WESTERN UNION

Technical Review

Office Automation by Telegraph

•

Switching Telegrams from Tie Lines to Trunks

•

Character Generation in Telegraph Systems

•

Switching System 33 (Brooklyn)

•

Private Wire Services

VOL. 12 NO. 4
OCTOBER 1958

WESTERN UNION Technical Review

VOLUME 12
NUMBER 4

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

OCTOBER
1 9 5 8

CONTENTS

Published Quarterly by

THE WESTERN UNION TELEGRAPH COMPANY

COMMITTEE ON TECHNICAL PUBLICATION

F. B. BRAMHALL, Development and Research, *Chairman*
NELL ORGAN, Development and Research, *Editorial Secretary*

I. S. COGGESHALL	Internat'l Communications
A. E. FROST	Planning
H. H. HAGLUND	Plant and Engineering
G. HOTCHKISS	Development and Research
G. P. OSLIN	Public Relations
M. J. REYNOLDS	Patents
H. M. SAUNDERS	Private Wire Services
C. G. SMITH	Industrial Engineering
H. W. THOMPSON	Operating

Address all communications to THE WESTERN UNION TELEGRAPH CO., COMMITTEE ON TECHNICAL PUBLICATION, 60 HUDSON ST., NEW YORK 13, N. Y.

Subscriptions $1.50 per year

Printed in U.S.A.


WU

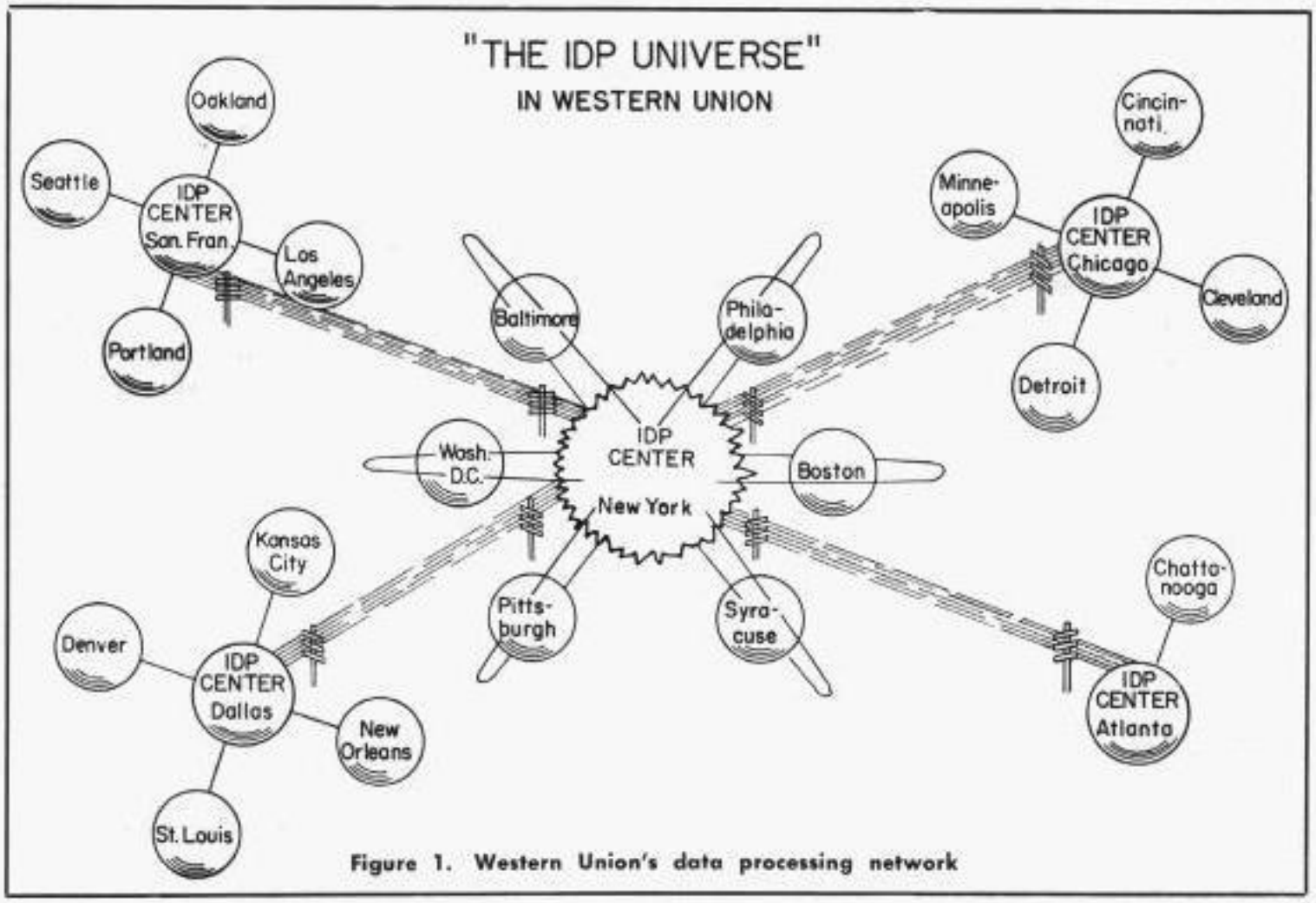


Figure 1. Western Union's data processing network

WARREN F. GREGORY, Senior Supervisor of Methods, Accounting

WILFRED J. WALSH, Senior Supervisor of Methods, Accounting

A Nationwide System for Office Automation and Timely Reports for Management

Concomitant with ever increasing interest in business machines for processing commercial data, is the growing awareness of need for readily available data transmission facilities. As the medium for rapid transmission of information or data, telegraphy has had no equal for 100 years hence its employment by the Telegraph Company itself for "timely reports to management" is hardly surprising. Discussion of such a practical coalescence of telegraphy and data processing may help others apply similar procedures.

THE Western Union Telegraph Company has improved clerical efficiency and achieved better management control through the development of a nationwide integrated data processing system which utilizes its public telegraph network and automatic techniques to furnish management with prompt, complete and significant information on which to base timely decisions. This data-gathering network quickly assembles the detailed information, relating to the vital field of payroll and production control in every major city coast-to-coast, for processing at central accounting installations by business machines and electronic calculators to provide more effective reporting and improved analysis of business data.

The development of office mechanization in Western Union was a natural complement to the Telegraph Company's high-speed message transmission system.

A paper presented before the AIEE-IRE-ASME Technical Conference on Automatic Techniques in Detroit, Mich., April 1958.

The company's technological advancement immediately following World War II resulted in automation of its telegraph operations on a nationwide basis with a highly mechanized national network of message centers being placed in service. Each message center serves several states and 5-channel, common-language, perforated tape is used to transmit telegrams to destination over this network without manual retransmission at any point en route. This mechanized network and the 5-channel perforated tape inevitably became important links in the chain of integrated data processing as management sought to narrow the time interval between the happening of the event and the taking of a logical decision based thereon.

The Problem

Since the Telegraph Company is a service organization and manufactures no product, its labor cost is the most significant item in its total operating expense. Constant emphasis, therefore, must be placed on maximum efficiency in the deployment of its operating and maintenance personnel. Such emphasis can be applied only through the communication of current and pertinent data concerning men, load and equipment to all levels of management. This communication problem is a most complex one, for Western Union has over 37,000 employees who work in some 2,100 locations throughout the country. While, naturally, large segments of these employees are located at the more populous points, there are many locations where the office complement is but five or fewer employees.

In most instances the volume of payroll and other operating data to be processed at any location is insufficient to justify economically the installation of punched-card equipment. The manual accumulation of the required data, the manual preparation for transmission, and subsequent retranscriptions incident to summarization at various levels of supervision, were too time-consuming and inefficient.

Early in the explorations it became apparent that the desired improvement in clerical efficiency and rapid preparation of management control data would require the collection of basic information from outlying points and telegraphing it to a central location for high-speed processing. The problem posed by originating the source data at numerous reporting locations in suitable form for subsequent automatic handling has many facets. Because of the distance between the originating and processing points, the system designed had to incorporate the virtue of simplicity. In dealing with a sensitive item, an employee's pay, misinterpretation and delay could not be tolerated.

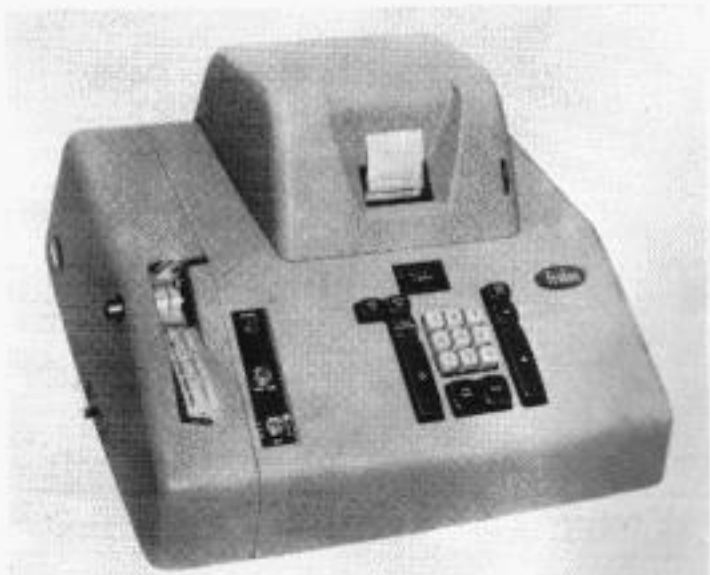


Figure 2. Add-punch equipment used to originate perforated telegraph tape at remote office

The information needed to process the pay and produce the required accounting data and desired management control reports would have to be reduced to a few simple codes. The coding problem was a most challenging one when it is considered that the proposition involved was one of producing more management information on the one hand and on the other serving the efficiency of wire transmission by reducing the number of reporting codes to fewer than were used heretofore in the conventional mechanized processing system.

It appeared that beyond the original all-important recording of the source data, the subsequent processing should be on the basis of "Look, Mom, no hands." This well may be a most apt description, for to master the "no hands" approach required careful planning to avoid the pitfalls of the

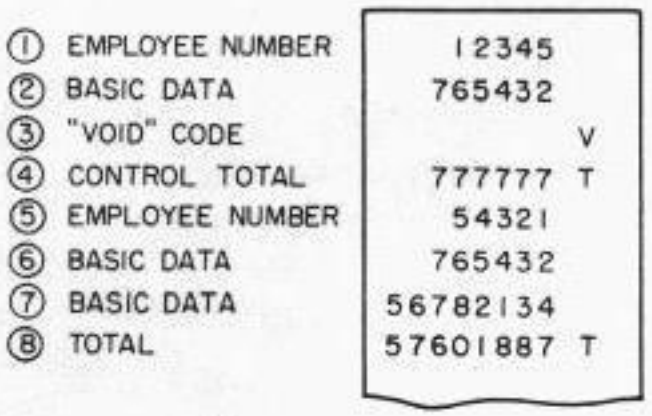
road ahead with attention to all the details ultimately to be produced. Inability to take cognizance of these factors could prove to be disastrous to the integrated data processing approach.

The Solution

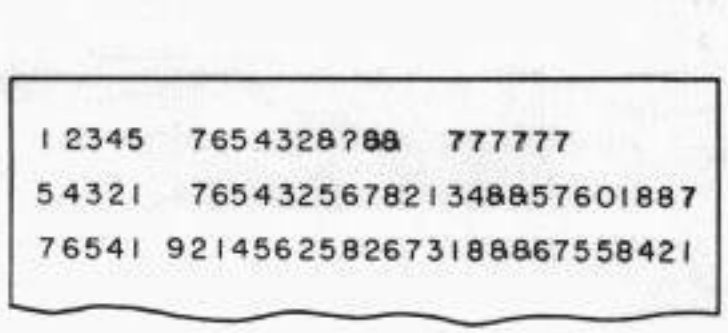
In effecting nationwide integrated data processing, a data handling system of central accounting installations has been established consisting of an IDP Center at each of the division headquarters in Atlanta, Chicago, Dallas, and San Francisco. At New York there is a large installation called the Home Office IDP Center. At the tributary points surrounding each IDP Center, illustrated in Figure 1, integrated data processing procedures, using telegraph transmission to and from these central accounting installations, are in operation. Further, the division points have the capability of being linked by means of wire transmission with the Home Office in New York.

After a study of the available equipment, an adding machine which incorporates a tape-punching mechanism was selected as best suited to meet the requisites of data origination at the remote points. This reliable and simple-to-operate machine (Figure 2) can double as regular office equipment when not employed in originating the basic data for transmission.

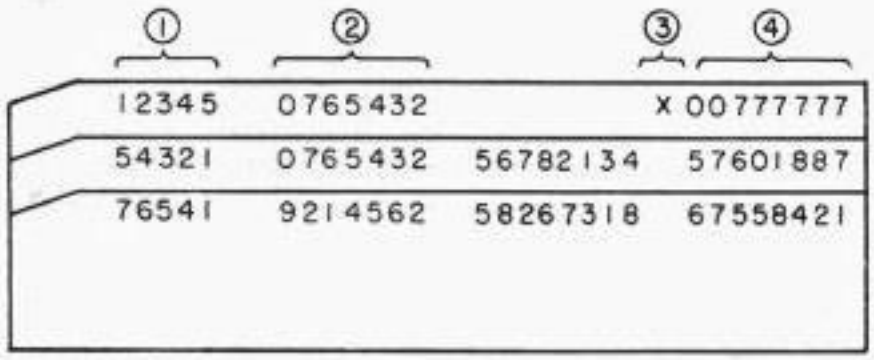
As items are added or subtracted on the adding machine, essential data pertinent to the operation being performed, such as



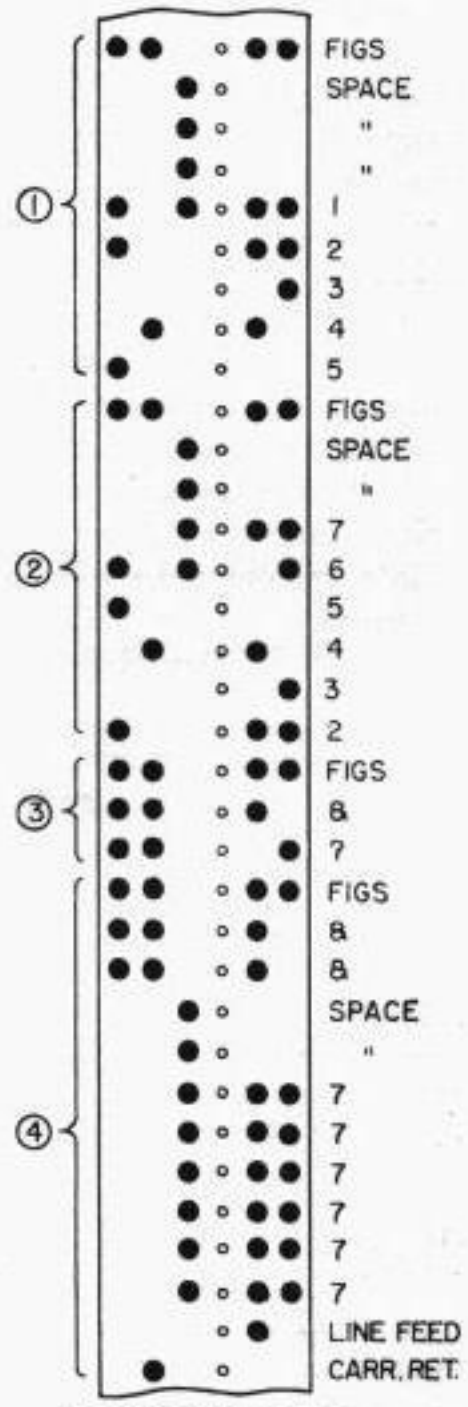
ADDING MACHINE TAPE



TELEGRAPHIC MESSAGE



PUNCHED CARDS



PERFORATED TAPE

Figure 3. Remote data origination and transition to ultimate punched card

the time expended by each employee and the associated work units, are automatically punched as 8-digit words in 5-channel paper tape. The tape perforating mechanism automatically introduces telegraph space codes for the high-order zeros to complete an 8-digit word. These space codes improve the readability of the received printed copy at the central processing installation, but for punched-card purposes are read as zeros in a tape-to-card converter. Thus it will be noted in Figure 3 that, in the case of the number 00012345, the operator enters only the five digits 12345. Advantage is taken of this arrangement by assigning zero codes to the most frequently occurring items and locating such codes in the high-order position of the 8-digit word. This feature is of importance because the operation was designed not only to minimize the add-punch time in originating the data but also to meet the punched-card requirement that an assigned field remain constant.

The add-punch machine is programmed to insert automatically, without conscious effort by the operator, the 5-channel codes, illustrated in Figure 3, to actuate the figures shift, carriage return and line feed functions in the telegraph printing equipment. This automatic programming includes codes to control the action of the tape-to-card converter (Figure 4) causing it to skip, aligning it to position for punching the void "X" symbol and the "hash" total in the assigned card columns and maintaining an important "in step" check between tape and card.

The printed adding machine tape, of course, is the original document and provides a visual check of the accuracy of the data keyed into the add-punch. The 5-channel perforated tape is used to telegraph the source data to the IDP Center where a perforated tape and a simultaneously produced printed copy are received. Standard telegraph transmitters, reperforators and page teleprinters are used.

Once the received perforated tape has been converted to punched cards in a tape-to-card converter at the central processing point, the cards are associated with the master records and processed for automatic preparation of payrolls and management control reports. Such master records are maintained in punched card form and contain the repetitive data required for mechanical processing of the pay for each employee, along with a data-processing card for every objective production standard which has been established for various operating functions in each responsibility center.

Photo H-2223-A

Figure 4. Perforated tape converted to punched cards by IBM Type 46 tape-to-card converter

Accuracy

To insure accuracy, in the course of processing an electronic calculator (Figure 5) adds the numbers in each "word" group and compares the total with the transmitted "hash" total. If they do not agree, the card is rejected for correction. This error detection has proved to be very satisfactory in practice and an error which was not detected by this check has yet to

be discovered. The central processing unit is enabled to pinpoint any error which might possibly have been introduced at any step from origination of the perforated tape at the remote point to machine verification of the ultimate punched card.

Photo H-1894-B

Figure 5. Electronic calculator, IBM Type 604

Accuracy of telegraph transmission under machine control has proved excellent and keeps queries to the originating point at a bare minimum. Even if a punched card is mutilated or an error introduced through equipment failure at the central processing point, the printed copy of the telegraph message provides the necessary ready reference for prompt correction and enables the processing cycle to continue with minimum delay.

After processing at the central accounting installation has been completed, the resulting punched cards are fed into a card-to-tape converter, illustrated in Figure 6, which produces the 5-channel perforated tape used to telegraph the weekly pay data back to the remote point as well as to send selected daily, weekly and monthly management control information to appropriate supervisory levels. Thus the integrated data processing cycle is completed.

The Outstation Payroll

The outstation payroll phase of the Telegraph Company's office automation best illustrates the principles, the motivations and the achieved results of the integrated data processing concept. Involved are four specific categories of employees, i.e., adult main and branch office employees, messenger personnel, operating employees assigned to message centers, and plant and engineering personnel. Each category presents a different problem in assembling the pay data for reporting and in arranging for the production of significant information which varies according to the function of the particular group.

While it was recognized at the outset that standardization was highly desirable, it was also necessary that the nature of the four payrolls be considered in order

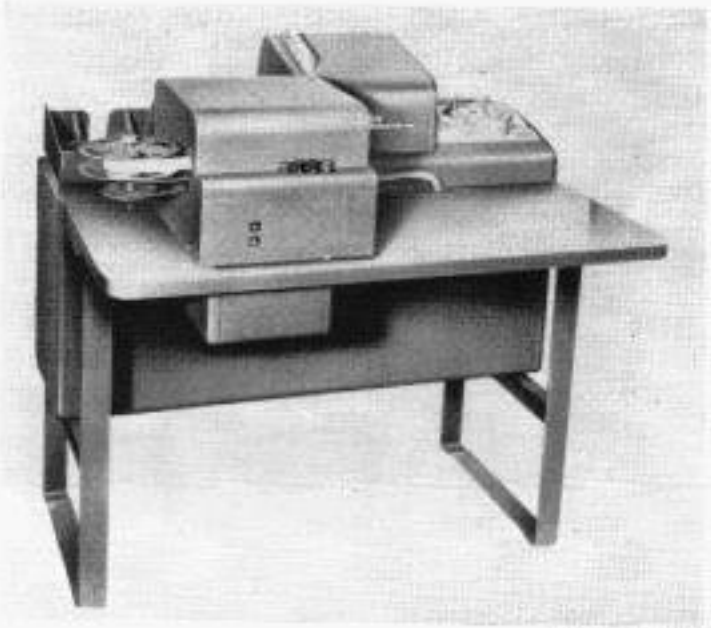


Photo C-2460

Figure 6. Card-to-tape converter, IBM Type 63

not to penalize everybody merely to satisfy the fetish of uniformity. Consequently, four separate types of payroll input are provided but arranged in such manner that they meet standardization at the central processing point in producing the pay data retaining, however, their individuality for the purpose of accounting and management reports.

"Exception" Type Payroll

The main and branch payroll comprises the clerical forces in the local headquarters office and the personnel who

serve the public in the small branch telegraph offices throughout the city. Except in the case of a few relief employees, the assignments are static and generally are governed by the prescribed open hours of the office. The exception type of payroll reporting which is ideally suited for this type of personnel has been adopted in mechanized processing. This system minimizes clerical handling and transmission and is built around the principle of "accounting by exception," i.e., making operative on an individual basis only those items that vary from the predetermined assignment pattern as produced in advance by the central accounting location from its master record. Any variations from this pattern become "exceptions" which are keyed at the outstation into an add-punch machine to set up adjustments of the predetermined pattern to conform to actual. The reporting for each "exception" consists of the employee number, eight digits of supplemental information and a "hash" control total calculated and introduced into the perforated tape by the add-punch machine.

Initially it appeared that a greater number than eight digits would be required to convey all the information needed to calculate the pay and process the associated reports. The choice of eight digits was made in the interest of achieving maximum speed of adding machine operation at the outlying office as well as most efficient use of the storage capacity in the available electronic calculating equipment at the central processing point by the assignment of a 3-position and a 5-position storage unit to each word for the purpose of proof of the control total. Studies showed that the maximum operating efficiency was obtained by the add-punch operator upon the use of 8-digit words. A lesser number of digits tended to introduce a waiting period between words while the tape-perforating cycle for the previous word was being completed. This objection was not encountered in keying more than eight digits, but the use of larger words, perhaps because of size alone, tended to introduce inaccuracies in keying the data.

The following illustrates the use of the 8-digit word in the exception notice:

	1st Exception			2nd Exception			
Employee Number	Pay Code	Job Code	Hours	Pay Code	Job Code	Hours	Control "Hash" Total
10260	0 2 0	06	325	020	07	475	04024060

- Total hours (3.25).
- Wage account to be charged with expense.
- Applicability and rate of premium pay.
- Classification for wage-hour report.
- Disposition of predetermined pay card:
  - 0 — Exception notice supplements predetermined pay card,
  - 9 — Exception notice cancels and supersedes predetermined pay card.

Exception notices, after receipt in perforated tape form, are converted to punched cards at the central processing point and serve to adjust the predetermined pay cards. Subsequent mechanized processing of the verified punched cards follows a pattern which is so commonplace that

there is perhaps no need to dwell upon it except to mention the two procedures for preparing the pay check and stub. For employees located at the processing or nearby points, checks are written on an accounting machine equipped with a dual carriage, Figure 7. By means of this dual carriage, the check register and pay register are produced simultaneously with the writing of the checks.

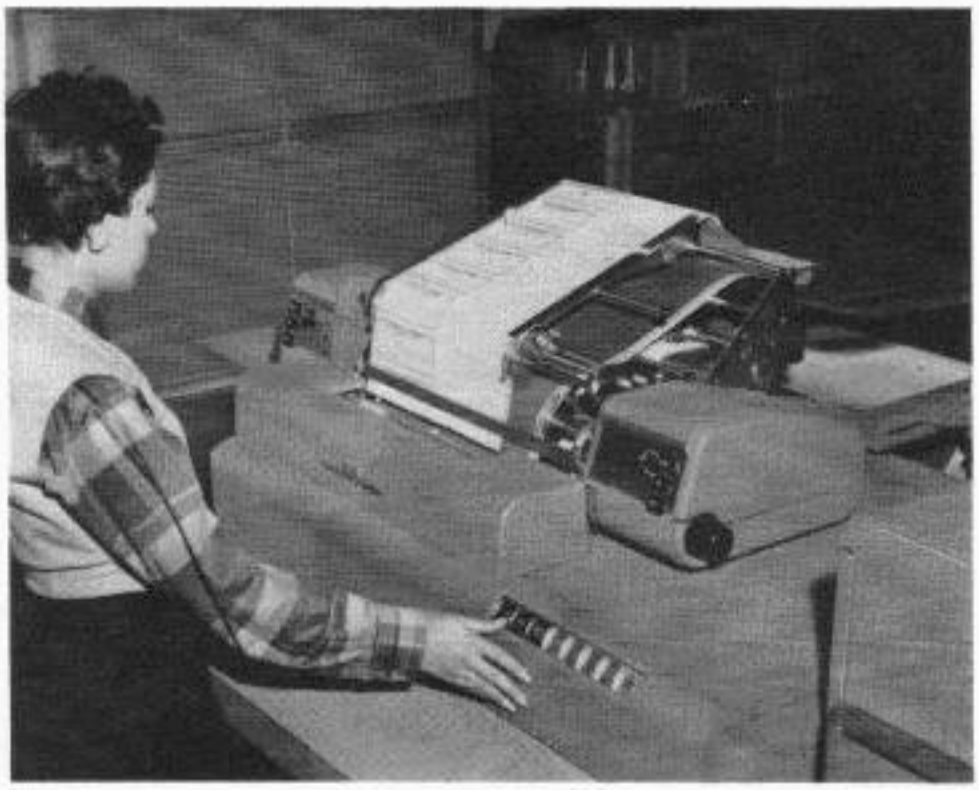


Photo H-1894-D

Figure 7. Pay checks and pay registers simultaneously printed by IBM Type 402 accounting machine equipped with dual carriage

For employees located at remote points, the pay checks and stubs, showing all necessary data concerning gross pay, detail of deductions and net pay, are telegraphed back to the outstation. In this operation the appropriate punched cards are fed into a card-to-tape converter which produces 5-channel perforated tape. The outstation office is then furnished with a control total and prepares a Type 15 printer equipped with a sprocket feed, Figure 8, for reception of pay check data

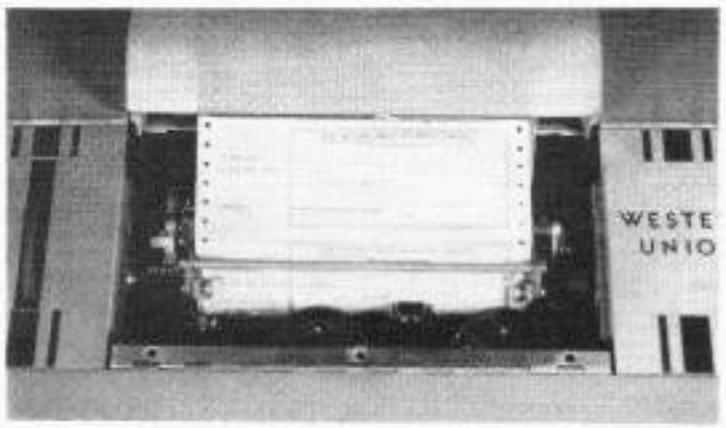


Photo R-11,289

Figure 8. Pay checks and pay registers printed by Type 15 page printer

on continuous-feed type pay checks and stubs. The punched telegraph tape at the central point actuates the telegraph printer at the remote point to print the checks automatically. Carbon copies of the checks serve as check register and pay register.

The usual complement of subsidiary reports, consisting of wage account distribution, earnings records, savings bond purchase report and various deduction registers for union dues, hospitalization, group insurance, and so forth, is processed by the central point. In addition, a weekly management control report, the load data for which has been prepared on the add-punch machine at the remote point, is processed, converted to tape and transmitted back by wire. This report is an important management tool in which the work units data furnished by the outstation office are associated with the hours expended for each work classification and a comparison made with objective performance standards established for that office.

Messenger (Weekly Reporting) Payrolls

The messenger payroll has the least stringent statistical requirements of all the payrolls. The high degree of turnover in the messenger force coupled with part-time irregular assignments preclude use of the "exception" type plan outlined previously. The time worked data for each messenger are locally recorded on a weekly time record and summarized at the close of the pay period.

The total weekly hours worked and applicable pay codes are keyed into the add-punch machine in the format illustrated below.

Employee Number		* Dual Rate				Straight Time		Time and One-half		Double Time	
		Mode	Code	VA	Rate	Code	Hours	Code	Hours	Code	Hours
(1)	20385	3	9	57	100	0	3200	2	0100	4	0100
(2)	20400					0	4000	2	0400		
(3)	20415					1	4000				

Total hours (40.00).
Shift differential code.
Hourly rate ($1.00).
Hourly vehicle allowance.
Signals that master card rate is to be disregarded.
Mode of travel code.

(1)	(2)	(3)
20385	20400	20415
3957100	4000	14000
3200	20400	
20100		34415 T
40100	44800 T	
4040885 T		

* Used only when payment is at other than master card authorized rate.

After the above information for each messenger employee has been keyed into the add-punch machine, the resulting perforated paper tape is used to telegraph the data to the central processing point, where this information is converted to cards and channeled into the standard payroll processing.

Central Office Daily Production and Payroll Data

Employees assigned to large message centers are in the main concerned with the movement of telegraph traffic and work around the clock in one or more of approximately 50 job classifications. Due to the size of the operation, standard methods of production control must be applied. These include preparation and maintenance of effective control records of hours and units of work by tour, by method of operation and by day, and the development of corresponding force requirement. A positive method of reporting of the telegraph load and the actual hours worked in each method of operation is utilized to produce the required daily management control data, as distinguished from the "exception" method prescribed for the main and branch office personnel.

At the outstation the employee uses a daily time card to record by time-stamp impressions the various assignments he covers throughout each working day. Upon completion of his tour of duty, the

elapsed time for each assignment is evaluated and coded locally. Transmission of the data to the central location takes the following format:

At the central accounting installation, after conversion and verification, the punched cards are combined with master-card data and mechanically processed to

Employee Number	1st Job Pay Code	1st Job Job Code	1st Job Hours	2nd Job Pay Code	2nd Job Job Code	2nd Job Hours	3rd Job Pay Code	3rd Job Job Code	3rd Job Hours
10260	1 2 0	06	225	220	06	575	292	12	125

- Total hours (2.25).
- Method of operation.
- Applicability and rate of premium pay.
- Classification of time for wage-hour report.
- Tour during which work was performed.

To supplement the daily time worked advices, the total work units handled in each method are logged at the close of each tour. The next morning the log sheets are summarized by method and tour on the add-punch machine. In this operation the method, tour, and load totals are perforated into 5-channel tape for telegraph transmission to the central processing point.

produce a daily cost and production report. The processed punched cards are converted to tape in a card-to-tape converter and these management data covering the previous days activities are automatically telegraphed back to the reporting office on the day following the date under report. In addition to the daily performance figures, cumulative data showing the performance to date for the

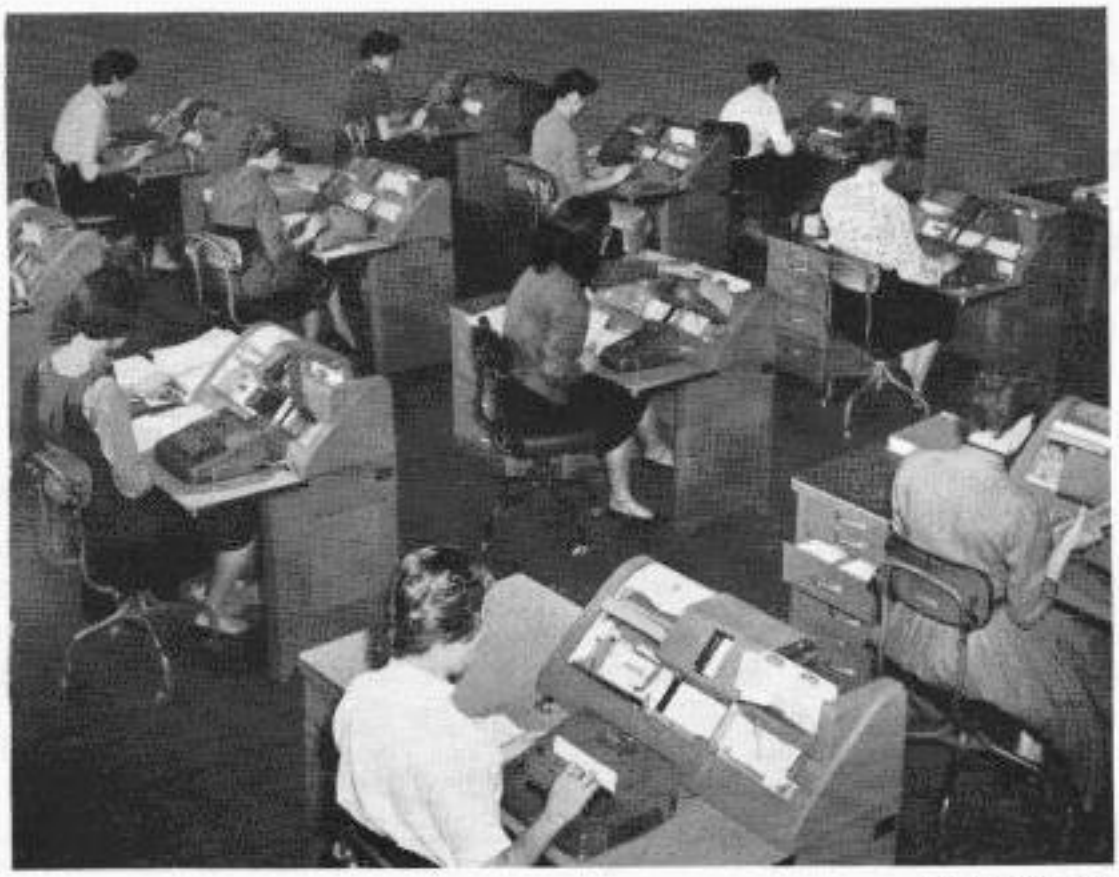


Photo H-2223-B

Figure 9. Section of a Western Union data processing center

week under report are furnished to local management. The timeliness of this information is of great importance to the supervisory forces at the outstation as they study the patterns of the shifting work load on each tour and project the assignment of the available force to render best possible service to the Telegraph Company's patrons.

The subsequent mechanized weekly payroll processing at the central point follows the procedures previously recounted for other payroll units.

Payroll and Responsibility Accounting

The data reported for Western Union's Plant and Engineering Department cover approximately 40 different kinds of work functions performed in more than 300 responsibility centers reporting to 16 area headquarters. Generally, a dispatcher records on each employee's daily work report, as the workman is moved from one assignment to another, the hours worked and codes identifying the nature of work performed. Throughout the day these cards are racked, as a call record, to control the activity of the force. When an employee works detached from such a unit, he carries his daily work report and records the required data as he completes each designated assignment.

Each line of information recorded consists of three or fewer "words" of the 8-digit pattern previously discussed from which stems all the information required to pay the employee, account for the wages and provide management control information. A typical entry is shown below:

Of primary concern, of course, is the payment of the employee. The 2-digit pay code and the hours posted in word A of the work report permit the development of the related wage cost when associated with the employee's master card at the central accounting installation. Word B of the work report with its multiple heading furnishes the coding required to provide accounting information covering, (1) construction work, (2) maintenance and shop work, and (3) building service.

The accounting data keyed from word B together with costs developed for pay purposes from word A are carried forward into ultimate punched-card format at the central processing center with all the flexibility required to obtain the charges to the basic accounts and projects. Initial data are augmented by account and subaccount classifications which are introduced mechanically from master cards. Similarly, a recoding operation enables the loading of direct labor with the cost of local supervision and nonproductive time for cost accounting purposes. At the close of the month, mechanical summarization produces a monthly statement of the charges and credits to several hundred accounting subdivisions. Mechanically updated individual project ledgers support the capital entries on this statement and a status report of all uncompleted projects is prepared for the supervisory forces at area headquarters.

The ultimate objective in this processing, to provide management with control information, requires the use of much of the data contained in words A, B and C. In addition to those elements mentioned for pay and accounting purposes, such factors as work codes, location codes, equipment

Word A			Word B			Word C		
Work Code	Pay Code	Total Hours	(1) (2) (3) Area Location Building	Project Account Account	Year Nbr. Units Sub	Unit Code	Travel Time	Auto Mileage
30	00	4.5	12	4321	57	000	0.3	006

codes, number of units, automobile mileage and travel time are utilized to produce management reports. Several summarizations by responsibility centers are made for four general classifications of work and, in turn, each of these is summarized by areas and again for the entire system. At each level the results are compared with objective standards and a percentage of performance developed. To illustrate the extent of this processing, performance data are calculated each week for approximately 3,500 work functions.

RESULTING MANAGEMENT TOOLS

Having described the complete integrated data processing cycle for the various payrolls, it may now be timely to review the objectives and the potential of the management information made possible through mechanical use of the original data which was put into common language tape only once at the outlying office.

Daily Report of Performance

Management's prompt evaluation of the manpower applied to the work load in peak and slack periods of each day is made possible by the Central Office Daily and Progressive Report of Performance, wherein the mechanical association of the worked hours with the message load establishes the daily production on each tour in every method of operation. Further, the performance for the day under report can be studied in the light of the weekly trend determined through the cumulative report of the production data, and thus the effectiveness of any production control measures that are being applied can be measured immediately.

Time delays are not permitted to dilute the value and usefulness of these supervisory tools because today's results are in the hands of interested management personnel tomorrow afternoon.

Weekly Management Control Report

Available each week is a "Management Control Report" which reflects the progress toward management goals. For this purpose, operations at each office have been grouped into responsibility centers according to the major activities in each operation or function, including such clerical functions as timekeeping, bookkeeping, and so forth. Objective standards have been provided to measure the work required and the mechanically derived comparison of standard hours with actual hours makes it possible to evaluate the performance for various work centers within the office and thus to focus attention on operations where corrective measures may bring about improvement in results. The performance ratios for each outlying office are computed quickly at the distant processing center with detachment and impartiality which makes it feasible to compare, on an equitable basis, the performance at one office with that at another.

The mechanism at the central processing point continuously evaluates the efficiency of operating performance at each reporting office and indicates specific areas which require corrective action. The timeliness of this report makes it possible for all supervisory levels to make decisions on current facts, not past history.

* * * * *

The initial phases of Western Union's system for office automation and timely reports for management were installed in September 1955 with an experimental payroll data operation between the Baltimore and New York offices. Management's reaction to the results of the pilot installation was such that the methods have since been expanded into a nationwide system. Practical experience in the intervening two years has demonstrated that, in automating clerical functions, distance is not a barrier where the mechanized operations can be effectively handled at central accounting installations.

The considerable progress which has been made in the application of modern

data processing techniques only points the way to an ever-broadening field of advantageous integrated data processing applications. A program for progressive improvement and expansion of Western Union's integrated data processing concept is being vigorously pursued.

References

1. Some Aspects of Telegraphic Data Preparation and Transmission, WILLIAM B. BLANTON, *Western Union Technical Review*, Vol. 11, No. 4, October 1957.

2. Integrated Data Processing: The Fundamentals, H. F. VAN GORDER, *American Management Association, "A New Approach to Office Mechanization,"* pp. 7-18.

3. The Origination of Data, H. W. MOORE, *American Management Association, "A New Approach to Office Mechanization,"* pp. 18-31.

Warren F. Gregory joined Western Union in 1928 after attending Northwestern University and the Chicago YMCA College. Prior to his assignment to systems and procedures work in 1951 he had extensive experience in the operating, accounting and auditing functions of Telegraph Company operations. His interest in electronics developed during World War II as the result of two years' Radar training in Army Signal Corps schools and subsequent service as instructor and Radar technician with the Air Force in the Asiatic-Pacific theatre of operations. Mr. Gregory is responsible to the Director of Accounting Methods for the development and evaluation of integrated data processing procedures involving electronic data processing systems. He is a member of the System and Procedures Association and of Business Electronics Round Table II.

Wilfred J. Walsh is a graduate of St. John's College. From the time he entered Western Union service in 1937 he has spearheaded the advancement of many phases of its mechanized accounting, initiating the first punched-card payroll procedures in 1944, and has been in the forefront of its extension to the present systemwide status. In 1949-1950 he developed and installed mechanized cost accounting procedures for the Telegraph Company's nationwide plant and equipment. Mr. Walsh collaborated with Warren F. Gregory in the development of the "outstation payroll" technique, its application to daily production data, its use with objective standards, and the return of the mechanically developed results by telegraph transmission to the point of origin.

W. Dail Cannon Receives 1958 d'Humy Award

PRESENTATION to W. Dail Cannon of the 1958 d'Humy Award "for a most significant contribution to the telegraph art" is to be made by President Walter P. Marshall of Western Union on October 1, it has been announced.

W. DAIL CANNON

Mr. Cannon, a member of the Company's radio-wire transmission research staff, is to receive the bronze medallion, certificate of award and honorarium before several hundred friends and associates at a ceremony in the Western Union auditorium at 60 Hudson Street, New York. As imprinted on the certificate of award the citation reads, "For ingenious contributions to electronic circuitry for telecommunication through applied mathematics — notably in modulation, amplification, instrumentation, and delay measurement."

Participating in the scheduled program will be H. P. Corwith, vice president, development and research department, as chairman, M. V. Creedon, general supervisor of installation, plant and engineering department, who will speak briefly on "Research as a Guide for Plant Engineering," Albert Boggs, assistant to radio-wire transmission engineer, development and research department, who is to review the work of the medalist in a talk on "The Scientific Approach to Telegraph Transmission," and F. B. Bramhall, automation engineer, whose subject, "Today's Efforts Can Pay Off Tomorrow," will indicate the significance of the work of the medalist in terms of its influence on future achievements in telegraph communications.

The d'Humy Award has been made annually since 1956 in memory of Fernand E. d'Humy, former engineering vice president of Western Union, under whose able and stimulating direction the Development and Research Department was established and the Company's modern telegraph switching, facsimile and microwave systems were created.

Certificate of the F. E. d'Humy Award

RONALD S. WISHART, Assistant Project Analysis Engineer

Background for Plan 37 Switching

Telegraph system improvements of broad scope seldom have been arrived at without extensive planning, testing and review. Information about such background contributes to understanding.

IN CONNECTION with articles in this issue on "Switching Telegrams from Tie Lines to Trunks Plan 37" by F. Leslie Currie and Alan C. Hildreth, and "Character Generation in Telegraph Systems" by Frank T. Turner, it is of interest to review briefly the developments and tests which culminated in Plan 37 now employed at Detroit, Michigan, for switching messages from customer tie lines directly into the Western Union nationwide switching network. This development and testing stretched over the period from late 1946 to 1956.

After the installation of 15 switching centers serving all areas in the continental United States, and especially following the development of means of switching directly to customers by using Type 346-A tables,[1] it was evident that every effort should be made to eliminate manual retransmission of customers' messages going into the system and to use the customers' own sending. There were, however, certain obvious difficulties in providing an automatic or semiautomatic system for doing this.

The Western Union switching system was designed to accommodate tape transmission which was standard in Western Union offices and the keyboards and character codes of page teleprinters, some of which were in use in tie lines, were not compatible with this transmission. To provide tape transmission from page teleprinters involved page-to-tape translators which presented considerable technical difficulty in design to meet operating requirements, and economic results did not appear favorable.

For their convenience customers having tie lines had been encouraged to send as little as possible in excess of the bare address and text and certain charge information. They knew that Western Union operators; in resending the messages onto trunk circuits, would put them in proper format for delivery to the distant correspondent. In an automatic system the editing job, which consisted of insertions, transpositions, and deletions in order to put messages in proper form for trunk operation and produce good copy for transmission and delivery, was a stumbling block. Correction of customers' errors was another factor. At one city 82.6 percent of the messages from customers required correction of errors. At another, 62.9 percent required similar correction.

In 1947 there were about 18,000 tie-line customer teleprinters in service and the vast majority of these were tape teleprinters. Such page teleprinters as existed were used for heavier traffic loads than were the tape teleprinters. Also, there were at the time less than 200 Telefax tie lines. Under these conditions investigations started on the basis of tape transmission, and to take care of errors in customers' sending, editing positions of different types were arranged to gather knowledge of the problem. One used perforated tape, the others hard copy from customer tie lines. These positions were designed to provide one-operator control of both receiving from a tie line and transmission into the switching system, and among these the arrangements were:

a. Reception from customer printers in perforated tape and editing this tape as is done in sending to tie lines on 346-A tables. A keyboard was used to add top lines, the city from and date, and to make corrections. A printer was used to record accounting information. Incidentally, this test included stopping movement of tape in a transmitter electronically, by the reading of editing pencil marks.

b. Reception from customers on a page printer arranged to receive from tape customers. This copy could be readily scanned, edited and manually resent.

c. Reception on a tape printer with large type. The tape was passed line by line across a manual perforator under control of an operator who manually converted the message into proper form by reperforating it.

With any of these arrangements, one operator could exceed the output of operators separately receiving from tape tie lines and then manually sending into the network but results were not considered sufficiently satisfactory. To lighten the load of editing it was then recommended that customers be taught to formulate the beginning of the message correctly for automatic retransmission but this was not enthusiastically received as a proposal that could be generally effective.

During these investigations, however, page teleprinter tie lines increased in number and it became obvious that it would be necessary to standardize keyboards, as suggested as early as 1946, so that teleprinters with either tape or page transmission could be switched into the system with minor difficulty. When it was recognized that keyboard standardization[2] would aid in other improvements as well as in tie-line switching, a program was adopted in 1953 and completed in November 1956.

Until a more general improvement in customer sending could be obtained, a limited program of direct connection to the system of large customers who had trained operators was pursued. While the customer receives on a page printer, his sending to Western Union is in tape form using standard Western Union format for messages. This arrangement worked out well and some 350 larger users have been connected in that manner to various switching centers. Also, a method of receiving at tributary offices from similar customers was instituted and means of automatically relaying over trunks to a switching center was designed by the Plant and Engineering Department. This development[3] which is known as Plan 35 can serve 24 tie-line customers from each unit. As in the case of direct connected tie lines at switching centers, the customers' operators follow the exact Western Union format for messages.

While this arrangement served where it was economical and practical to apply it, there were still a vast majority of teleprinter customer installations that did not fit into such a program, so consideration of this problem continued. It had been proposed in 1951 that instead of trying to educate customers in the exact preamble or "top line" to send at the beginning of a message, an automatic transmission of this intelligence should be made from the central office to which the customer was connected. This transmission, consisting of identifying number, office from, and date and filing time, would be registered on both the customer's printer and on a printer-perforator at the central office. The customer tie-line operator then need only preface the address with the tie-line call letters and message category. If necessary, more than one office from could be provided using the same number sequence. This suggestion, plus two other factors, began to improve the prospects of switching from the average customer tie line into the Western Union switching system.

The Desk-Fax program to provide tie lines to smaller users was replacing most of the smaller tape teleprinter connections with facsimile units. This removed from the picture many occasional users of teleprinters with their less expert operators

and produced a considerable decrease in the error average. In fact, it was found that in the city which had averaged 62.9 percent of errored messages per customer in 1947, the average had dropped to 38.9 percent and 15 percent were minor errors in the address. It was decided that the remaining obvious customers' errors could be eliminated elsewhere in the system.

Standardization of keyboards (between tape and page printers) would minimize the problem of accepting transmission into the system from these units. While page transmission into the system would produce occasional short message lines after passing at destination through a tape-to-page translator (which may insert carriage return, line feed, functions after 58 characters rather than the 72 maximum possible in page transmission), and "equals" signs (the tape indication for line feed), at undesirable locations in a message received on tape printers, it was expected that both these faults would be eliminated in due course. (Alteration of tape-to-page translators to recognize page transmission and accept lengths of lines as originally sent will eliminate the first trouble, and page reception on trunks[4] and occasional editing elsewhere will take care of the other.)

In mid-1956 accelerated development was undertaken. The proposal of 1951 for sending the preamble, identifying number and office from, date and filing time, from the central office to both the customer and to the central office printer-perforator simultaneously, was adopted with the addition of automatic recognition of customer call letters and their transmission. Many message safeguards were introduced as well as means for accounting for messages passing into the system. This development, although designed for use in reperforator switching offices, can with further modifications be applied to large manual offices connected to switching centers by trunks.

The experimental installation of the system at the Detroit switching center in March 1958 has been favorably received and the results have been excellent since then. There has been a considerable improvement in the origin-to-destination speed of service of messages; in fact, an average of ten minutes is gained through the application of the new system.

References

1. Switching to Patrons' Teleprinter Tie Lines, R. S. WISHART and G. G. LIGHT, *Western Union Technical Review*, Vol. 3, No. 2, April 1949.
2. Keyboard Standardization, ROBERT W. HARRIS, *Western Union Technical Review*, Vol. 10, No. 1, January 1956.
3. Switching System 35 for Larger Tributary Offices, R. V. MORGENSTERN and HERBERT BUCHWALD, *Western Union Technical Review*, Vol. 12, No. 1, January 1958.
4. Some Recent Western Union Developments in Printing Telegraph Apparatus (Message Separator Teleprinter), FRED W. SMITH, *Western Union Technical Review*, Vol. 12, No. 3, July 1958.

A biographical sketch of the author appears in the April 1956 issue of Technical Review.

F. LESLIE CURRIE, Assistant to Systems and Equipment Engineer

ALAN E. HILDRETH, Jr., Engineer, Electronics

Switching Telegrams from Tie Lines to Trunks Plan 37

Establishment of efficient interconnected telegraph switching centers at important cities provided a basic network with which tributary telegraph operations could be integrated. The operating practices essential to mechanical telegraphy were introduced at branch offices and other locations under Western Union direction without undue difficulty but development of satisfactory arrangements to permit tie-line customers generally to send directly into the network has involved development of new circuitry and equipment.

SWITCHING from tie lines to trunks, as described in this article, is a plan of operation developed for use at reperforator switching centers to facilitate direct transmission of outgoing telegrams from patron operated tie lines into Western Union's nationwide reperforator switching system. The first installation of this plan was made in Detroit, Michigan, during 1958.

When the 15 large central telegraph offices located in cities strategically situated about the country were converted from manually operated offices to area reperforator switching centers some years ago, the branch offices and most of the other tributary offices manned by Telegraph Company personnel were equipped to transmit their outgoing traffic directly into the reperforator switching systems. That traffic is processed automatically and directly through the switching systems without requiring any manual repunching of the messages, or any other manual effort, at those centers. Circuits connecting those tributary offices with the switching centers became integral parts of the reperforator switching system circuitry.

With relatively few exceptions the important tributary tie-line circuits which are operated by the patrons' personnel, however, continued to be served on a manual basis, as before, with all outgoing traffic continuing to be manually repunched at the central office before introduction into the reperforator switching system. The inflexible "top line" information, which must form the forepart of each message for its proper automatic handling, was considered to be too exacting in accuracy, and to constitute too much extra work to be delegated to the personnel of most customers as their responsibility. Basically, the top line must contain information for controlling selective switching operations of the reperforator switching system, as well as pertinent accounting information for revenue purposes. No deviation from the prescribed format for the selective switching information is permissible, and the accounting information must be sufficiently complete to enable proper billing for the service rendered.

Studies undertaken with a view of devising a practical plan for transmitting outgoing traffic from customer tie lines directly into the reperforator switching systems without manual reperforation at the switching centers culminated in Plan 37, described herein. While this plan retains the manual feature of answering incoming calls at the switching centers by means of plugs and jacks at a turret, the operation from then on is automatic through the switching system. Thus, the benefits of improved speed of service and improved operating economies, which are inherent attributes of reperforator switching system operation over manual operation, may now also accrue to the important tie-line segment of traffic.

The crux of the plan was the development of a satisfactory generating means to formulate automatically and accurately the top line information for each message

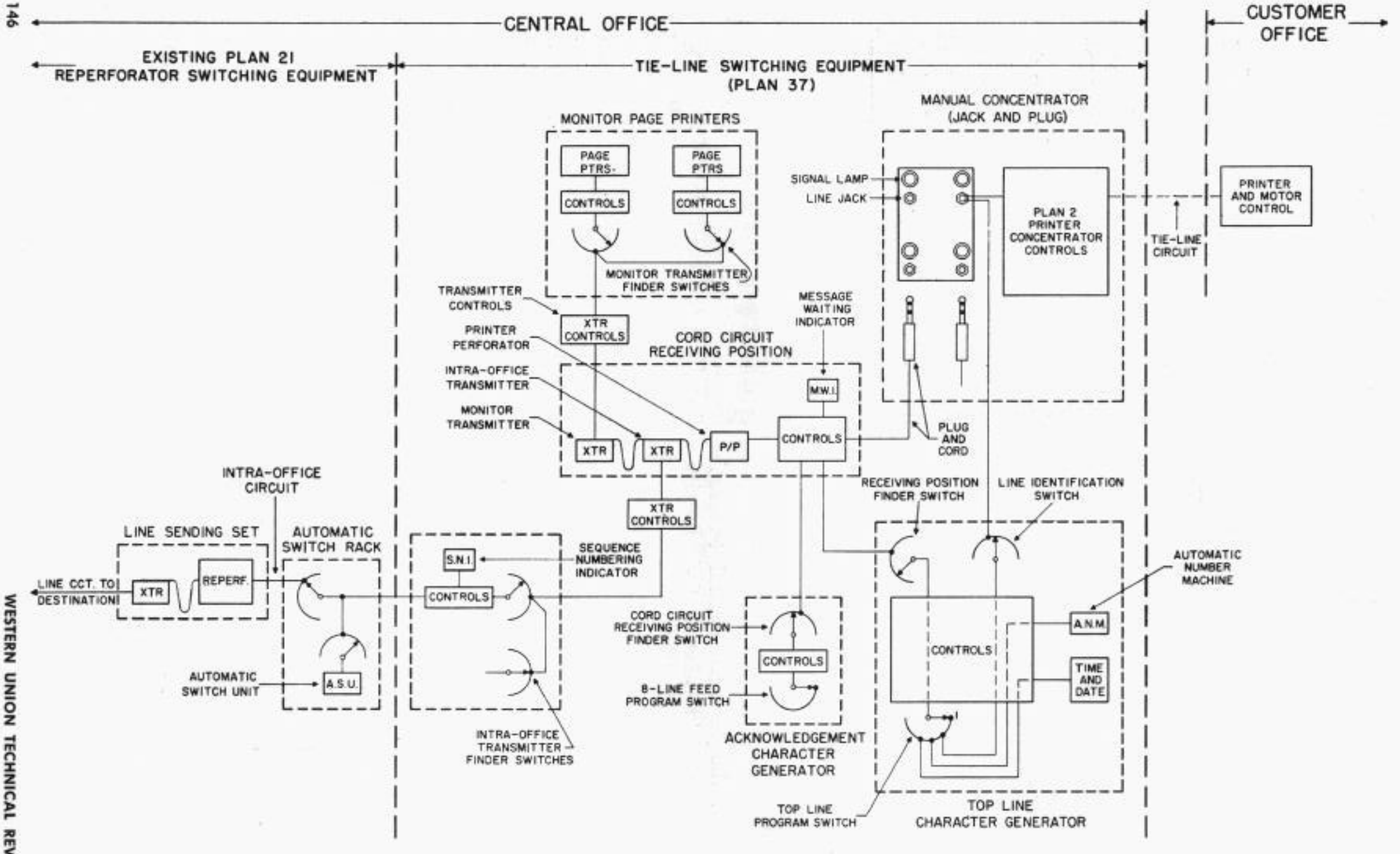


Figure 1. Block diagram

and to transmit it automatically, at the proper time, to both the customer, or tie-line circuit, and the reperforator switching system receiving position. This feature serves to reduce to a satisfactory minimum the efforts and the responsibility required of the customer's operator in the preparation of the top line information, and thereby largely nullifies previous objections to transmission directly from customer tie lines into the reperforator switching systems.

EQUIPMENT

The design includes a number of equipment assemblies as outlined in the block diagram of Figure 1. The principal items of that equipment for a typical installation to serve 300 tie lines are a manually operated plug and jack turret, 24 cord circuit receiving positions, 8 intra-office circuits, 8 page printer monitors, 2 top line generators, and 1 eight-line-feed (acknowledgment) generator. Of course, installations may vary in size to conform to the anticipated load requirements. Several views of the equipment assemblies at Detroit are included as a part of this article.

The tie-line circuits are terminated at the central office in the normal line equipment of manually operated Printer Concentrator Plan 2, and are connected in multiple to the turret studs of the printer concentrator turrets, and to the jacks of the switching from tie lines to trunks turret.

The patron office equipment is the same as normally provided for Printer Concentrator Plan 2 tie-line service, and consists principally of a teleprinter, a motor control unit, and a calling signal lamp. The printer records all transmission and is fitted with keyboard for manual sending.

Central Office Turret

The plug and jack turret, Figure 2, provides for manually controlled connections between the cord circuit receiving positions and the patron tie lines. A cord and plug is associated with each receiving

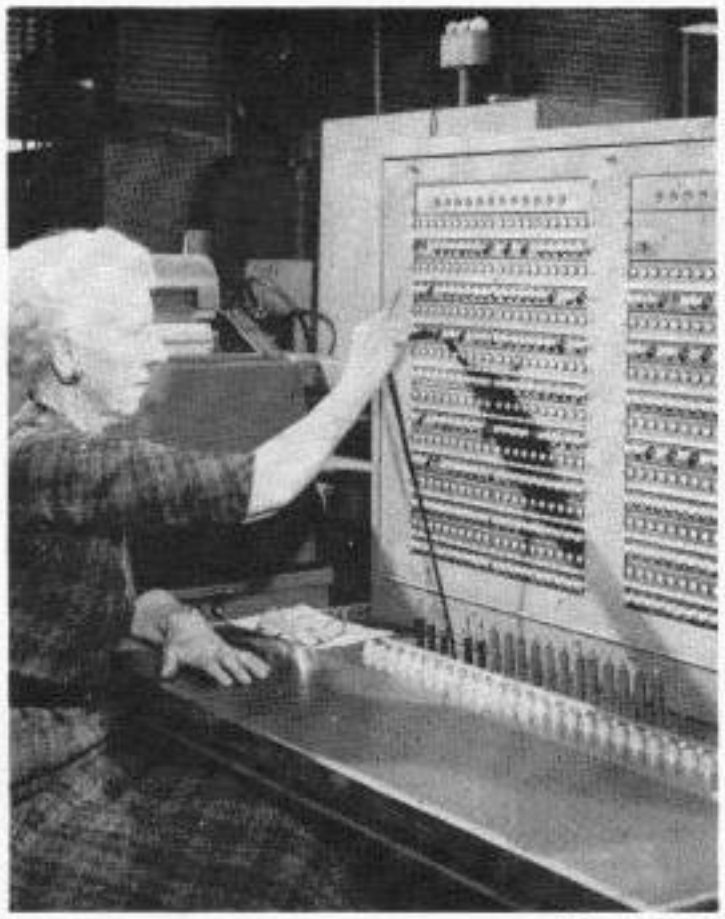


Photo R-11,200

Figure 2. Tie-line switching turret

position and a jack with each tie line. These plugs and jacks provide three conductor connections: tip, ring and sleeve. The tip connection serves for the tie-line circuit, the ring for the automatic line identification, and the sleeve for the cord circuit receiving position equipment hold circuit.

The cord circuit receiving position, Figure 3, serves primarily for recording the message from the top line generator and from the customer, and for resending it to the intra-office circuit and to the page printer monitors.

The equipment consists, essentially, of a printer-perforator for recording the message on a tape in both typed and perforated form; two transmitters, one for sending the code perforated in the tape into the intra-office circuit, and the other for sending it to a monitor page printer; a message-waiting indicator for remembering the number of messages in the tape awaiting intra-office connections and for initiating new calls until all of them are transmitted; and a group of control relays. The latter function for numerous purposes such as to repeat the line signals to the printer-perforator; to collaborate with the

printer-perforator space and carriage return pull bar contacts for requesting a top line generator connection at the start of each telegram, and an eight-line-feed generator connection at the end of each telegram; to advance the message-waiting indicator one step for each completed message perforated in the tape; to electrically disconnect the cord circuit equipment from the tie line at the end of message; and to light the disconnect lamp of the respective cord at the turret at the finish of each transmission.

Photo R-11,201

Figure 3. Cord circuit receiving table (two cord circuit receiving positions)

The transmission of the messages over the intra-office circuits follows the same pattern used for switching from heavy tributaries and from local sending positions in Reperforator Switching System Plan 21. All the intra-office transmitters have access to the group of intra-office circuits on a line finder basis (Figure 4).

Page Printer Monitors

In order to provide a typed page copy of each telegram for servicing and for accounting purposes, a monitor transmitter is provided in tandem with the intra-office transmitter at each cord circuit receiving position. The monitor transmitter works into one of the group of monitor printers provided for this function, with all monitor printers available to all monitor transmitters. The printers are Type 15 machines fed with fan-fold paper and equipped with a burster for message separation and a basket for receiving the completed pages.

Top Line Generator

The top line generator connects, automatically, to each cord circuit at the start of each telegram and functions to generate and to transmit the essential top line information pertinent to the telegram to the cord circuit printer-perforator and to the connected tie line. This feature relieves the customer's operator of the responsibility for preparing that part of the message and insures accurate identification of the telegram's origin.

The top line information normally gives the area of destination, the area of origin, the originating switching office, the cord circuit identification, the message sequence number, the customer tie-line identification, the city of origin, the date, and the time. A typical illustration is given below for a message originating over tie line ZGH at Detroit and destined to the Syracuse area:

SY DE DZF001

WUX ZGH DETROIT MICH 31 1039 AME

The codes and numerals are identified below in the order of their appearance:

SY — Syracuse (the routing symbol for the area of destination)

DE — Detroit (the area of origin)

DZF — Detroit cord circuit F (the originating switching office and the cord circuit identity)

001 — Message sequence number (each message is automatically numbered sequentially as it is received without regard to the tie line over which it originates)

WUX ZGH — Western Union tie-line identity (each line is assigned an individual letter group identification code)

DETROIT MICH — City of origin

31 — Day of the month

1039 AME — Time Eastern zone

The top line generator, Figure 4, consists principally of a finder switch to effect connections to the different cord circuits; one or more line identification switches to determine the tie-line identity (call letters); a program switch to direct and to serialize, in proper order, the different characters forming the top line information; a matrix* for converting the programized top line characters into the 5-unit teleprinter code; a distributor for serializing the 5-unit code and for transmitting it over a single conductor circuit; an automatic numbering machine to number the messages sequentially, in the order in which the top line generator is connected, with one series of numbers; a time and date machine to provide the time and date for each message; two line relays to repeat the coded transmission from the distributor, one to the cord circuit receiving position printer-perforator and the tie line, and the other to a top line tape monitor printer for producing a continuous tape record of the top line of all messages in the order of their connection with the top line

* See "Character Generation in Telegraph Systems" by Frank T. Turner in this issue.

generator; and several control relays for effectuating the proper operation of the above-mentioned equipment items.

Eight-Line-Feed Generator

The eight-line-feed generator connects automatically to the cord circuit receiving equipment at the end of each telegram, generates eight successive line-feed code combinations and transmits them to the connected tie line. This transmission constitutes the acknowledgment signal to the customer that the telegram was successfully received.

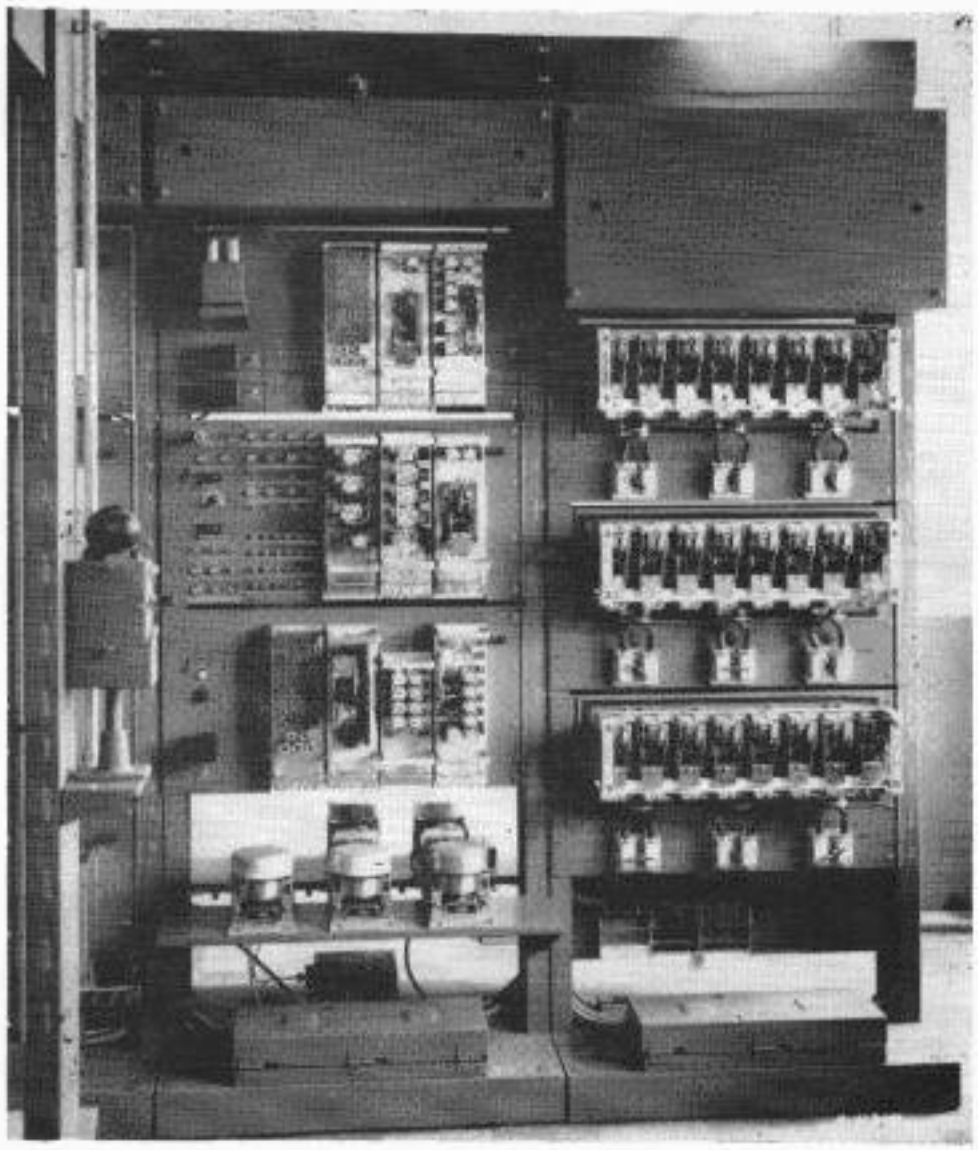


Photo R-11,204

Figure 4. Top line generator (left) and line finder rack (right) with relay and switch covers removed

The equipment consists, chiefly, of a finder switch for effecting connections to the cord circuit receiving positions; a program switch for coding and counting the eight line-feed characters; a distributor to serialize that code combination for single line transmission; and some control relays

for effectuating the proper operation of the above equipment items.

OPERATION

The manner in which calls are initiated at the patron offices for outgoing telegrams is identical to that used for Printer Concentrator Plan 2 operation.

relay, in series with the line at the central office, to release and lock itself released. Its release lights the calling lamp in the turret for the respective tie line. The central office turret operator answers the call by inserting the plug of an idle cord circuit receiving position into the jack.

The call light at the turret is extinguished, and the tie-line potential polarity is reversed from positive to negative.

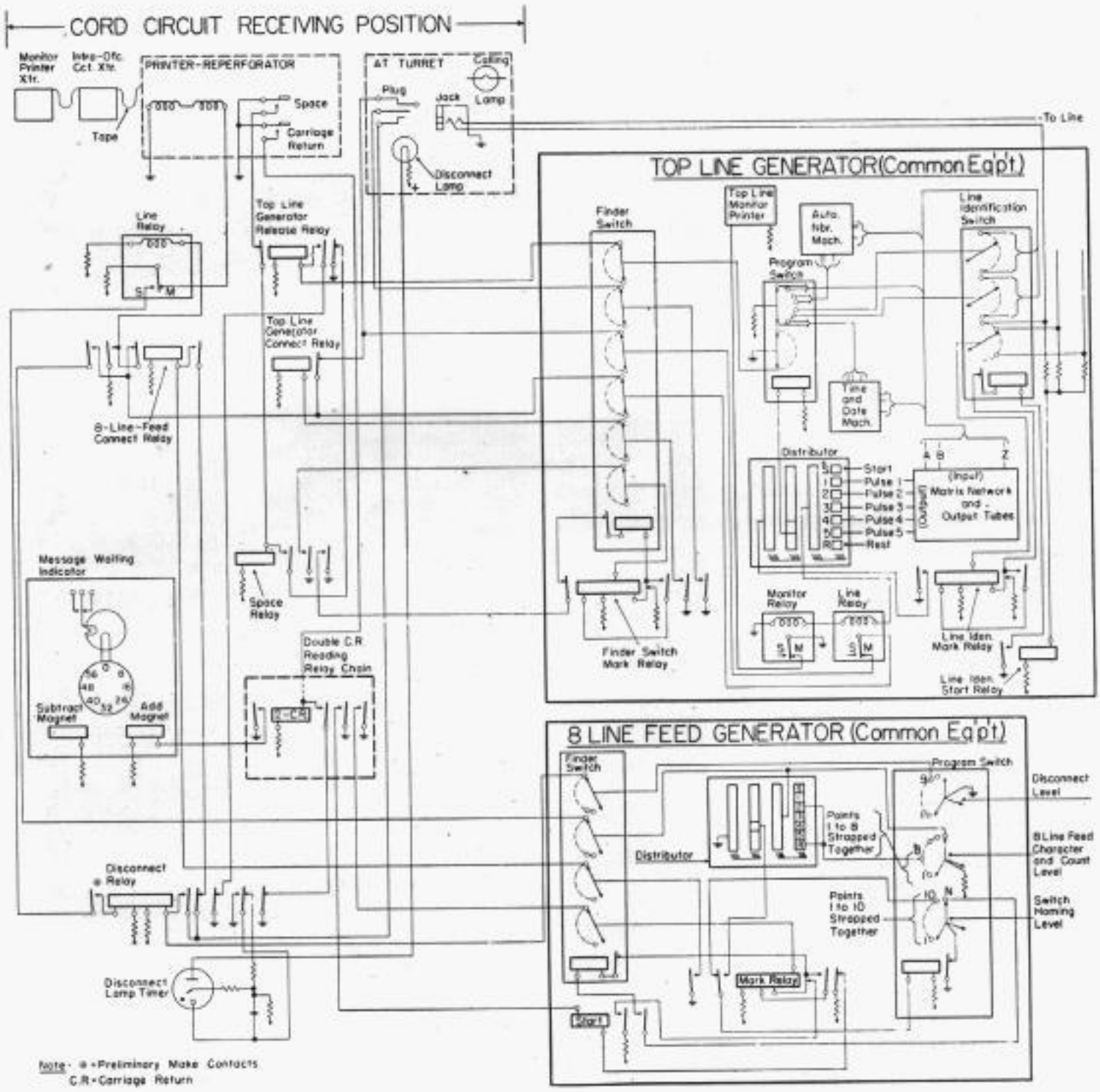


Figure 5. Schematic circuit diagram (cord circuit receiving position and common character generators)

The patron operator opens the line circuit, momentarily, either by means of a series line push button, or by starting the teleprinter motor, depressing one of the keys and reversing her motor switch. That circuit opening allows the operated signal

Positive polarity line potential is used for stand-by and negative for operate. Application of negative potential to line activates a motor control polar relay at the patron's office which starts the teleprinter motor operating.

The teleprinter motor starting serves to signal the caller that the central office connection is completed and to send the area selection characters for the geographical destination of the message and then the space character. A list of those area selection characters is furnished to each patron. The patron then awaits reception of the top line which was requested by the space character.

Simplified Diagram Shows Theory

The schematic diagram in Figure 5 illustrates the general circuit theory of the cord circuit receiving position, the top line generator, and the eight-line-feed generator, but for reasons of simplicity it does not conform fully with all actual circuit details.

When the space character is received at the central office, the closure of the printer-perforator space contacts operates the space relay. That relay, operated, completes circuits for connecting the top line generator to the cord circuit receiving position by positioning the top line generator finder switch and operating the mark relay.

The mark relay, operated, completes circuits for connecting the line relay contacts of the top line generator in series with the tie line, and for positioning the line identification switch to the tie-line jack. The latter action is accomplished through ring connection of the plug and jack which operates the line identification start relay and marks the selected position of the switch. When the line identification switch wiper contacts reach the selected position, the line identification switch mark relay operates and prepares a connection from ground through a commutator segment of the distributor to the step magnet of the program switch.

The program switch, therefore, will advance one step for each rotation of the continuously rotating distributor commutator brushes and will complete a circuit, at each step, to a selected character input of the matrix network.

The matrix network functions to formulate the proper 5-unit teleprinter code combination for each of those selected characters and to apply it through output tubes to the pulse segments of the distributor. The distributor serializes the code pulses and transmits them through the windings of a line relay and monitor relay. The line relay repeats those pulses into the tie-line circuit and thence to the printer-perforator of the cord circuit receiving position and to the patron's teleprinter. The top line monitor relay repeats them to the top line monitor tape printer which produces a continuous tape record of all top line connections.

Certain positions of the program switch route the character selection connection through an automatic numbering machine and through a time and date machine to the matrix input. The positions of the different unit switches of those two machines will determine the character selections.

When the program switch is advanced through a cycle of operation, it completes a circuit for operating the top line release relay of the cord circuit receiving position which, when operated, releases the space relay. The space relay, released, releases the top line generator which then becomes available for connection to another cord circuit receiving position for a new cycle of operation.

The cessation of transmission from the top line generator is the signal to the patron's operator to start sending the telegram by keyboard operation of her teleprinter. The telegram, when completed, is terminated with the standard end-of-message signals, two successive carriage returns. All of this transmission is recorded by the printer-perforator of the connected cord circuit receiving position in tape form containing both the code perforations and the typed characters.

Double CR Relay Chain

When the end-of-message signal, double carriage returns, is received by the printer-perforator, the CR contacts operate and actuate the double carriage return relay chain. The operation of the 2-CR relay of that relay chain, which operates only for two successive carriage returns, completes the circuits for effecting a connection by the common eight-line-feed

generator to the respective cord circuit receiving equipment, advances the message-waiting indicator one step, and causes the printer-perforator to feed out a measured length of blank tape.

The eight-line-feed generator start relay operates, the finder switch is positioned, and the mark relay operates. The latter relay, operated, completes the circuits for operating the eight-line-feed connect relay of the cord circuit receiving position, and for stepping the eight-line-feed generator program switch by means of a circuit through a segment of the distributor.

The eight-line-feed connect relay of the cord circuit disconnects the tie line from the cord circuit line relay and battery, and connects it through the eight-line-feed program switch contacts to battery. When the program switch is stepped from its normal position of rest, marking battery is applied to the rest, and the second segments of the distributor and that condition continues for the first eight steps of the switch wiper contacts. Thus, each cycle of operation results in the transmission of eight line-feed code signals which cause the patron's page printer to feed out eight line feeds of blank paper.

When the eight-line-feed program switch finishes its cycle of operation, it completes a circuit to operate the disconnect relay of the cord circuit receiving position. That relay, operated, releases the eight-line-feed connect relay, and the 2-CR relay. The 2-CR relay, released, releases the eight-line-feed generator. The latter now is available for service with another cord circuit receiving position.

The operation of the disconnect relay also releases the other operated control relays of the cord circuit receiving position and conditions the disconnect lamp timer to start its timing cycle. At the end of the timing cycle, the disconnect lamp of the plug at the turret is lighted. The removal of the plug from the jack by the turret operator opens the hold circuit and causes the disconnect relay to release and the disconnect lamp to extinguish.

A customer with a series of telegrams to send can start the next message during the timer interval and hold the connection to the same cord circuit receiving position. The first spacing signal from the customer applies battery through the tongue and space contacts of the line relay, through the preliminary make contacts of the disconnect relay, to release the disconnect relay and thereby deactivate the timer.

Intra-Office Transmission

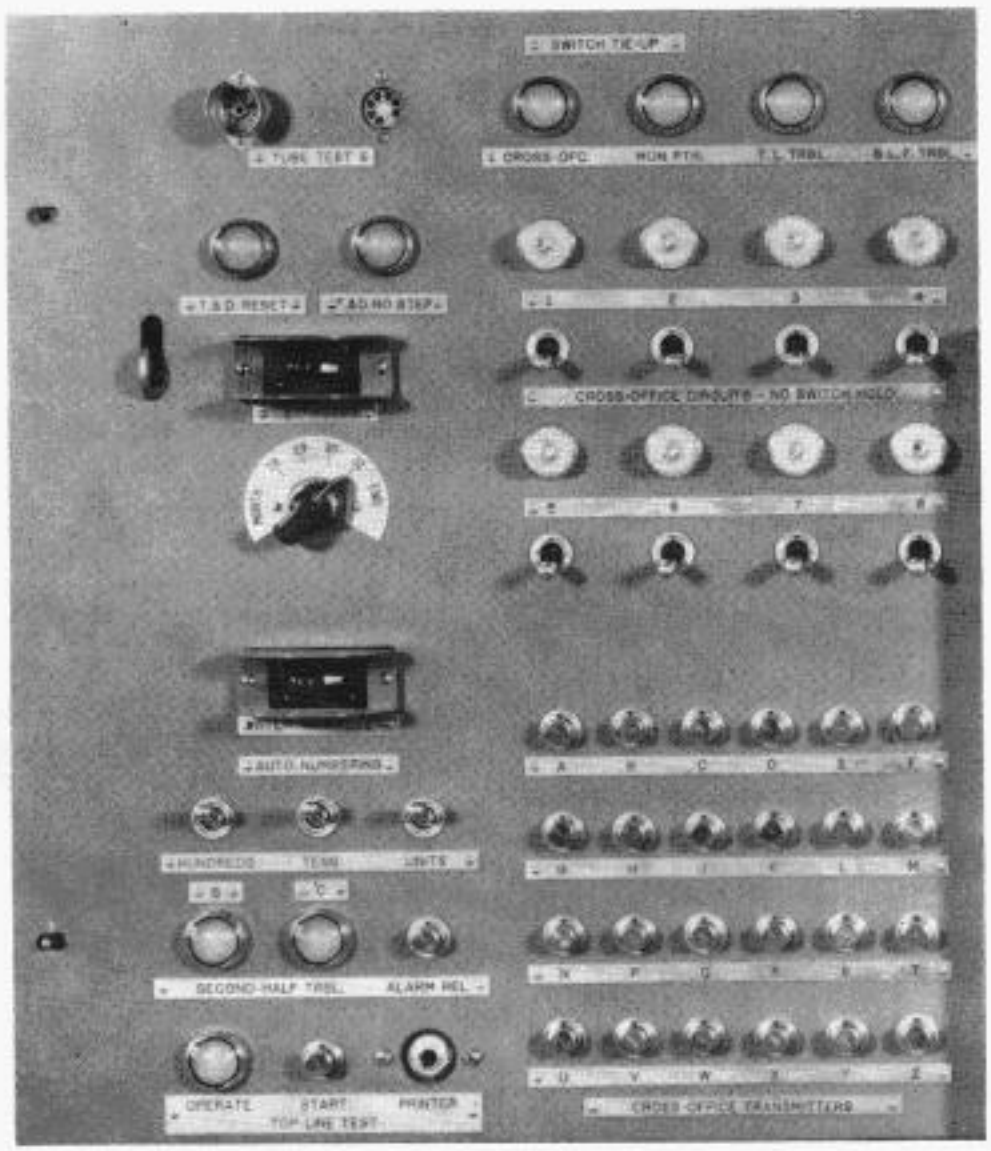
As the tape is punched by the printer-perforator, the blank tape and carriage return characters in the tape ahead of the telegram being punched are idled through the intra-office transmitter until the first character in the message is reached. The tape then stops until the message recording is finished and the message-waiting indicator has been stepped off zero by the end-of-message characters. The transmitter finder switches then connect the intra-office transmitter to an idle intra-office switching circuit. When the connection is complete, the switching controls secure a connection into the automatic switch rack and the selection characters are read. A connection to the selected line sending position is effected and the automatic numbering machine of the sending aisle equipment transmits a sending circuit, or a channel identifying number, into the sending aisle reperforator. The intra-office transmission is started at half speed and a read-back comparison of certain fixed characters is made between the sending aisle reperforator and a comparison switch. This switch, which is part of the intra-office controls, is similar in function to the sequence number indicator used in the present receiving equipment of reperforator switching systems. Since an intra-office switching control circuit may be used by any one of the associated intra-office transmitters, and because the telegrams are not necessarily taken in the order in which the top lines were generated, no comparison of the cord circuit designation letter, or message number, is made. The read-back includes the last five characters transmitted by the automatic numbering machine and the following portion of the top line:

DE (space) DZF (figure) 001 (letter)
(line feed)

The fixed characters only are compared. The characters transmitted by the automatic numbering machine, the cord circuit letter, and the message number are checked for presence only; i.e., any character other than blank is accepted as satisfactory. This system of checking provides at least two checks of each intelligence pulse to insure that the intra-office connection is satisfactory. After the characters are compared correctly, the message proceeds at full speed until the message-ending characters are detected at the line sending position. At the end of the message, the line sending position releases the intra-office circuit, and the intra-office and transmitter controls are returned to the idle condition.

If the checked characters had not compared correctly, a wrong comparison alarm would have operated requesting a connection to the auto control rack. That unit causes BUST THIS and two carriage return characters to be punched by the line sending reperforator and read back, in part, for comparison in the auto control rack. If this comparison is correct, the line sending equipment is released. The connection between the transmitter and intra-office controls is maintained and a wrong comparison alarm is brought up at the cord circuit receiving position. The tape may now be checked by the supervisor who may make a patch tape, or take other action as required.

In the event of a "no switch" signal from the automatic switch rack, a "no switch" indication is locked in the transmitter control circuit and the intra-office circuit is released. The supervisor may restart the message or, if the selection characters in the tape are not valid, switch the message manually to a selective switching position. If repeated "no switch" indications are noted when the selection characters are valid, equipment failure is indicated and it is desirable to maintain the connection between the intra-office transmitter and the intra-office controls. For this purpose, a "no switch hold" switch is provided on the T&R service panel for each of the intra-office circuits as shown in Figure 6. Operation of these switches prevents the release of the intra-office circuit on a "no switch," enabling the technician to determine which intra-office control circuit is giving trouble. To facilitate this determination, a connection indicator circuit is provided on the panel. Operation of one of the transmitter push buttons will light the lamp corresponding to the intra-



Water Mill Photo

Figure 6. Testing and Regulating (T & R) service panel

F. Leslie Currie started work for Western Union in 1917 and, except for an absence on military furlough during World War I for service in the U. S. Navy, has been continuously in the service of the Telegraph Company. After receiving a B.S. in E.E. degree from the Milwaukee School of Engineering in 1924, he was transferred from the Traffic Department in Milwaukee to the Engineering Department in New York. Since that time he has been engaged in the design and development of a wide range of apparatus and circuitry for telegraph applications. Some of his noteworthy contributions are the major circuitry development for teleprinter subcenter switching systems, for several of the automatic facsimile concentrators, and for portions of Reperforator Switching Systems Plans 20 and 21. The latter includes the push-button switching, the dial switching teleprinter monitor, the multiaddress book switching, CND multisend switching, and automatic local sending from telephone recording positions. Mr. Currie also actively participated in the detailed circuitry design of the Switching from Tie Lines to Trunks Plan 37, covered in this article.

Alan E. Hildreth, Jr., joined the Western Union Electronics Laboratory at Water Mill, N. Y., in 1945 as a Laboratory Assistant while a student at Northeastern University. After a tour of duty in the Army, he returned to the Laboratory under the University's cooperative work program, and received the B.S. in E.E. degree with honors in 1951. He has been engaged in circuit development and equipment design, including the transistorized teletypewriter converter and packaging of the multipoint selective signalling equipment, both Signal Corps developments. In connection with this tie line to trunk switching development, he was involved with the construction and testing of the experimental and final design models of the equipment at the Laboratory, as well as with the initial testing of the apparatus after installation in Detroit. Mr. Hildreth is a member of Tau Beta Pi and Eta Kappa Nu honorary engineering fraternities, and a Member of IRE.

office control circuit to which that transmitter is connected.

Page Printer Monitors

The monitor transmitter and controls are arranged to idle the blank, letter shift, carriage return and line feed characters in the tape ahead of the message. When a character other than one of these is over the pins, the transmitter stops and requests a connection to one of the page printer monitors which are available to all the transmitters on a line finder basis. When a printer is available, it is seized by the transmitter and transmission into the printer commences through a tape-to-page translator rack. At the end of the message, the message-ending characters are read by

the translator which releases the printer from the transmitter and resets the transmitter controls to idle the tape looking for the next telegram.

Special Handling

The efficient handling of some types of telegrams originating at tie-line customers' offices continues to require special attention at the switching center and for that reason those messages are selectively switched to a special supervisory page printer located in the switching aisle. Those messages are recorded in typed page form and when retransmission is required must be manually repunched into perforated tape form and reswitched.

The messages, generally, will be in the category of international, book or multiple-address and supervisory messages. The international messages require a complex word count and for that reason all customer operators cannot be expected to be skilled in their preparation. Therefore, those customer operators so skilled may route their international messages directly, but all others must send them to the special supervisory page printer for completion and resending.

The book or multiple-address messages frequently consist of so few message copies that they can be transmitted as single messages more economically than processed through the book message center. Therefore, book messages composed of a large number of copies will be selectively switched directly to the book message center, and those composed of a small number of copies will be sent to the special supervisory page printer for supervisory determination as to the method of their handling.

Supervisory notes originating at tie-line customers' offices usually are acknowledgments for messages received at those offices, or are queries pertaining to those messages.

★ ★ ★ ★ ★

The plan described herein has been in operation for several months in Detroit and its performance is conforming with expectations. Improved speed of service, automatic instead of manual message relaying, and reduced operating costs are factors which promise expanded application of this plan in the telegraph services.

FRANK T. TURNER, Senior Project Engineer, Electronics

Character Generation In Telegraph Systems

All telegraphy is accomplished, of course, by some method of "character generation" by which is meant the creation of electrical impulses with which to reproduce mostly alphabet letters, figures and "functions." As an example the messenger call box is, or was, a type of semiautomatic number generator quite widely known. Today an ingenious electronic telegraph signal generator develops 5-unit code for 31 characters.

For some years there has been a need for devices to generate automatically certain sequences of characters without the attention of an operator. Examples of this are found in sequence number generators, in automatic "Bust This" equipment, and in the top line generator for the tie-line switching system recently installed in Detroit.

Rotary Switch System

Earlier equipment designed for this purpose has developed the desired characters by the use of rotary stepping switches. The five levels of the switch correspond to the five pulses of the telegraph code. Each position of the switch has the five studs wired to mark or space battery according to the code for the character to be generated at that position of the switch.

The output of the switch may be sent parallel 5-wire as in certain cross-office applications, or connected to a distributor which will scan the five levels in the correct order to generate the signal in sequential form for ordinary single-wire telegraph transmission. In this case the distributor may generate the additional pulses required for start-stop transmission.

In the case of sequence number generation, a bank of rotary switches, one for each digit in the generated number, has the five signalling levels of each switch wired for the numbers 1, 2, and so forth, through 0. An additional rotary switch connects the outgoing circuit in turn to each of the generating switches in the correct sequence, and independent circuits step the generating switches to advance the count.

For automatic "Bust This" and time-and-date generators, it frequently is desirable to send the same signal to more than one line at the same time. Relay means for repeating the signal may be employed, but once the program switch has started through its sequence, any new request for the information must wait until the completion of the current transmission before it can be connected, or a garbled transmission may result. Additional signaling levels may be wired on the generating switches and separate programming switches supplied for each independent output required, but the capacity of the generating switches is limited by the fact that five levels on the generating switches are required for each independent output.

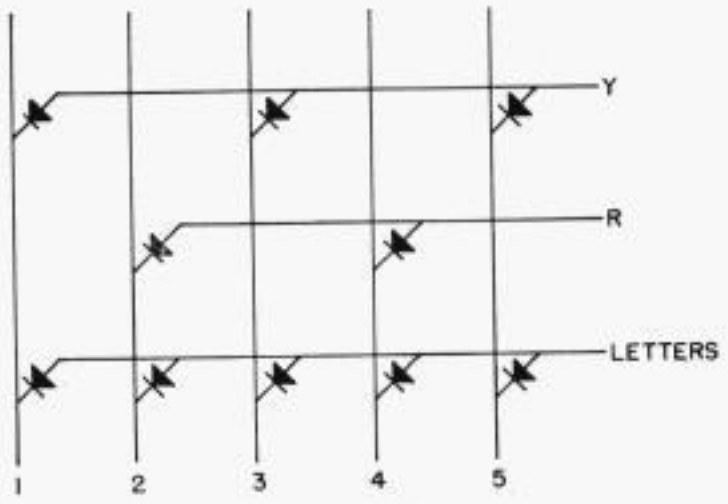


Figure 1. Portion of diode matrix

In more recent equipment such as the Detroit tie-line switching system, a new method of character generation is used. This is a so-called "matrix," in which an array or combination of circuit elements such as diodes (rectifiers) or neon tubes

are connected to generate the desired pattern of marking and spacing signals on five output leads when any single one of 31 input leads is energized.

Diode Matrix Method

In Figure 1 is shown a portion of a matrix in which diodes are used as the elements. The figure shows five output lines, one for each element of the 5-unit telegraph code, and three input lines, for letters shift and the letters R and Y. If positive battery is applied to the R input line, for example, positive potential will appear on the output lines 2 and 4. Although the input line for letters shift connects to all five output lines, the potential on output lines 2 and 4 is prevented from passing by way of the letters input line to any of the other output lines by the fact that the diodes will pass current in only one direction. A certain small amount of reverse leakage is unavoidable, however, and the associated circuitry must be designed with this fact in mind.

The output signal may be used in several ways. It would be possible to operate the matrix at a high level and connect directly to standard telegraph devices. However, the normal telegraph current of 60 milliamperes would require large diodes which would add considerably to the size and cost of the device since a matrix may use up to 80 diodes.

It has been found more economical to operate the matrix at a level of 5 to 6 milliamperes and apply the output to some type of amplifier. In present equipment, the output lines are connected to the starter anodes of Type 5823 cold-cathode glow-discharge tubes which can carry about 30 milliamperes in their main anode circuits. The main anode circuits can then send the signal on a 5-wire basis, or can be scanned by a standard distributor to send on a single-wire basis, as was the case with the earlier equipment.

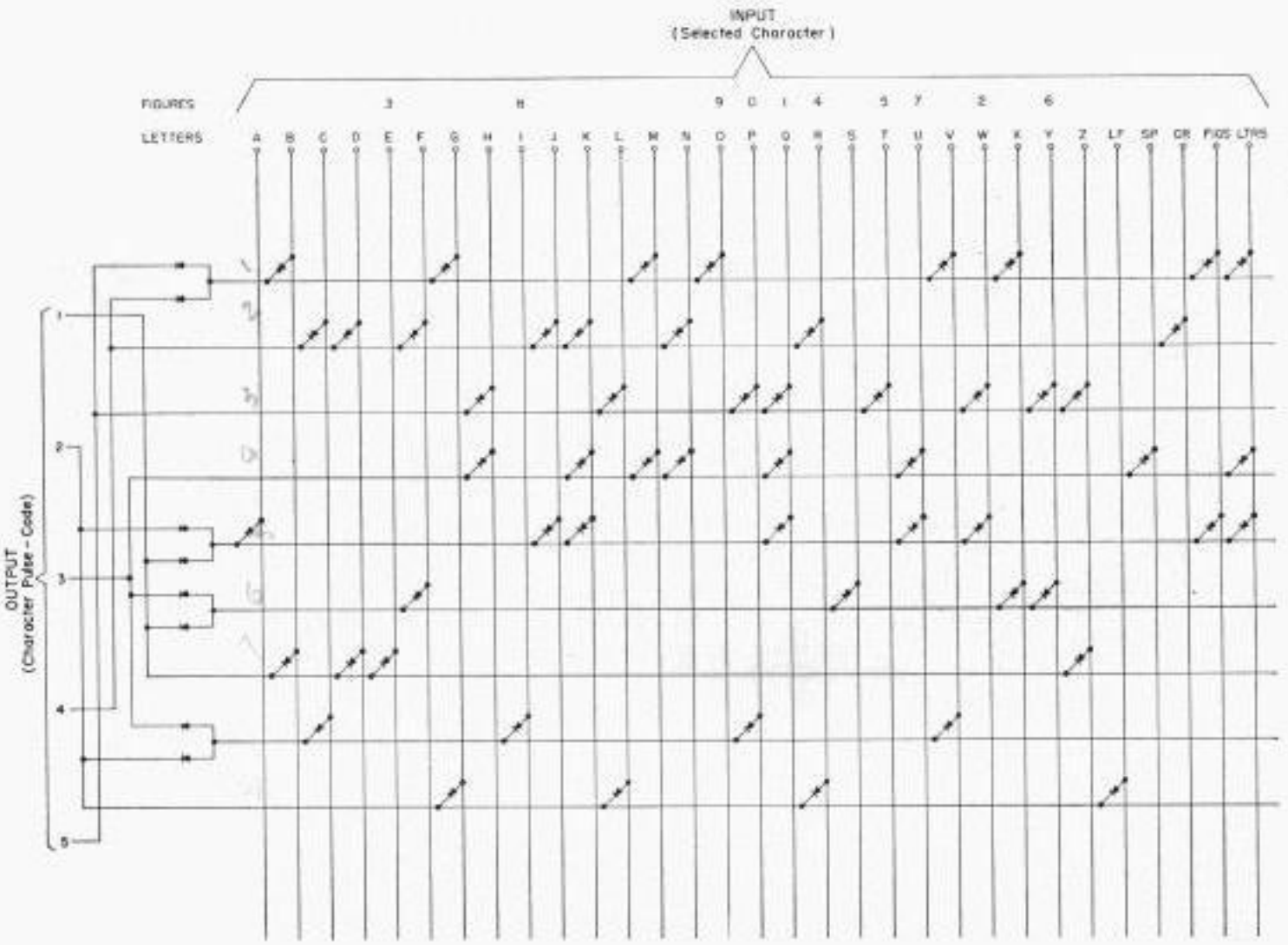


Figure 2. Diode matrix plan

Since with the use of a matrix for character generation only one input line need be energized for the generation of the entire 5-unit code for the desired character, it will be seen that the complexity of

equipment for the automatic generation of signals of considerable length can be substantially reduced by this method. As only one level of a switch is required for signal generation, it is possible to supply a large number of independent outputs from a single switch of reasonable size.

The full matrix for 31 characters requires 80 elements. The diode lends itself readily to a modification of the basic matrix circuit in which input lines are combined in such a way as to reduce the total number of elements needed (see Figure 2). This reduction is not obtained, however, without certain accompanying disadvantages. The number of leakage paths is increased, and in some applications a higher quality of diode having less back current may be required. This may result in failure to achieve the reduction in overall cost which might be anticipated from the reduction in the number of diodes. Furthermore, in the case of a particular diode which has been used in Western Union equipment for this purpose, there is about five volts drop across the diode when conducting. Since in the modified matrix the marking current to a particular output line may pass through a varying number of diodes from one up to three, depending on the particular character chosen, there will be an undesirable variation in output voltage.

The life of most diodes is potentially infinite, there being no wearing out or using up of active material. In spite of this, however, there will be a certain number of failures in any given period of time for a large number of diodes as a result of various minor and little-understood factors. Selenium diodes, for example, unless hermetically sealed in metal or glass envelopes, are susceptible to damage by minute quantities of certain chemical vapors, mecury being a notable offender of this type. It is anticipated, however, that diode matrices of the type now in use will give many years of trouble-free service under normal conditions.

Use of Neon Lamps

Gas-filled cold-cathode glow-discharge tubes may also be used as matrix elements. The Detroit tie-line switching equipment is designed to use, interchangeably with the diode matrix, a neon lamp matrix using the small NE-2 lamps as elements. The principle of operation of the neon lamp matrix is the same as that of

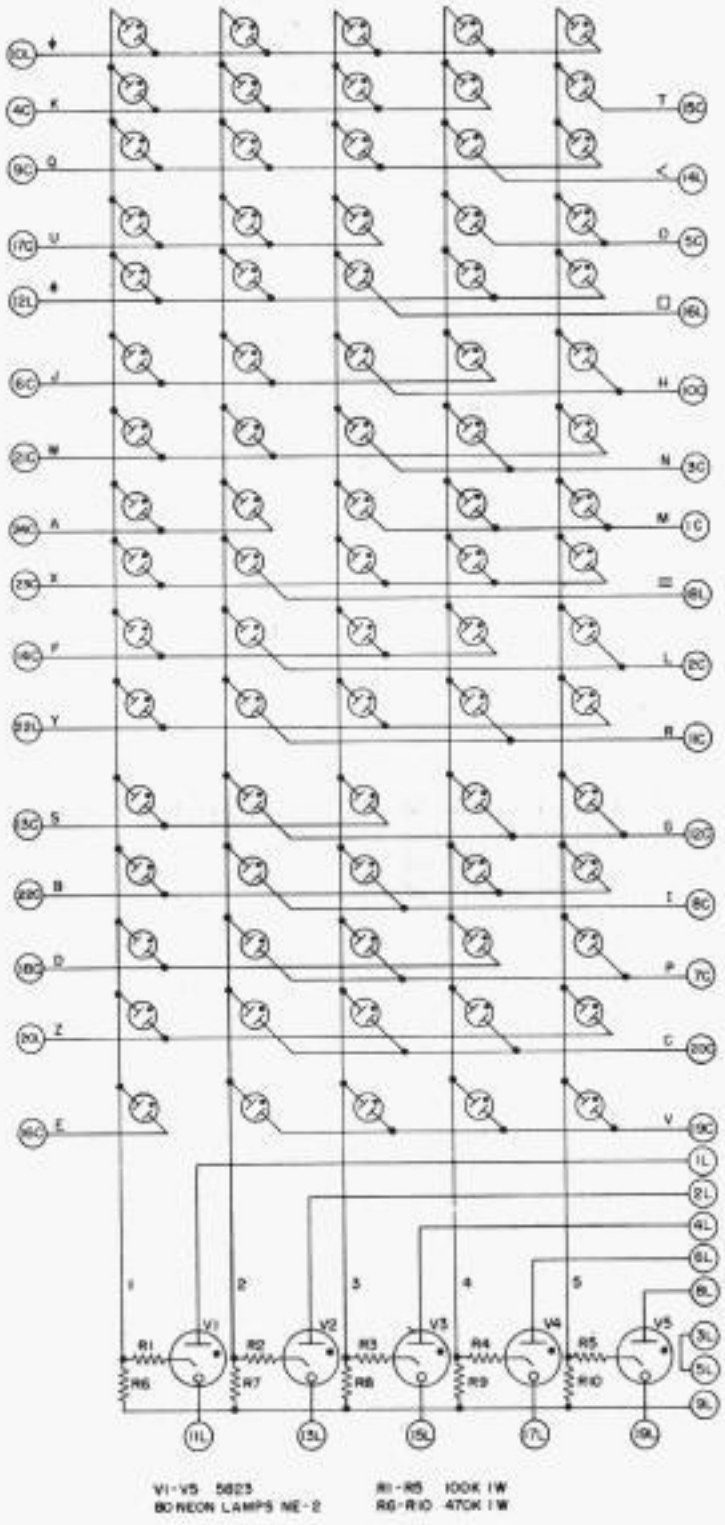
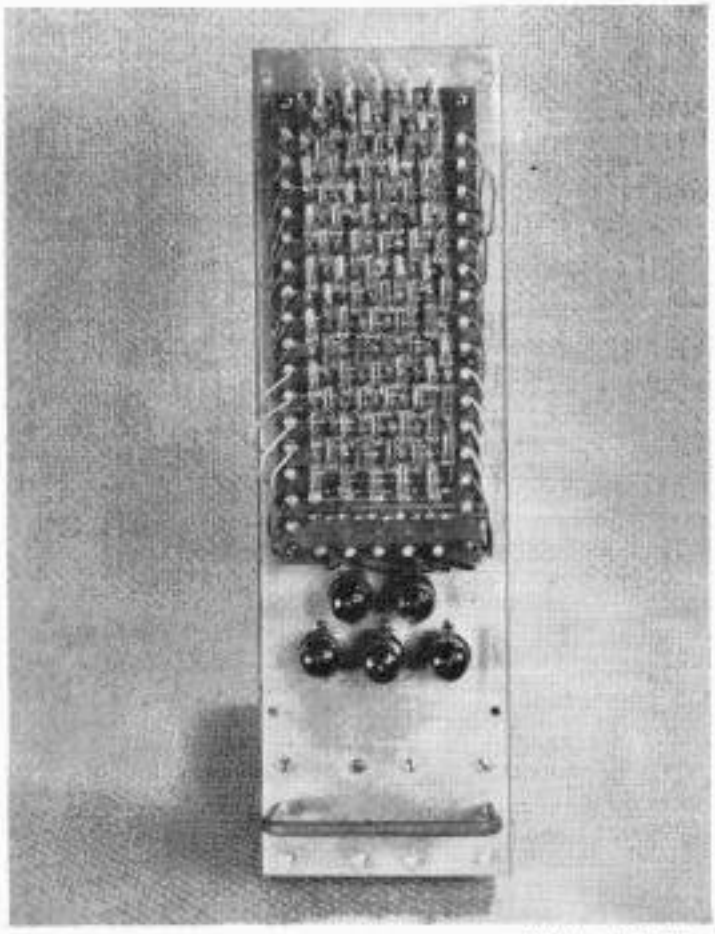


Figure 3. Neon matrix schematic

the diode matrix, except for a difference in the mechanism which prevents leakage to an unmarked output line. The neon lamp used will conduct equally well in either direction, but no trouble results from this if the input and output voltages are properly chosen.

The lamps break down and conduct when a potential of about 70 to 75 volts is applied across them. The input line must be energized with at least this voltage in order to obtain any output. The output voltage is the input voltage minus



Water Mill Photo

Figure 4. Neon matrix

the 60-volt (approx.) lamp drop. Any leakage path to an unmarked output line, however, includes two lamps in series, and the output voltage on the marked line must be at least 140 to 150 volts to break down the lamps in a potential leakage path. Even if the output voltage is sufficient to bring this about, the conducting drop of the two lamps (about 60 volts each) is subtracted from the applied voltage on the leak path and only 20 to 30 volts will appear on the nominally unmarked output. This is more than 100 volts less than the output signal required to cause this condition.

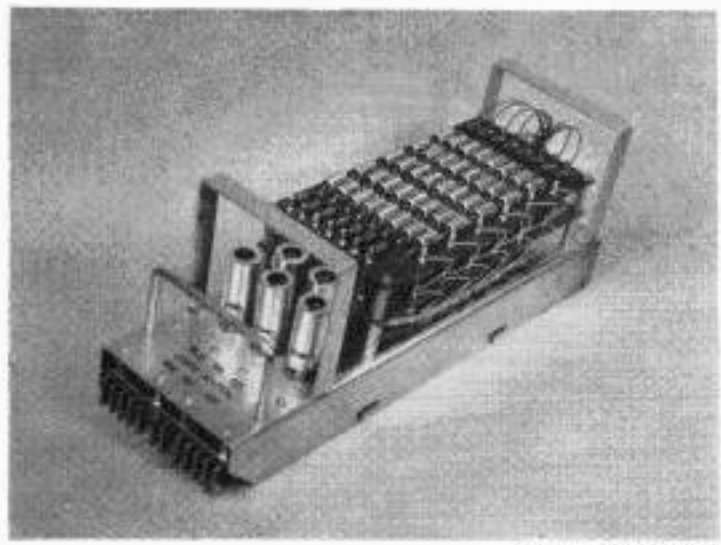
In the ordinary case, the output voltage is kept safely below 140 volts and it can be said for all ordinary applications that no leakage whatsoever occurs, the current in a neon lamp at any voltage less than the breakdown being in the order of a very small fraction of a microampere. The circuit for the neon matrix is shown in Figure 3.

To summarize the performance, the neon matrix may be energized with from 75 to 200 volts applied to an input line for an output voltage ranging up to a maximum of 140 volts with no leakage output whatever, while higher output voltages may be obtained at the cost of some leakage signal. The leakage output, however, will always be something of the order of 120 volts below the normal output on a marked line.

Estimated Lamp Life

Unlike the diode, the neon lamp does not have a potentially infinite service life. Loss of emissive power of the electrodes, and cleanup of gas limit the life to a value which can be predicted with some degree of certainty. By interpolation from data supplied by the manufacturer, a life of 4000 hours of continuous d-c service may be expected.

In the Detroit tie-line switching system the matrix supplying the first half of the top line has the greatest use. In this, the most frequently used character is the function "space" which appears three



Water Mill Photo

Figure 5. Diode matrix

times for each top line. Since the neon lamp for this function is energized for the entire duration of the character, it will be used a total of 462 milliseconds for each top line. A total life of 4000 hours should be sufficient for the production of over 31,000,000 top lines. At the anticipated

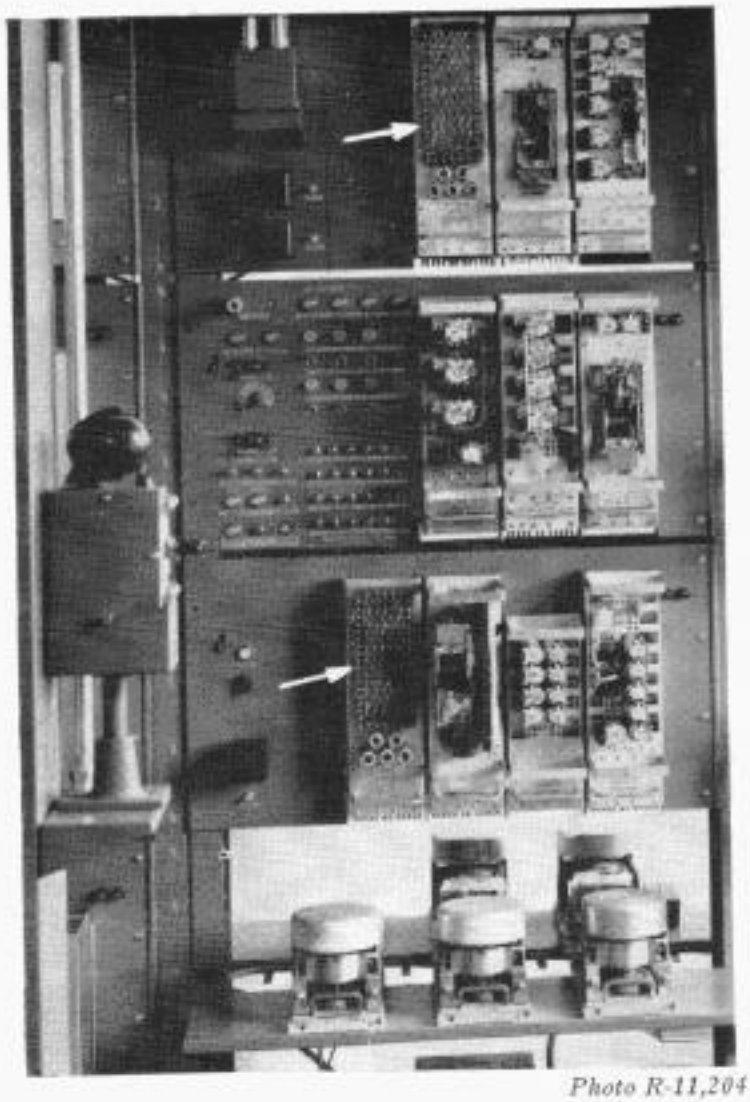


Photo R-11,204

Figure 6. Neon matrices (arrows) mounted on equipment at Detroit

volume of 2500 messages per day, the most used lamp in the matrix should have a life of about 50 years, assuming 250 working days per year.

The manufacturer's life rating, however, is based in part on blackening of the bulb, which is of no consequence in this service. It appears, then, that barring the appearance of some effect which cannot be foreseen at this time, the neon lamp matrix promises extremely long service, and it is the neon devices which are now actually in service in the Detroit Plan 37 installation.

Both neon and diode matrices are assembled on printed circuit boards which eliminates the possibility of wiring errors in the complex pattern of connections. Figures 4 and 5 show the completed units, and Figure 6 is a photograph of a portion of the Plan 37 installation showing the neon matrices.

Reference

SOME APPLICATIONS OF ELECTRONIC METHODS TO TELEGRAPH APPARATUS, R. O. CARTER and L. K. WHEELER, *Institution of Post Office Electrical Engineers Paper* 199 (1949).

Frank T. Turner of the Electronics Research Division, Water Mill, L. I., entered the employ of the Telegraph Company in March 1946. Prior to that time he had gained wide experience in the field of facsimile, having been employed by International News Photos for seven years in the design and production of facsimile apparatus. After a period of military service in the field of facsimile he came to Western Union and was for some years active in the design of facsimile equipment. Recently Mr. Turner has been engaged in the design of switching circuits for the Plan 37 tie-line switching system.

FRANK J. CALDERONE, Project Engineer, Apparatus

Switching System 33 Serving Branch Offices and Tie Lines

Distribution of telegraph traffic for the former city of Brooklyn has been facilitated by its retention of a postal and telegraphic identity which permits messages for its 2,764,000 people to be separated readily from those for 5,378,000 other New Yorkers. Because of this it has been convenient as well as practicable to provide at New York a special message tape switching arrangement to serve Brooklyn's branch offices and tie lines.

REPERFORATOR switching has provided many improved means of handling telegraph traffic. Plan 33 Switching System provides a method of direct switching to branch offices and tie lines without manual repunching and is similar in this respect to the torn-tape section of Plan 21.[1] Plan 33, as described here and familiarly known as "33 Brooklyn," provides sending facilities at New York for torn-tape switching primarily from Syracuse to Western Union branch offices and to tie lines located throughout the borough of Brooklyn, New York.

Operating Equipment

The bulk of the traffic handled in the 33 System is destined for branch offices; therefore, to minimize the handling and delay of switching, the system centers around Branch Office Switching Table 8262-A (Figure 1). This table provides two receiving terminations into 36-AS Printer Perforators; one is a receiving trunk from Syracuse, and the other a local line from a remotely located sending position from which traffic originating in the New York City area can be received at the 33 System for switching to either a branch office or a local tie line. Housed on the branch office table is a 3-gang MXD transmitter and three corded plugs, one for each of the three transmitters. Directly above the MXD is a 50-jack turret.

The combination of plug and jack is the method used for switching to branch offices. Four of the turret jacks are used for special purposes. Two are associated with local teleprinter receiving positions located in the same area as the local sending positions intended for rerouting and fall-back purposes. The third, or local jack, is connected to the receiving side of a teleprinter position operated as a split printer. The keyboard of this teleprinter is terminated in the Plan 31[2] section of the operating room so as to provide a sending connection to Syracuse for handling service messages associated with traffic in the 33 System. Operation of the space bar of the teleprinter keyboard brings up an answer next lamp at the Plan 31 turret and a link is established between Plan 33 receiving directly from Syracuse and Plan 31 sending directly to Syracuse. The operator at the Plan 31 section answering the call by plugging up to the corresponding call lamp jack, auto-

Photo H-2158-B

Figure 1. Position for switching to branch offices

matically causes a reversal to take place on the Plan 33 side, giving a visual go-ahead light signal to the operator requesting to send.

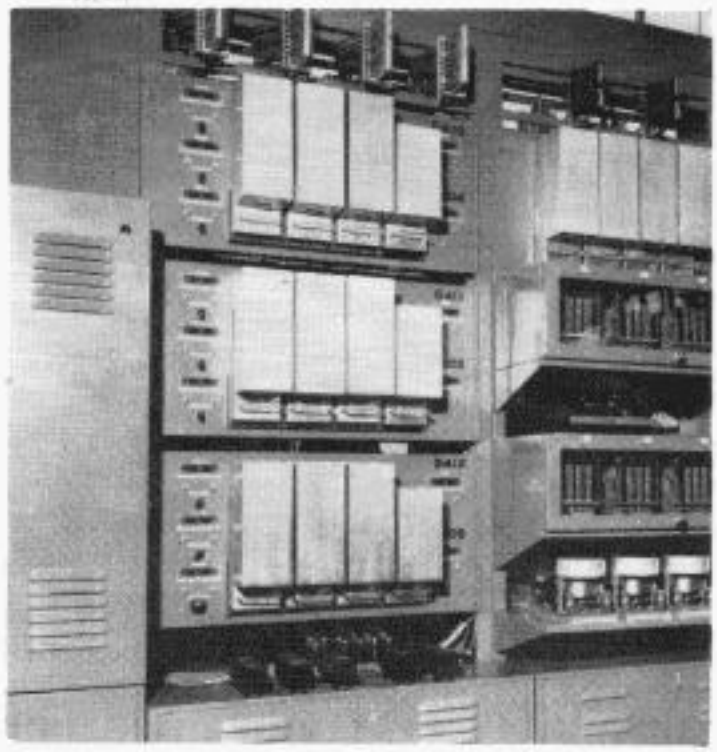


Photo H-2158-E

Figure 2A. Branch Office Equipment Rack 8366-A

The fourth jack is used for T&R (testing and regulating) purposes while the remaining 46 jacks terminate branch offices through a Plan 2 concentrator. Directly below the turret and above each transmitter cord is a set of two lights, a busy lamp (red) and a number request — end-of-message lamp (white). Located in line with transmitter cords are mounted local and trunk line signal lamps and tape feed switches and, at right, T&R and low tape switches.

A Branch Office Equipment Rack 8366-A (Figures 2A and 2B), is required for the operation of a Branch Office Switching Table 8262-A. This rack provides the necessary cord circuit equipment for branch office line connections, trunk facilities and control functions associated with each of the three cord and transmitter combinations of the switching table. Mounted on each door of this rack and associated with the operation of one switching table of three cord circuits are tape feed and cord circuit relay banks, plus facilities for monitoring and adjusting line and bias currents for local and main line trunks. The equipment rack is capable of working 18 cord circuits which is equivalent to handling six Branch Office Switching Tables 8262-A, housing three cord circuits each. It further provides control facilities for six trunks and six local circuits.

Each branch office line is equipped for automatic numbering. Automatic Numbering Machines 7014.17-A are provided and mounted on Automatic Numbering Machine Rack 8268-A (Figure 3). The rack is designed for 16 numbering machines, eight to the front and eight to the rear.

Type 15 teleprinters equipped with line feed reading contacts are used for recording the top line of every branch office message switched from the 33 System. Four printers are mounted on a Top Line Printer Rack 8270-A (Figure 4), and are automatically shared with a possible 20-cord circuit.

Figure 5 indicates the interconnections between the racks and associated equipment as covered in the above description. For each combination of an MXD trans-

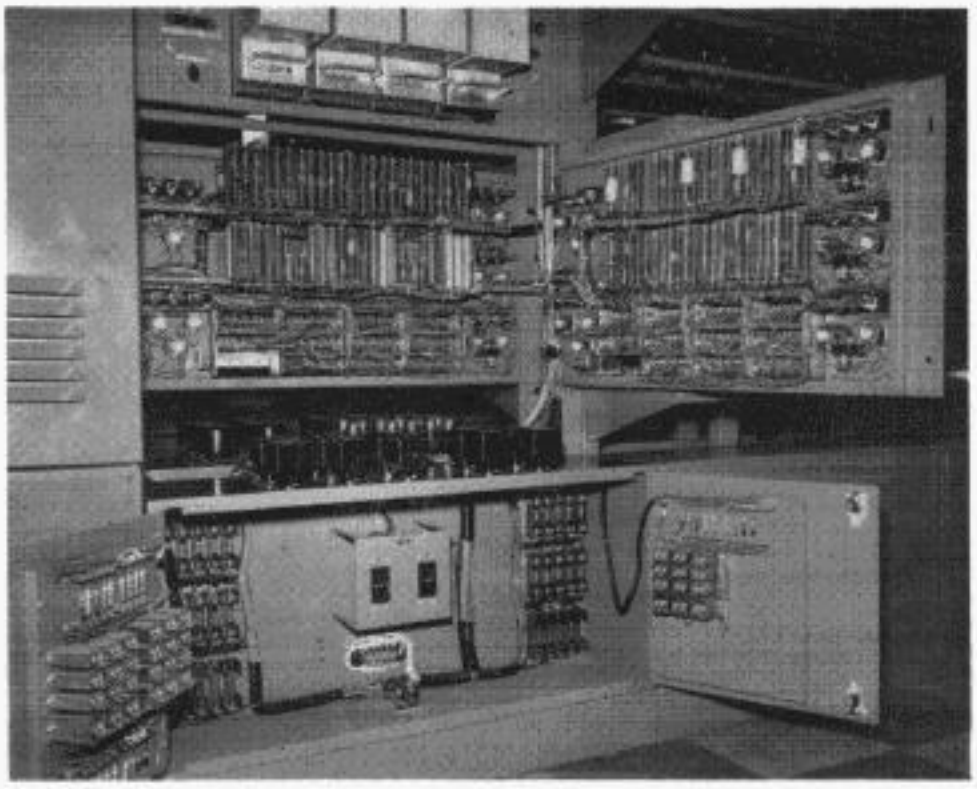


Photo H-2158-D

Figure 2B. Lower part of 8366-A rack, doors open

mitter and 3-conductor plug, there is an associated cord circuit. Each cord circuit comprises the circuitry of switching relays for preliminary and direct connections from the sending MXD transmitter to the allotter from the Plan 2 concentrator, to the top line printer rack and automatic numbering machine rack.

Switching to Branch Offices

Incoming traffic from the trunks is received on Printer-Perforator 36-AS in chadless tape form at a nominal rate of 77 wpm (actually 76.6 wpm, 460 operations per minute). The message tapes are torn off at the prescribed perforated letters

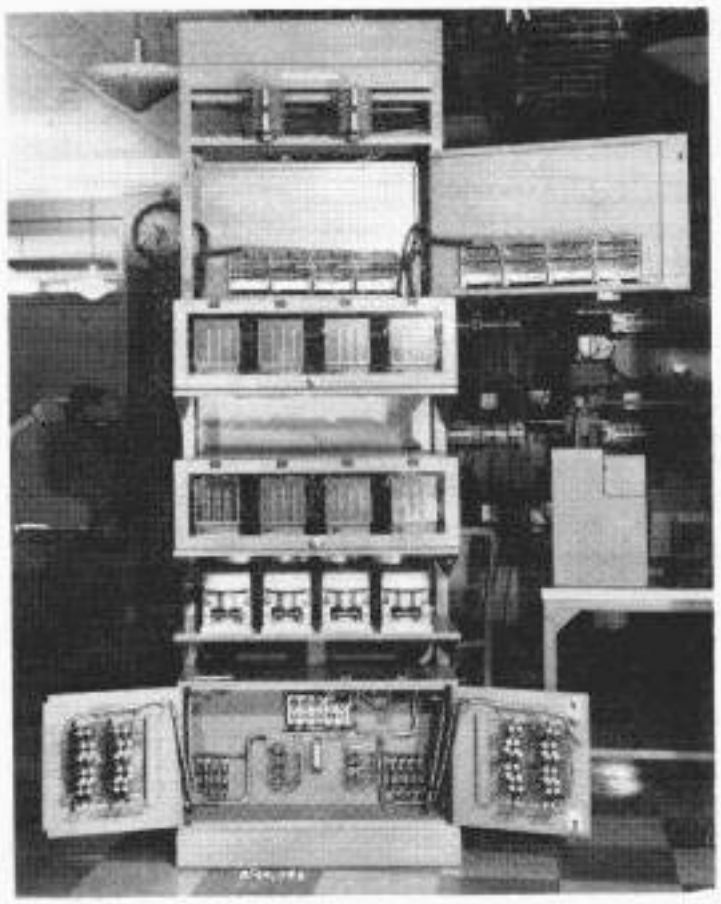


Photo R-10,798

Figure 3. Automatic Numbering Machine Rack 8268-A

character which follows the end-of-message signal, namely, CRCR. The message tape to be switched is inserted into one of the three transmitters. The routing chart is then consulted, if necessary, for the correct call letters of the branch office to which it is to be switched and the operator plugs up to the jack indicated by the call letters of that branch office.

The operator's insertion of the 3-conductor plug into the turret jack initiates several related operations. The plug tip is associated with the line while its sleeve prepares a path from the Plan 2 concentrator through the allotter for a branch office connection to the cord circuit requesting the line connection. The switching relays of the cord circuit complete the branch office line connection as it is being made through the turret from the concentrator.

When the allotter connection has been completed, the cord circuit initiates a request for a top line printer. Each cord circuit is connected to a top line printer rack. Its positions are interconnected to a second rack in multiple. The positions are terminated in a 15 Type teleprinter

Photo H-2158-A

Figure 4. Four top line printers on two 8270-A racks

equipped with line feed function lever contacts from which a disconnection signal, line feed, can be read. As soon as a top line printer has been connected to the branch office line, the cord circuit switching relays allow the automatic numbering machine rack to function.

The ring of the plug is associated with the numbering machine circuitry. On the completion of a number request the automatic numbering machine circuit functions, sending an automatic number from its distributor to the branch office. The number sent to the line may be composed of CRLFNSpaceBA123, indicating the origin as "N" New York, the destination as "B" Brooklyn office on the "A" channel,

and the message number in sequence as 123. The CRLF is sent at the start of each automatic number and is part of the call letter switch of the numbering machine. This will insure against an over line on the top line printer if the line feed should happen to be omitted following the message check in the previous message. The LF of the numbering machine does not disconnect the top line printer due to a differentiation made by the cord circuit relays.

without the interruption of pulling down and again plugging into the turret.

End-of-Message

The text of the message continues to be sent from the MXD transmitter until it reaches the end-of-message signal CRCR, at which time the fourth pulse auxiliary reading contacts, which are independent of the line reading contacts of the transmitter and are part of the transmitter, read CRCR. These newly designed contacts

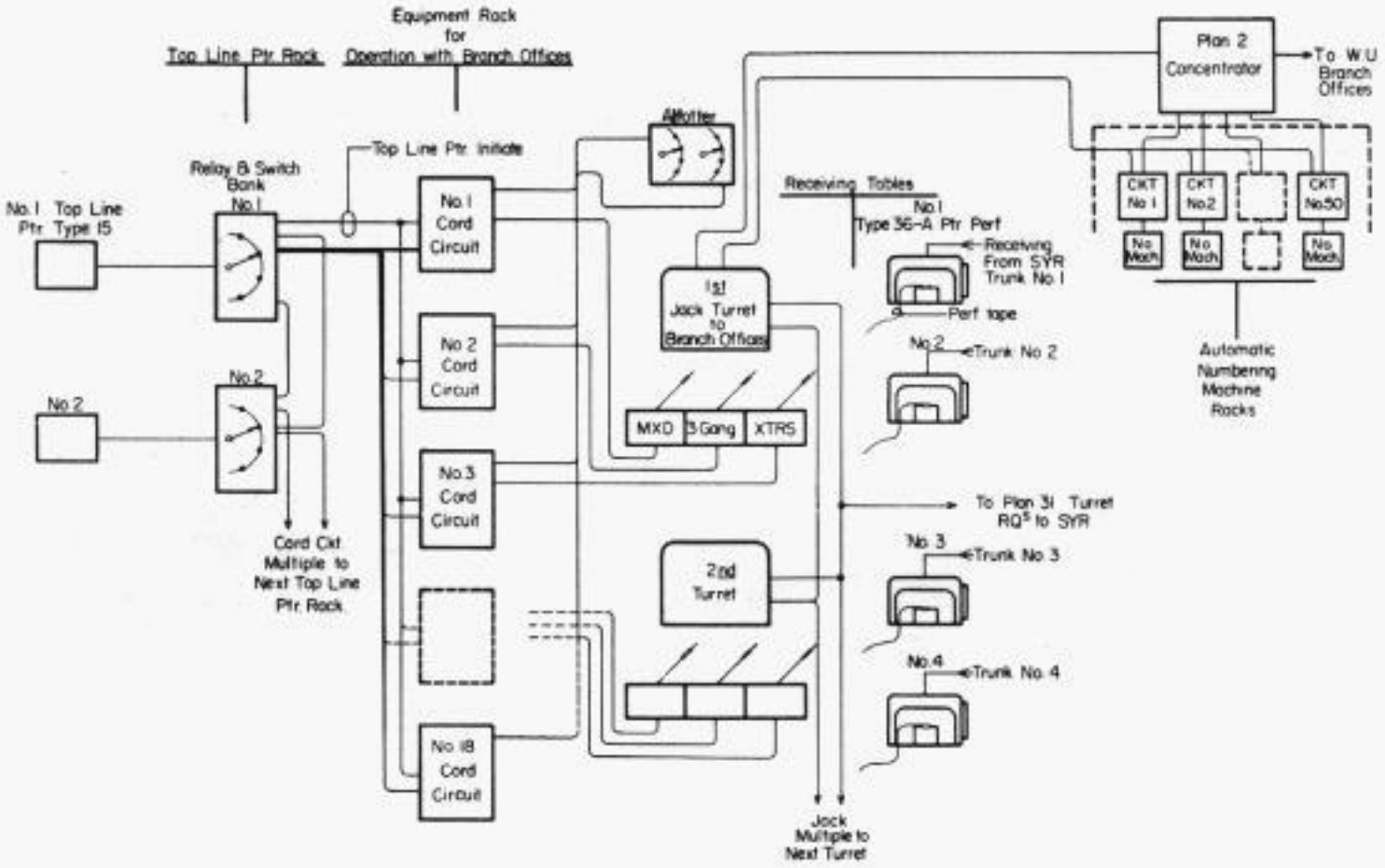


Figure 5. Schematic diagram of Plan 33 switching circuits and equipment

When the automatic number is completed, the auxiliary autostop relay in the cord circuit is released, allowing the MXD transmitter to step. As the message advances to the equals sign or line feed following the message check, the top line printer is disconnected while the transmitter continues to send the text of the message. The top line printer disconnection on the second equals sign allows it to be reselected by another cord circuit which may have a request in for top line printer connection. Therefore, the top line printers may be shared for an automatic pickup or selection by other cord circuits

make it possible to read the CRCR function at the transmitter independently of the normal transmitter reading pins. This saves the necessity of burdening the cord circuitry with additional reading relay banks or providing line monitors with separate reading contacts for reading control functions. The reading of the double CR places a stop on the MXD transmitter and disconnects the cord circuit from its branch office line connections.

The automatic disconnect of the cord circuit from the line does two things in addition to effecting the line disconnect; it brings on a blinking white light at the turret indicating transmission has been

completed, and shows that the turret connection may be pulled down. This visual indication of end-of-message will remain on until the turret plug connection is removed. During the interim following the automatic disconnect, a second turret which may have been plugged up to the same jack, but held as "busied" with a steady red light, will be released automatically from the busied state and its circuit seizure will take place as described above. In this manner, any number of turret connections made simultaneously to the same jack will be successively connected for transmission to a branch office without any manual requirement, even though several transmitters are being used. Each cord circuit, its transmitter, and associated plug, will be automatically selected. The cord circuits will go from busied to transmission completed, recording the top line of each branch office message with an automatic sequential number, until all messages have cleared the transmitters.

Tie-Line Switching

That part of Switching System 33 which handles switching to Brooklyn tape or page tie lines is similar in operation to the torn-tape section, reperforator switching Plan 21. The Brooklyn tape and page tie-line circuits are terminated in a switching turret as part of Tie-Line Switching Table 8264-A, Figure 6. In conjunction with the operation of Table 8264-A, as in Plan 21, the following associated equipment is necessary for torn-tape switching to tie lines: a tape-to-page translator,[3] a tie-line equipment rack, and a time and date transmitter rack.[4]

The operation of the torn-tape section, briefly, is as follows: The message to be switched to a particular tie line is inserted in one of three MXD transmitters of Tie-Line Switching Table 8264-A. The associated plug of the MXD is plugged up to a tie-line customer's jack in the turret. The jack is so poled that the insertion of a plug will cause the established circuit to distinguish between tie lines terminating in a tape or in a page teleprinter. If it is a tape printer termination, the line is picked up directly and transmission will proceed until the end-of-message signal is read by the monitor printer through its period and bail contacts at which point the time and date are transmitted to the line.

If the tie line is terminated in a page teleprinter the polarity of battery on the jack which meets the plug will operate the signal relay for page operation thus picking up a translator. When a translator connection is made to the cord circuit, the

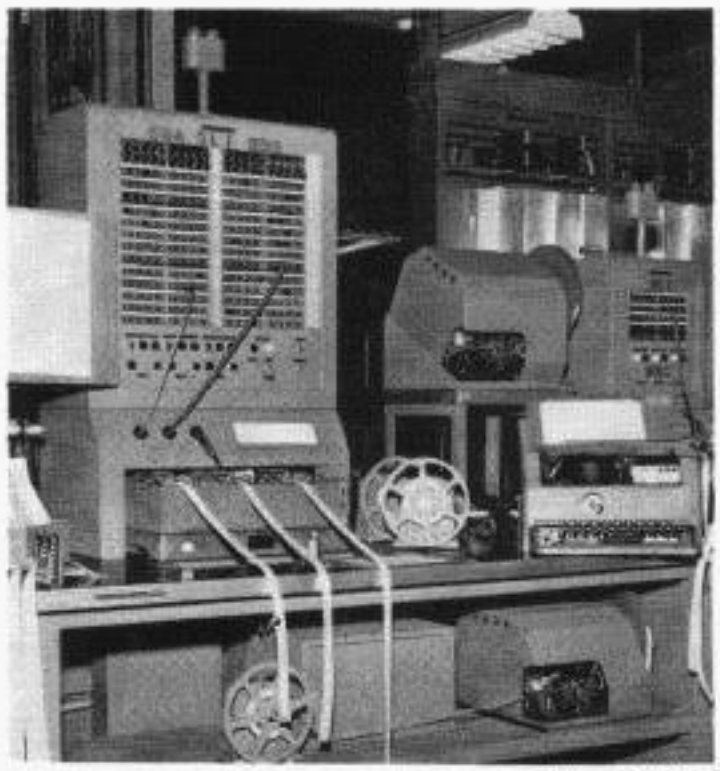


Photo H-2158-C

Figure 6. Position for switching into tie lines

cord circuit MXD is allowed to step or transmit. The perforated tape copy is transmitted from the MXD to the translator where it is reperforated. The reperforated tape passes to a transmitter from which it is processed for translation. The functions of upper-case F are converted to paragraph, CRLF and five spaces; all line feeds are converted to CRLF. The character count is such that after the 58th character a space is automatically converted to a CRLF. Since keyboard standardization, the function of the tape-to-page translator has been decreased and its converting functions have been limited to those mentioned. When the MXD transmits the CRCR, the end-of-message signal, the translator will absorb the first fourth pulse and on the second CR will request time and date followed by eight line feeds to be sent to the line. The reading of the second CR of CRCR causes a time and date initiate

to be given to the time and date rack from the translator, operating the request for time relay, RT, at the time and date rack. With the operation of the RT relay, the cut-in relay CI at the time and date rack is operated. Upon completion of the operation of these relays, the time is sent to the line; operation of the cut-out relay CO then causes the time and date request relay at the translator to release which in turn releases and completes the cord circuit function associated with Tie-Line Switching Table 8264-A. The end-of-message signal CRCR, which terminates a message in the torn-tape system, is read at the monitor printer through a set of period and bail contacts mounted on each printer associated with each MXD.

The only additional innovation in the 33 System, for tape-to-page operation, over the Plan 21 torn-tape switching to tie lines, is that of being able to insert a keyboard into the line with each of the three MXD circuits. The same keyboard may be connected to a printer-perforator in the Plan 31 section of the operating room for sending RQ's directly into Syracuse from Switching System 33.

References

1. SWITCHING TO PATRONS' TELEPRINTER TIE LINES, R. S. WISHART and G. G. LIGHT, *Western Union Technical Review*, Vol. 3, No. 2, April 1949.
2. TELEGRAPH SWITCHING FOR REMOTE BRANCH OFFICES, R. L. PARCELS and F. A. LUCK, *Western Union Technical Review*, Vol. 6, No. 3, July 1952.
3. TAPE-TO-PAGE TRANSLATOR, A. E. FROST, *Western Union Technical Review*, Vol. 3, No. 2, April 1949.
4. THE AUTOMATIC TIME AND DATE TRANSMITTER, W. S. W. EDGAR, Jr., *Western Union Technical Review*, Vol. 2, No. 4, Oct. 1948.

Frank J. Calderone joined Western Union as an engineer's assistant in 1945, after four and a half years of military service as a senior noncommissioned officer in the United States Marine Corps Reserve. He attended Georgia Tech, and received his B.S. degree from Fordham University in 1953. Mr. Calderone has been a member of the multiplex group of the office of the Apparatus Engineer and was associated with the application of torn-tape switching to tie lines of reperforator switching. Assigned to the cable group for a period, he assisted in the development of ocean cable six-channel multiplex. He has been directly associated with the design, development and testing of small office reperforation, Plan 34, and with Switching System 33 — Branch Offices and Tie Lines, described in this article.

Upon the Retirement of H. H. Haglund

The Committee on Technical Publication takes this means of signalizing retirement from the Telegraph Company's service of one of its most diligent members—H. H. ("Happy") Haglund. No pseudonym ever fitted a bearer better, nor has one been more universally accepted as "a natural." Yet among his fellow engineers his reputation rests more solidly on accomplishment than on any one facet of his nature.

Out of the West he brought a pioneer's acceptance of the challenges of adjustment and change; he became a spearhead in the revolt against key-and-sounder tradition. He participated in the evolution of printing telegraph which finally produced the Western Union multiplex system, and personally contributed much to its projection, through submarine cables, overseas. Transplanted to New York, he had surrounded himself by 1928 with a group of Western Union engineers whose reputations became tops in the industry as the years went by. His group became pre-eminent in the forging and shaping of the pulse, laying the groundwork of an art which even today is reaching out into higher frequencies and other modes of transmission.

No one in his group excelled Haglund himself in the storage and manipulation of trains of pulses. A number of patents issued to him on channeling of pulses; synchronizing, anticipating, regenerating, storing, and repeating them; reversing their direction, gating them through assigners, and translating them from one code into another, attest to his mastery of the subject. He was first to use, for any commercial signaling purpose whatsoever, the critical control-grid properties of the thyratron tube to render its anode circuit sharply conductive and nonconductive. In its telegraph cable application the then new device became a main-line relay, operating without bias or bounce, and at hitherto unrealizable speeds.

Haglund led his associates into the field of patents and he led them into print. Therein he made contributions of great value to Western Union's Committee on Technical Publication even before he joined it as the Plant and Engineering Department's representative in 1950. Since then, perhaps as a mechanism of escape from the exacting demands of his executive job as Assistant Director of Applied Engineering, he has enjoyed being a benign sort of literary "whip," rounding up the junior laggards in the cloak rooms and getting them out into the arena where technical papers are produced.

Haglund's perennial photograph originally appeared alongside an article he wrote for TECHNICAL REVIEW in 1949. It served again as recently as July of this year with his article on the centennial of the Atlantic cables, for the adequate reason that there had been no net change in his appearance in the nine-year interval. It is used here again because the photographer has preserved for posterity the characteristic transient that gave Happy his name.—I.S.C.

GEORGE O. VINCENT, Manager — Administration.
Facsimile and Private Wire Services

Private Wire Services In Data Processing By Western Union

The Telegraph Company's earnest endeavor to provide private wire customers with telegraph arrangements best suited to their individual requirements has led to development of a variety of equipment types and network plans most of which have been recorded in detail in the *Technical Review* or elsewhere. A summarization which includes short descriptions of a dozen or more of those systems, although comprising no new material, can be of much value as a ready reference for comparative information on the different arrangements, a convenient illustrated catalog with their type numbers, and a basic bibliography of these multiform telegraph networks.

It is the purpose of this presentation to highlight Western Union communications equipment for both messages and data. Some has been in use for many years, some is of fairly recent design and engineering. Details of various specially-engineered and designed data communications, data processing and data control systems built by Western Union are included.

Circuits or channels on a lease basis are provided for 60-, 65-, 75-, and 100-word-per-minute teleprinter operation. A circuit may be a single, that is, with one station at each end, sending and receiving on an alternate basis; or it may be a duplex with simultaneous sending and receiving at each end. Either type may also be a "way" circuit; that is, with three or more stations sharing the use of the channel.

There are available tape teleprinters, page teleprinters, Type 19 sets, automatic transmitters, typing reperforators, nontyping reperforators, manual perforators and, for central installations, torn-tape switching equipment, push-button switching equipment, or fully automatic switching equipment. Many hundreds of associated items also are available.

Teleprinters may be supplied with features providing for creation of multilith or other types of masters for reproduction of copies, multiple interleaved carbon sets of forms, horizontal tabulation, vertical tabulation or form feed, sprocket or pin feed, automatic positive vertical forms alignment and automatic station selection.

The Type 19 set provides for preparation and transmission of 5-channel code perforated tape in addition to teleprinter operation. The tape is prepunched before it is transmitted to the line, thus conserving valuable circuit time. Prepunching of the tape also permits editing, and deletion of manual errors. The transmitter associated with the set may be arranged with a special selector, a device that permits the transmitter to start itself without operator attention whenever the circuit is available. This arrangement is a valuable facility on way circuits, eliminating the waiting for an opportunity to send.

Public Message Data Service

While the systems presented are for use by private wire services, there is no reason to confine the handling of data to such systems. Western Union's nationwide public message network can be utilized for the automatic transmission of perforated tapes. Such transmissions are necessarily confined to the 5-channel code since the Telegraph Company's entire multimillion-dollar high-speed plant is based on this code arrangement. Satisfactory tests have been made for customers who present perforated tapes in one city, and desire an accurate copy for their office in another city for business machine or computer processing.

Western Union itself is utilizing this system for nationwide integrated data processing of payroll, equipment inventory, and other statistical and management control information. More than half a million words and groups of figures weekly, giving detailed information about telegraph operations in every major city coast-to-coast, are quickly assembled at special centers for processing by business machines and calculators.

This system links 18 control cities which transmit assembled information to one of five integrated data processing centers in New York, Atlanta, Chicago, Dallas, and San Francisco. A "nonsense" total, automatically produced by equipment at the control cities, is included in each line of figures transmitted. At the center a calculating machine automatically adds each line of figures received to obtain a similar "nonsense" total, thus insuring accuracy. The machine releases the data for final processing only if the two totals agree. The "nonsense" total idea for accuracy checking purposes of transmission over 5-channel code tape transmission systems has proved to be surprisingly good. (*A Nationwide System for Office Automation and Timely Reports for Management, Warren F. Gregory and Wilfred J. Walsh, Western Union Technical Review, Vol. 12, No. 4, October 1958.)*

Edit

A system has been developed that will provide error detection and correction for data, both alphabetic and numeric. It has been dubbed "EDIT" from its literal meaning of "error deletion by iterative transmission." A technique of totalling the marking pulses in a line of data on a weighted binary basis is employed. Equipments at the sending and receiving ends of a circuit provide error detection and correction while transmission is taking place. The transmitting equipment can send tapes already having checking information or can automatically insert checking information after each line. In either case the transmitter will stop after sending the checking information for each line of data to await instructions from the receiving station. The receiving equipment checks each line of data with its associated checking characters. If the check indicates no error, the transmitter is signaled to send the next line. If an error is indicated the reperforator deletes the errored line from the tape and signals the transmitter to repeat the line of data.

The EDIT transmitter is arranged for handling 5-, 6-, 7-, and 8-channel tapes. It can step and read the tape either forward or backward. Electronic distributors are associated with the reperforator and transmitter and may be operated at regular telegraph channel speeds of 65, 75 and 100 words per minute, or at higher speeds up to 200 words per minute. (*Some Aspects of Telegraphic Data Preparation and Transmission, William B. Blanton, Western Union Technical Review, Vol. 11, No. 4, 1957.)*

Plan 111 Switching System

The Plan 111 Switching System, sometimes referred to as semiautomatic, is an extremely versatile and flexible torn-tape arrangement designed for small and medium-sized communications and data networks. Messages from outlying stations are received at the center in printed-perforated tape in the receiving consoles, each one of which will

Plan 111 switching center for torn-tape data or message relay is versatile, flexible, compact.

Photos R-10,016 and R-8287

Plan 51 switching system with continuous tape has semiautomatic push-button controls for 60 circuits.

accommodate three circuits. Each sending console will accommodate six circuits. Switching is accomplished simply by tearing the tape at the receiving console and inserting it in the transmitter associated with the appropriate outgoing circuit. Selection of appropriate stations on way circuits is by push button, and master sending of messages or data is made available by a small applique unit placed on top of the sending console.

Plan 54 semiautomatic system for 125 circuits includes automatic numbering machines in consoles.

Plan 55(1) automatic system was designed for U. S. Air Force traffic at 100 words per minute.

Plan 55(2) includes U.S.A.F. message priority features.

Plan 55(3) has associated traffic control boards.

Plan 56 automatic system with priority features switches automatically without attendants for 10 or 20 circuits.

Plan 57 automatic system with newest in circuitry is improved commercial version of military traffic center.

Outgoing messages are automatically numbered by the equipment. A center can be expanded on a simple building-block basis as may be required for additional circuits. (*A Simplified Telegraph Switching System Plan 111-A, T. S. Pessagno, Western Union Technical Review, Vol. 9, No. 2, April 1955.*)

Plan 51 Switching System

Plan 51 will accommodate a system of up to 60 circuits with a greater message and data volume. Communications are received in perforated tape as in Plan 111 but the tape passes directly into a line transmitter. This is often referred to as continuous tape switching as opposed to torn-tape switching. The destination is read from the tape, a push button is depressed by the attendant, and the message is on its way. The transmitter stops automatically and signals the attendant at the end of each transmission so that the next destination can be selected. Automatic numbering and automatic logging of transmissions are provided, and master sending can also be furnished. (*A Modern Reperforator Switching System for Patron Telegraph Service, R. F. Dirkes, Western Union Technical Review, Vol. 2, No. 4, October 1948.*)

Plan 54 Switching System

Larger yet is the Plan 54 Switching System in that its capacity is 125 circuits. In operation it is similar to Plan 51, but with improvements. The separate automatic numbering machine cabinets used in Plan 51 are eliminated by placing the machines in the receiving and sending consoles, thus conserving expensive floor space. Master sending is also available as well as multichannel selection. (*Private Wire Switching System Plan 54, George O. Vincent, Western Union Technical Review, Vol. 10, No. 4, October 1956.*)

Plan 55 Switching System

Plan 55 is a new high-speed electronic private wire system designed for the United States Air Force for use in the United States as well as overseas. In addition to switching information automatically from one circuit to another, the system provides push-button fall-back operation. In other words, it can be operated at will as a push-button switching center similar to Plan 54 and Plan 51, or for switching any tapes with mutilated direction codes. Each center can accommodate 200 destinations and 400 cross-office circuits. All terminals in the consoles are equipped with Cannon plug connectors, making installation on the customer's premises a quick and simple matter. The system is designed for 100-word-per-minute tributary operation with 200-word-per-minute cross-office switching and automatic parity checking and priority message features. It will utilize more than 200,000 miles of circuits and serve over 200 Air Force locations, and its volume will exceed 2½ billion words a year. (*Automatic Telegraph Switching System Plan 55-A, Gilbert S. Vernam, Western Union Technical Review, Vol. 12, No. 2, April 1958.*)

Plan 56 Switching System

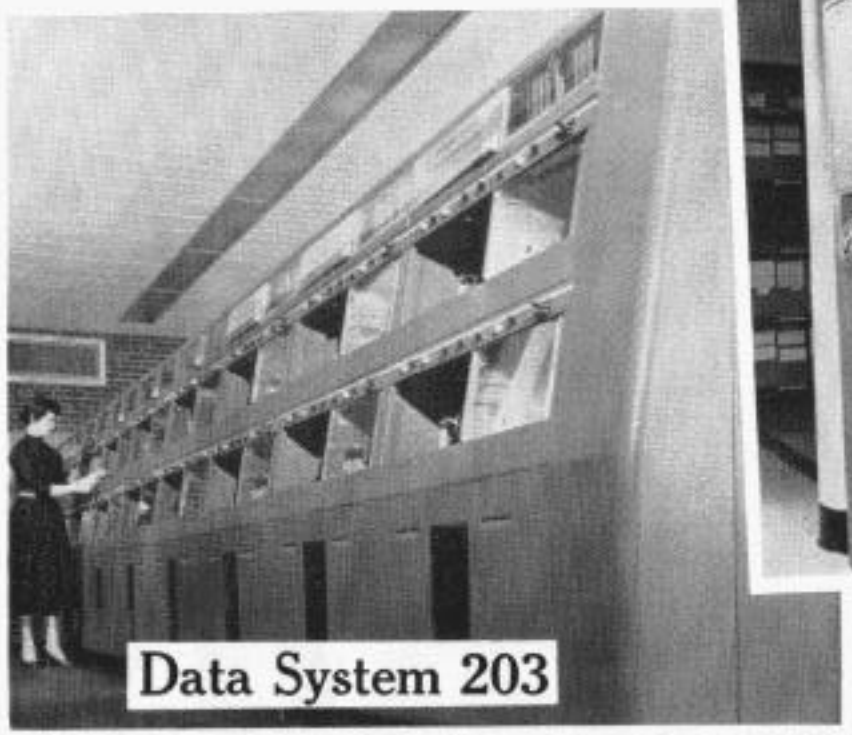
Plan 56 was designed for, but not necessarily limited to, brokerage systems. Circuits and equipment all operate at 75-word-per-minute speed. It is fully automatic, requiring no switching attendants. It has a priority feature which permits more important messages, such as those involving buying and selling at market, to reach the exchange in seconds, getting ahead of other communications of a routine or less urgent nature. Its capacity is 20 circuits. A new system for 10 circuits has just been designed and is designated Plan 56.1. (*A High-Speed Fully Automatic Teleprinter Switching System for Brokerage Firms, Charles J. Holloman, Western Union Technical Review, Vol. 11, No. 1, January 1957.*)

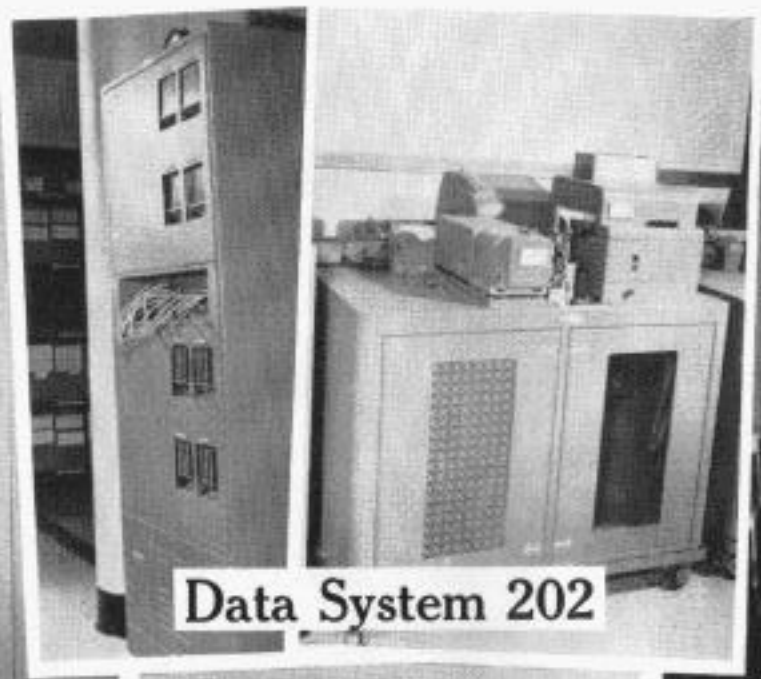
Plan 57 Switching System

This will be the commercial version of the Air Force's Plan 55 system—fully automatic, with high-speed electronic features and all of the other desirable features developed by experience in recent years in other systems. The laboratory model has already been built and a prototype is expected to be installed by the end of this year, with other installations already on order immediately following. The system makes use of transistors, and like Plan 55 accommodates 100-word-per-minute tributary circuits and 200-word-per-minute cross-office circuits. The latter circuits will parity-check each character, not only insuring local circuit continuity but also protecting for such conditions as tape outage, tape jams, and equipment troubles. (*An article on Plan 57 will apear in a future issue of the Review.*)

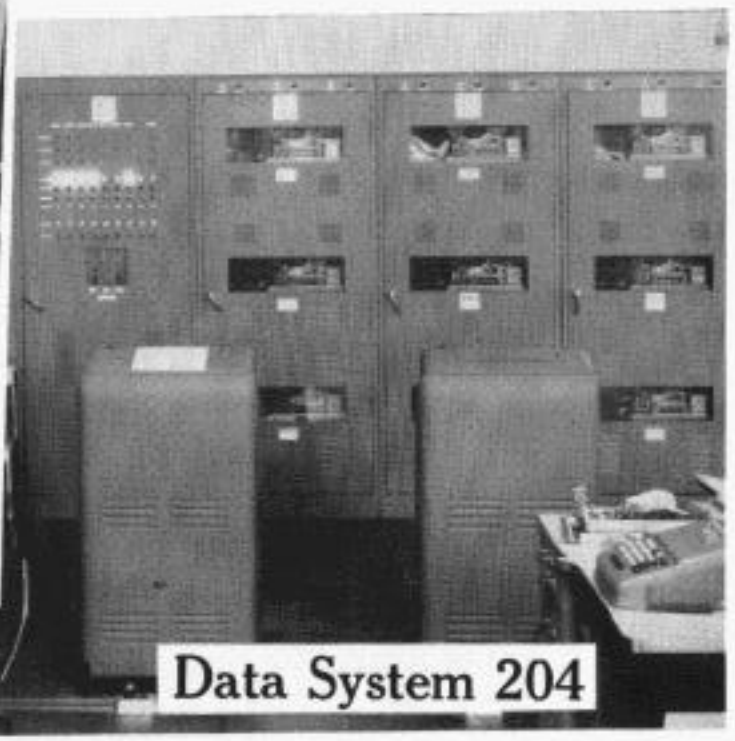
Data Communications System 201

In 1954 Western Union designed and built, for U. S. Steel's American Steel and Wire





WESTERN UNION



DATA SYSTEM 201 prepares orders, shipping data, accounting information, sales statistics and other records for company's operations in three cities.
DATA SYSTEM 202 automatic message numbering machine cabinet type 8024 associated with transmitter console type 8022 for use with IBM card-to-tape converter.
DATA SYSTEM 203 handles both telegrams and payroll, order, billing, production and other data for UNIVAC processing.
DATA SYSTEM 204 stores accounting information received from branch offices at central office to be processed by computer.

Division, the first specially-engineered communications system for integrated data processing. It comprehended service between a major headquarters sales office, and two distantly located mills. While the system required only the normal speed teleprinter circuits, a considerable array of equipment was involved at the terminals, consisting of various arrangements of page teleprinters, automatic perforated tape transmitters, printer-perforators, and three new designs of control cabinets with push-button controls and indicator lights.

At the sales office, prepunched master tapes containing product descriptions are kept on file, and for each of certain customers, his name, shipping instructions, and the most frequently ordered items are kept in the prepunched tapes. These tapes also contain the controlling codes for the various editing operations. The operator at the sales office uses these tapes, entering, as an initial operation, the variable information. From then on, all of the necessary copies even including shipping labels, and a multilith master for mill copies are produced with a minimum of effort. Printer-perforators operating in response to codes in the perforated tape produce selected parts of the transmission in accumulated form for tape-to-card converters for statistics for sales, accounts receivable, and production control. *(Telegraph Applications of Integrated Data Processing, Robert F. Dirkes, Western Union Technical Review, Vol. 10, No. 3, July 1956.)*

Data Communications System 202

This system was designed to meet the requirements of private wire service customers who desire to use tape from a card-to-tape converter for transmission over a private wire system to supplement a standard teleprinter termination. It was specifically designed for United Air Lines for use with the IBM 063 card-to-tape converter, which can be arranged to provide a standard message termination signal, such as "carriage return, carriage return, letters" (teleprinter machine functional characters), at the end of each card at the option of the operator. This system provides for automatic numbering of each transmission when required. There are two basic parts:

1. A transmitter table which is arranged to "nest" with the IBM 063 machine to accept its perforated tape and to transmit it.
2. A numbering machine cabinet built of variable basic units and containing the required control equipment to send automatic numbers, and a timer control.

The timer control is used on way circuits (more than two stations on the same circuit) to prevent the tape from being transmitted into a busy circuit.

Data Communications System 203

The best known of the specially designed systems is one installed for Sylvania Electric Products in a beautiful building at Camillus, N. Y., near Syracuse, which Sylvania constructed for housing the system and a Remington Rand UNIVAC computer for centralizing data handling for their decentralized organization reaching across the United States and to places in Canada. The nationwide communications system utilizes standard teleprinters, Type 19 automatic sending and receiving sets, and three Plan 111 Private Wire Switching Centers. The system handles administrative messages, as well as data for such functions as payroll, invoicing, order and production scheduling and so forth. Messages and data may be transmitted from any station on the system in a random manner; that is, one transmission may be a message, the next data for payroll, and the next a message. The 203 equipment at Camillus was adapted, from automatic equipment used for many years in commercial telegraph systems for handling public messages, to sort incoming data into the various required classifications and accumulate and store it in perforated tape reels, for processing by UNIVAC. The system is composed of five basic cabinet units: (1) reperforator receiving positions; (2) automatic switching; (3) transmitter finders; (4) automatic control unit; (5) data storage positions.

Each receiving cabinet is double-decked and equipped to terminate two circuits, one in the upper and one in the lower position. The receiving reperforators operate at a speed of 75 words per minute, and intra-office circuits operate at 150 words per minute. There is an automatic error-checking feature for the first section of each transmission. *(Control System for Integrated Data Processing, Philip R. Easterlin, Western Union Technical Review, Vol. 10, No. 3, July 1956.)*

Data Communications System 204

The equipment used in this system was originally designed for the Liberty Mutual

Insurance Company and is used to transmit accounting information from tributary or branch offices to a central accounting center. The information is received at the main office in perforated tape form, stored on reels, and subsequently processed by a computer. The central accounting department has complete control of communication at all times by means of a monitor equipment cabinet and its complement of printer-perforator consoles, and sending and receiving teleprinters. Tributary communications circuits may be either single or way-operated. Perforated tape for transmission from branches of the customer is prepared on Friden's Flexowriters.

Data Communications System 205

Designed for General Electric Company and installed at many locations in the United States, the main system consists of an originating station composed of an automatic tape transmitter, a control panel and cabinet, and a sending-receiving teleprinter. The operator has a prepunched tape file which contains constant information, such as a product description. Also contained in this master tape are codes which cause the transmitter to stop and the teleprinter keyboard to be activated, permitting the operator to add variable information to the order form, such as quantity. By the operator coding the control panel, a matter of simply pressing buttons, the order form is transmitted by wire to a warehouse, and information, as a by-product of the wire transmission, is distributed to printer-perforators on the system. *(General Electric's Telegraph Switching System After Five Years, V. L. Hughes, Western Union Technical Review, Vol. 8, No. 4, October 1954.)*

Photos H-2011 and H-2009

Data System 205 for transmitting purchase orders from offices to warehouses and assembling business data by wire combines prepunched tape and keyboard sending.

Data Communications System 206

This is a rather simple system permitting the transmission of messages or data to unattended stations equipped with sprocket or pin-feed multicopy forms. The equipment provides assurance to the sending station that, at the receiving station which may be a thousand miles away, the forms are properly lined up for the information. It is popular with trucking companies for sending waybills to stations during night hours when no operator is available to cover the receiving end, and can be used to advantage in other applications.

Data Communications Systems 207, 208, 209

No. 207 is a data processing system originally designed for the railroad industry to meet requirements for accomplishing six different processing functions relating to train consists in perforated tape form. In addition to a page teleprinter, printer-perforator, and an automatic tape transmitter, the equipment contains a control cabinet for the processing functions. This system has since been redesigned to utilize a program board, like an IBM plug board, so that instead of using characters for the various "tricks," the position of the forms governs. It is called Data Communications System 209; 208 is a reservation and computer network for airlines and other usage. *(Telegraph Applications of Integrated Data Processing, Robert F. Dirkes, Western Union Technical Review, Vol. 10, No. 3, July 1956.)*

Seven-Channel Code System

A communications system has been designed for the government, for an agency engaged in standardizing and uniformly identi-

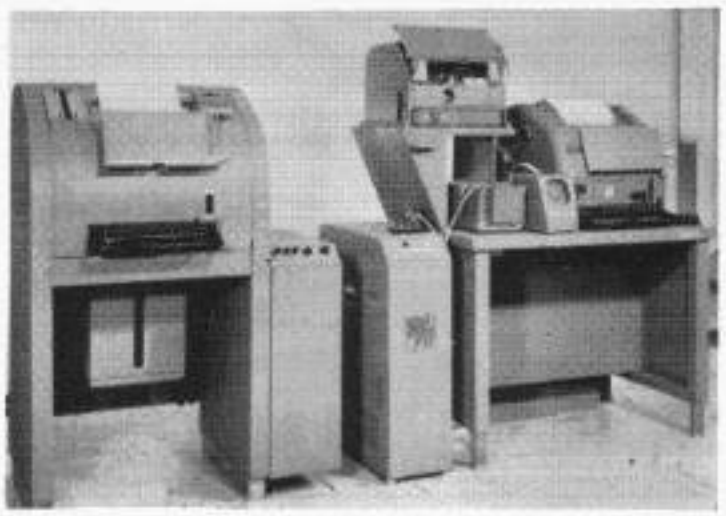


Photo R-10,831

Data System 206 for messages or data employs sprocket or pin-feed multicopy forms.

Photo R-10,482

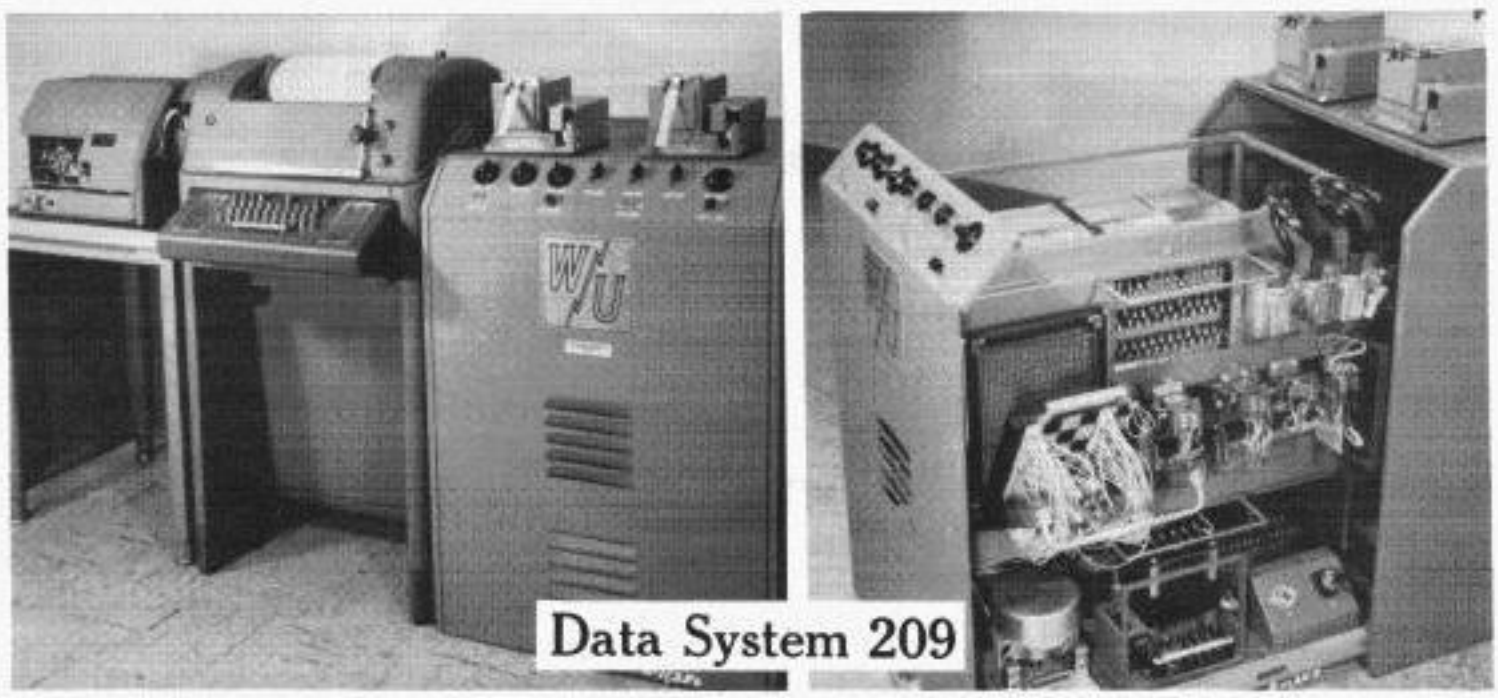
Data System 207 controls processing functions by punched characters; similar system 209 uses program board.

fying over 3,000,000 inventory items, with three objectives: (1) to reflect new procurements; (2) to reflect changing identification data on existing inventory items; and (3) to withdraw items no longer in use. One of the requirements for this communications system which would link stations to a central data processing center is for 7-channel codes without conversion and for error detection in transmission of data prior to electronic computer processing.

The central station equipment consists of a paper tape reader or automatic transmitter, and a punch or perforator, a control unit, and a Type 28 teleprinter equipped with a "stunt box." The outstation or remote station equipment is basically the same except for the design of the control unit. Friden's Commercial Controls readers and punches are used. One of the features of the system is its ability to work on way circuits, which is valuable when remote stations do not have the volume to keep a circuit busy for nearly eight hours daily. When an error in transmission is detected by the receiving equipment, the sending equipment is automatically stopped. Tapes are manually reset to send that section of data over again.

IBM Card Transceivers

Western Union provides circuits operating at 60-, 75-, and 100-word-per-minute speeds for IBM card transceiver operation, with or without alternate teleprinter connections for



Photos R-11,256-7

Data System 209 includes page teleprinter, printer-perforator, and automatic tape transmitters plus a control cabinet to permit positioning of forms to govern the processing functions. Note program plug board in control cabinet at right.

regular traffic or conversations. A new type of communications channel has been developed that will permit the maximum speed of 11 fully-punched 80-column cards per minute on a telegraph channel, or at a speed of approximately 180 bits per second. *(An article describing this operation will appear in a future issue of the Review.)*

Teledata

Friden Teledata equipment combined with a communications channel provides a means for automatic 5-, 6-, 7-, or 8-channel tape transmission and reception. Error detection is incorporated and transmission is automatically stopped when an error is detected in either transmitting or receiving. Installations usually provide for alternate teleprinter operation by means of switches so that both perforated tapes and messages can be exchanged.

★ ★ ★ ★ ★

Though this has been only a brief resume of some of the uses of telegraph equipment and services, it shows that tremendous progress has been made in just a few short years since IDP became of general and wide interest, and that in any application developed for electronics in centralized processing of data, Western Union has a wide variety of equipment and services adaptable to provide truly tailor-made or custom-built nationwide data as well as message communications systems.

A biographical sketch of the author appears in the October 1956 issue of TECHNICAL REVIEW.

Patents Recently Issued to Western Union

Repeater Amplifier

W. D. CANNON

2,838,616—JUNE 10, 1958

A single-ended, transformerless, negative feed-back amplifier for a submerged telegraph repeater which utilizes the series heater circuit for the vacuum tubes, together with any needed supplemental resistance, as the output coupling impedance between the amplifier and the cable, hence reducing the amplifier power requirements which must be furnished from the shore end. Signal-shaping provision is also included.

●

Microwave Lens

C. B. YOUNG, JR.

2,841,793—JUNE 10, 1958

A circular path-length delay antenna lens composed of two stacks of spaced trough-shaped plates symmetrical with respect to a horizontal plane through the center, the plates decreasing in size toward the periphery to form a double convex hyperbolic contour.

●

Facsimile Telegraph System

L. W. FRANKLIN, M. J. REYNOLDS

2,843,660—JULY 15, 1958

A station for the reception of telegrams by facsimile over a regular telephone subscriber's loop. A facsimile recorder, which normally may operate from a radio receiver, is transferred to the telephone loop and the telephone set is disconnected either by the subscriber following telephoned instructions or automatically pursuant to transmission of a facsimile ringing tone from the central office. Transmission of a short interrogatory tone signal from the central office is answered with a buzzer tone go-ahead signal and a longer interrogatory tone signal restores the station to normal.