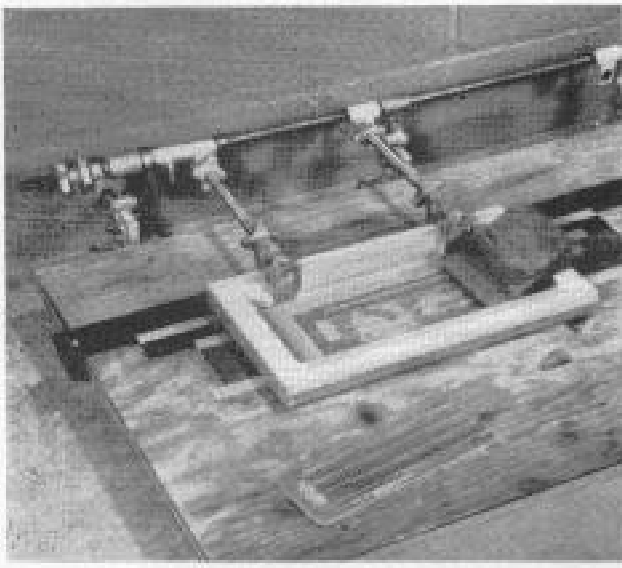
From layout to a finished address coding insert .... Above, clockwise: original layout, photonegative, photopositive stencil, silk screen and silk-screened address-coding insert used in Plan 57 switching system code reading card assemblies

Silk screening applied to printed circuitry .... Above: expanded layout (5x), photopositive reduction and silk screen shown with screened circuit, etched board, and front and rear of circuit board solder dipped and eyeletted

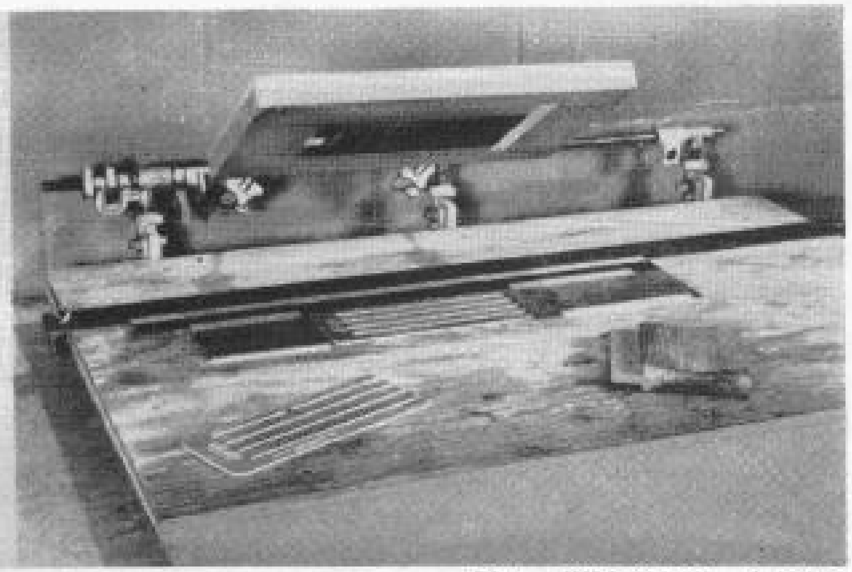
The film-cutting technique is quite adequate for copy where considerable tolerance is permissible, such as poster and art work. The direct photographic method is used widely in the textile printing field. The photographic reduction of copy allows for reproduction of considerable detail with close tolerance. This is possible because of the minimizing effect on variations and inaccuracies brought about by photographically reducing the large scale copy to the desired size. The high degree of accuracy obtainable makes screens prepared in this manner suitable for laying out panel markings, dial calibrations and printed circuit boards where registration of copy is most important.

Printing Process

A silk-screen setup is illustrated showing the screen held in an adjustable fixture which orients it on the work piece which in turn is held in stops on the printing table. Once the screen has been set accurately with respect to the work, the screen may be raised, the work piece changed and the screen lowered again with positive registration on the successive pieces to be printed. When alignment has been established the screen is charged with the printing medium, lowered on the work piece and the printing medium pulled over the screen surface with a squeegee. The squeegee must fill the screen to the extent that the entire printing portion is covered with one pass. This is important to prevent blurring of the copy which might result if subsequent passes were necessary. It should also be noted that the screen surface is held off the work surface sufficiently so that, due to normal stretch of the fabric, it touches only at the point immediately under the squeegee in its excursion across the screen. This is done to prevent smudging of the copy when the screen is lifted to change work pieces. The operation illustrated is the marking of the address coding insert used in Plan 57 code reading card assemblies. The screen, and the intermediate steps necessary to its preparation, are shown. The photograph of the finished card illustrates the detail and registration obtainable. In this case the printing was done with white enamel. The card material is epoxy-fibreglass.



Setup for marking address coding inserts with screen down in marking position



Photos WM 404-32 and 404-33

Same as at left but with screen up showing printed address coding insert between runoff boards

Another important application in the silk-screen marking method is in the preparation of printed circuits. By using the photographic reduction method, a layout of perhaps five times full scale is reduced and a silk screen made. Obviously a layout made at this scale, with any reasonable degree of accuracy, will be well within the close tolerances required when reduced to normal size. All drilling centers and cropping indexes are included on the screen with the printed circuit so that no further mechanical layout is required on work printed with the screen. For printed circuit work an etchant resisting paint is used for marking on the copper-clad printed circuit board. When the paint is dry the printed board goes into the etching tank and the exposed copper is etched away leaving the resist-covered circuit, drilling centers, crop marks and circuit identification sharply delineated on the insulating backing. The resistant paint is now removed with a suitable solvent and the board is ready for drilling, tinning, eyeletting and assembly.

Other examples of silk-screen marking, some of which are illustrated, include front panel marking which might comprise dial calibrations, circuit labels, connection data, special trademarks and name designations, all printed with one screen, in one pass of the squeegee. Similarly, component mounting panels may be marked with component designations at the proper locations, as shown on the wiring diagrams, to facilitate assembly, wiring, and possible subsequent trouble shooting. Silk-screen printing has also been applied to the marking of unit covers, dial plates, various trademarks and name plates. The silk screen, when used to mark pilot runs or models, gives a professional, completely finished appearance to the equipments, with the additional feature of providing the facility for reproducing the marking.

One of the chief advantages of the silk-screen process is the ability to print the various kinds of copy mentioned and illustrated simultaneously with one screen and then faithfully repeat this printing when desired, for with reasonable care a silk screen may be stored almost indefinitely without harm. Where uniformity and registration of copy from piece to piece is desirable, as in the case of dial calibrations, the silk screen has decided advantages over many other marking methods. Perhaps the greatest disadvantage is the difficulty which arises in trying to adapt the silk screen to small surfaces such as narrow chassis edges, or multiplaned surfaces such as two panels which must be fabricated and finished before marking.

Economic Considerations

When considering the economics of silk screening several factors must be evaluated. These are detail, complexity, reproducibility and total number of units, to name the most important. While it is immediately obvious that in quantities of any sizeable amount silk-screen marking is economical, it is not always so obvious that if a draftman's layout can be converted into a silk screen in the time that it takes to convert it into copy by any other method, silk screening becomes economical. This is often the case where complex, detailed copy is required. For example, in the case of printed circuitry, where the pattern is apt to be very complex and tolerances small, the ratio of cost

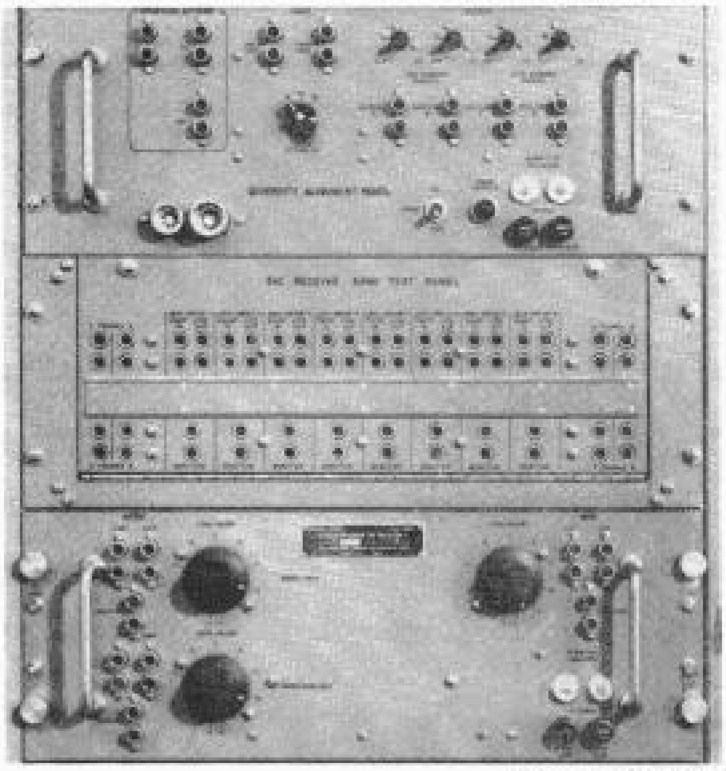


Photo WM 404-31

Apparatus panels marked with silk screens

Norman R. Lane joined the staff of Western Union's Water Mill Laboratories in 1940 while attending Northeastern University on a cooperative student basis. Upon receiving his Bachelor's Degree in 1943 he was assigned to the Navy Trainer Program through which he contributed to the development and production of both the visual contact and radar contact trainers. Later he was connected with the development of various items at the laboratory including magnetrons, power sources for concentrated-arc and telcoarc lamps, flat-bed facsimile, and the production and testing of the AN/FGC-29 Terminal equipment. Following this he became concerned with the development of printed circuit design and production and coincidently with silk-screen techniques.

of screen preparation to cost of reproduction by other methods favors the silk screen even more, regardless of quantity. In the case of panel marking, for instance, where individual tags or labels have been used previously, a silk screen including all the marking may become more economical merely by eliminating the tag manufacture and mounting hole drilling. If drafting time required for screen layout is compared to individual tag drawings and mounting hole layout, the saving here may be found to be considerable also. Considering these facts, it becomes obvious that there is an economical application for the silk screen even though the marking is fairly simple and the number of units to be marked small. While a combination of high complexity and large quantity favors the silk-screen method, there is an economic barrier on the upper side, for when quantities become really large other methods of marking become even more economical.

For some years Western Union's Electronic Laboratories at Water Mill, N. Y., have been preparing and using silk screens in a wide variety of applications with very satisfactory results. The company's Chattanooga Works also uses the silk-screen marking process to advantage in production work there.

Patents Recently Issued to Western Union

Printing Telegraph Signal Normalizer

R. Steeneck
2,891,109—June 16, 1959

A type of regenerative repeater intended to repeat at a uniform rate the character signals only, as received at an intermittent rate from a circuit including a synchronous multiplex channel, which signals were originally supplied by a start-stop circuit such that the signals now include occasional blanks as well as possible deletions due to interference. The applications are primarily in military circuits employing a start-stop code throughout. The invention features two-character distributors with means for switching between the two ends of a brush arm to achieve character deletion, and short term and long term correction of a speed controlling crystal oscillator.

Facsimile Ticket and Message System

G. H. Ridings, R. J. Wise, C. Jelinek, Jr.
2,894,063—July 7, 1959

A facsimile ticket distribution system employing scanners of the type shown in Patent No. 2,639,322 located at a central ticket office for sending, in response to requests, space, time, date and other reservation data for reception in the blank areas of ticket forms loaded in recorders of the type shown in Patent No. 2,872,275 located at branch ticket offices. The system includes message blank wrapping, unwrapping and ejecting control means, interference protection for the phasing procedure and interlocking means to prevent start of a transmitter while the local receiver is operating.

Facsimile Optical Scanning System

R. J. Wise, J. H. Hackenberg, G. H. Ridings
2,894,065—July 7, 1959

A scanner for ticket and like material which employs a transparent drum, stationary except during the process of wrapping the blank thereon, with an inclined rotating internal mirror for inside scanning. The scanning light beam is directed into the open end of the tubular mirror housing whence it is reflected through an aperture in the housing and through the transparent drum to the inside surface of the message blank. The reflected beam emerges concentrically with the entering beam via the same aperture and mirror to a short focus Fresnel lens which concentrates the light on a photocell. Since specular reflection from the print and background areas of a glossy blank do not differentiate sufficiently, only diffused light is collected. The mirror mounting angle and the aperture position are, therefore, so chosen as to reject the directly reflected beam. A flange on the mirror housing serves to enclose the drum interior to block spurious light reflections.

Facsimile Transmitter for Telegraph Message Blanks and the Like

W. D. BUCKINGHAM, G. H. RIDGE, L. D. ROOT, F. T. TURNER
2,894,066—JULY 7, 1959

A "flat-bed" type of continuous facsimile scanner in which a message dropped into a loading slot is seized by retractile members which position the blank under a time stamp operable in response to a start signal, then deliver it to feed rollers and withdraw. The blank then advances rapidly until the message portion reaches the scanning position when it slows until scanning is completed after which it is rapidly ejected. An end-of-message indicator is manually operable to cause termination of scanning at the end of short messages with automatic return to normal for the next message.

Diversity Telegraph System

J. E. BOUGHTWOOD, F. H. CUSACK
2,899,548—AUGUST 11, 1959

A frequency diversity multichannel radio telegraph system particularly resistant to the effects of selective fading. As described, a first group of 8 frequency shift telegraph channels occupies the higher frequency half of a voice-frequency band while a second such group of 8 additional channels is translated downward to occupy the lower half of the same v.f. band to provide a total of 16 independent channels for radio transmission. The radio transmitter shown accommodates 2 v.f. bands, the lower one of which accepts the above-described 16 channels directly while the second band accepts the same channels after an upward frequency translation to thus provide duplicate transmissions for each of the 16 channels. At the radio receiver, first the v.f. bands and next the half bands are separated by conventional means to yield 32 telegraph channels in 16 pairs. The two channels of each pair are first equalized with respect to each other as to delay, and then amplified separately but under control of a common AGC so that the level ratio is maintained, but with a constant level for the output of the strongest channel. Next, amplifiers having outputs proportional to the square of their inputs, followed by discriminators with their two outputs connected in series for applying the signal to a post detection limiter, together serve to select the dominant signal while restricting the noise accompanying the weaker channel. In an expanded version, 4 transmission channels may be combined to yield a single diversity channel.

Dial Facsimile System

W. S. W. EDGAR, JR.
2,902,538—SEPTEMBER 1, 1959

A private facsimile intercommunication system arranged for direct dialing between transceiver-equipped outstations via common switching equipment located at a master station. No intermediate storage is required. Details of the busy test, rotary switch operation, station identification, phasing, and so forth, for normal interconnection, master sending, or sending to a telegraph office are described.

Method for Charging Submersible Chambers

E. L. NEWELL, P. H. WELLS
2,902,803—SEPTEMBER 8, 1959

The method of oil-filling a submerged repeater casing of the type described in Patent No. 2,903,500 below which comprises a series of cycles of evacuating followed by filling, first with an inert anhydrous gas and then by oil, so that upon submergence the anticipated contraction caused by temperature drop, hydrostatic pressure and voids will not exceed the volume compensating capacity of the bellows system.

Submersible Chamber

E. L. NEWELL, P. H. WELLS, C. H. CRAMER
2,903,500—SEPTEMBER 8, 1959

A structure for transmitting hydrostatic pressure to the interior of an oil-filled submerged repeater casing while preventing ingress of sea water which comprises a first bellows, or equivalent cylinder and piston, located external to the main body of the casing tandem connected to a second but more sensitive or thin-walled bellows located within the casing, the two being filled with oil.

Facsimile Transmitter Blanking System

M. J. MCCANN
2,903,511—SEPTEMBER 8, 1959

Provides a fast and positive interruption of signal transmission while scanning the message underlap space on a facsimile scanning drum. The output of the transmitting amplifier is gated off and on at the underlap period by a bistable multivibrator which is in turn controlled by voltage pulses generated respectively in a pair of pickup coils by magnets imbedded in the periphery of two discs located on the drum shaft and aligned with the leading and trailing edges of the underlap space. The length of the blanking period is adjustable by orientation of the magnet discs and, if desired, a blanking tone from a separate oscillator may be transmitted during the underlap period to prevent marking of the copy at the recorder during this period.

Facsimile Telegraph Scanning Apparatus

W. D. Buckingham

2,903,512—September 8, 1959

An optical system for a facsimile continuous, or flat-bed, scanner in which a beam from a point light source is deflected across the copy by an oscillating spherical mirror spaced equidistantly from both the light source and the copy a distance equal to its focal length so that the diameter of the ultimate scanning spot is the same as that of the light source. A line of reflected light from the scanned line of copy is collected by two symmetrically spaced elongated cylindrical mirrors and directed thereby to an elongated photocell, the respective spacings from copy to mirrors to photocell being each equal to the conjugate focal length of the mirrors so as to produce a line of light on the photocell corresponding in intensity at any instant to the tonal density of the copy. The long line of light thus averages out any nonuniformity in the emissivity of the photocell cathode. By quick return of the oscillating mirror the scanner is made compatible with drum-type recorders. Other features relate to the sheet feeding means and to a simplified method of cylindrical mirror construction.

Record Communication-Telephone System

G. H. Ridings

2,903,517—September 8, 1959

A method for employing a patron's telephone line together with its normal telephone subset and dial calling equipment for establishing connections for the exchange of messages by facsimile from a telegraph central office to a patron's transceiver. The originating operator, whether central office or patron, contacts the distant operator in usual telephonic manner and announces the forthcoming message. The recorder is readied and, in each case, the patron's transmitter sends test pulses while an attenuator is adjusted at the central office to assure a satisfactory received level regardless of the direction of transmission. The lifted telephone handsets are now manually replaced on appropriately designed handset lifting mechanisms attached to the subsets and embodying acoustic, magnetic or direct coupling to the facsimile equipment, and the patron's power switch is closed. Transmitter-receiver relationships are then completed, the handsets lift sufficiently to open the switch connection and message transmission proceeds, all automatically. Upon completion, end-of-message indicators are actuated and the handsets are dropped into normal rest position.

Sprocket Feed Paper Synchronizer

E. W. Hewitt

2,908,370—October 13, 1959

Attachment for assuring precise paper feedout in a teleprinter provided with sprocket feed for a paper roll bearing message blank severance lines and which may also be equipped with an automatic blank severing and ejecting device. At end of message the associated transmitter automatically sends additional blank feedout pulses but when the total feedouts reach a normal 22, the blank may be severed and further feedouts are ignored until the paper is released by a final carriage return or other release signal at the beginning of the next message.