WESTERN UNION

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From the President's Desk

Congratulations on the 15th anniversary of the Western Union TECHNICAL REVIEW. It is now firmly established as an important source of information on the technical progress of our company.

Revolutionary changes in the telecommunications industry, and Western Union's expansion into such areas as microwave transmission, data communications, Telex, Broadband Switching and private wire voice services have made early dissemination of information about engineering developments essential. TECHNICAL REVIEW has met this need most effectively.

During the past 15 years, the authors of technical articles have shared their knowledge and helped to educate their fellow employees in those areas where they have become expert. The articles appearing in this publication also aid the technical progress of the entire industry by making information available to other communications companies around the world, to engineering schools, military officers, manufacturers of equipment and others, concerning our engineering developments.

It has been said that "Knowledge is power." Western Union is proud of the TECHNICAL REVIEW and its accomplishments in spreading technical knowledge in the telecommunications industry. May it continue to serve as it has these past 15 years.

W. Marshall

Paul J. Howe, Retired—First Chairman of Committee on Technical Publications

Launching the Western Union Technical Review

15 Years Ago

AFTER THIRTEEN YEARS of retirement from Western Union, I accept, with pride, the invitation from the Committee on Technical Publications to reminisce on this, the 15th Anniversary of the Western Union TECHNICAL REVIEW. As I look over each new issue of this publication, I must admit that I am quite overwhelmed by the complexity of the telegraph business that was so familiar to me. For that reason I cannot help but be proud that, in a small way, I had something to do with launching the magazine which now spreads information about the scientific progress of Western Union Telegraph Company. No doubt this quarterly has helped the new employees at Western Union to learn, more easily, of those aspects of the Company's development with which they hope to be concerned. It also has enabled other people, both in and out of the Company's service, to at least understand what "blood," "brains" and "determination" can do for an industry that has served the nation continuously for over 100 years.

It is difficult to reminisce and still remain impersonal. I hope I may be forgiven if I briefly sketch some of the early experiences which taught me that progress in any art is dependent on the availability of complete and precise records of past achievements, and that regular and authentic reports of the present are most important. This is particularly true when the art happens to be as complicated as scientific and engineering development. Believing this to be a fact, many of Western Union personnel, like myself, realized the need for an information service to others in the field of communication.

During the period 1915-1929, it was my responsibility to establish relationship with numerous engineering colleges so that annual visits by representatives of the Western Union Engineering Department, often accompanied by a representative of the Traffic Department, would successfully recruit new graduates for the Company's service. It was also my job to follow up with the planning and carrying out of training courses for those whom we hired, to prepare them for their future roles in the Company. Many of the subsequent leaders in Western Union's technical and business progress, including three of the Company's Vice Presidents, were men whom I led into the service.

In 1944, I had the honor of writing a paper with Vice President F. E. d'Humy entitled "American Telegraphy After 100 Years." This was presented at the St. Louis Convention of the American Institute of Electrical Engineers, in connection with the Telegraph Centennial. In the research and writing of this article and the recruiting of engineers, along with their subsequent training, availability of detailed information regarding the telegraph art was a most important essential.

Some time later, I was asked to compile the technical material for the Western Union "History and Technical Progress, 1935-1945" for the Company's records. This involved the locating and collecting of data regarding practically all projects with which the department had been concerned, the preparation of numerous special papers by the engineers who had participated and, of course, the usual compilation and editing. The final result, in two volumes, was a complete record of practically all the technical phases of the Company's development during that period.

After my appointment as Chairman of the Committee on Technical Publications, I realized that here was just the "setup" for solving the problem of keeping our fund of knowledge up to date. And best of all, I found myself supported by Vice President d'Humy and many others with similar convictions. It did not take long for this committee to obtain authorization to establish a periodical to record and preserve up-to-date reports of scientific developments in Record Communications and to make this information available to those to whom it might be of interest. The "Western Union TECHNICAL REVIEW" was the obvious title. The first issue was published just fifteen years ago, in mimeograph form. The second issue was similar in presentation, and assured us, more than ever, that this publication would really fill our need. The Committee immediately recommended that future issues be printed professionally in a first-class format. It is interesting to note that in all the 15 years there has been little departure from the original format, or method of presentation.

Whatever success this publication has had is, of course, largely due to the guidance of the Committee on Technical Publications and to the support of the Company's top management. Nevertheless, from personal observation, I know there are two other factors which have contributed immeasurably to the success of the Western Union TECHNICAL REVIEW. One, is the loyal support of the many engineers and authors who often toiled hard into the night to make what they knew available to others. The second factor is the diligence of my former secretary, Nell Organ Ramhorst, who was the Committee's Editorial Secretary, until her recent retirement. Her zeal, many talents and good nature did much to insure that the engineer-authors came through, "on time," with "copy" and that the printed issues were always first-class in style and appearance.

In looking back fifteen years and recalling experiences which may have had some influence on the TECHNICAL REVIEW, I have found it a real pleasure to think of Western Union intensively once more. It has been rejuvenating to mentally recall and write for you some of the happenings that made those years now history.

MR. P. J. HOWE, retired from Western Union thirteen years ago, following a previous service of forty-three years with Western Union. He was responsible for the selection of many of the profound engineering talent in the Company today. Many of the engineers whom he introduced to Western Union are in top management positions, two are Vice-Presidents of the organization.

Because of his sincerity to the basic fundamentals of the Telegraph Art and his keen sense of personalities which displayed that talent, he contributed much to the documentation and recording of engineering progress. He has written many articles for the Western Union TECHNICAL REVIEW, which will be remembered by our readers.

While in retirement, he still maintains health and vigor by keeping busy with his home workshop, photography and his other hobbies. More important, his constant interest in his colleagues at Western Union and its progress is the reason he was "called upon" again to write this article.

F. Beaumont Bramhall—Retired

Fifteen Years of "Exploding Technology"

Editorial Note:

MR. F. B. BRAMHALL was Chairman of the Committee on Technical Publications from October 1949 to January 1959 and throughout those years was instrumental in shaping the philosophy of the Western Union TECHNICAL REVIEW. When asked to "look back fifteen years" and sum up his recollections for our 15th Anniversary Issue, he chose as his viewing point 1977. Our readers can well appreciate Mr. Bramhall is not one to "look back."

It is a simple enough task now in 1977 to recite the history of record communication over the past 15 years, and that history is the history of "The Western Union TECHNICAL REVIEW." The difficulty is to make the recitation of interest, because most Review readers remember the real milestones. Back in 1962 the phrase "exploding technology" was frequently heard, and for good reason. Thousands of new workers have just recently entered the field eager to exploit the tenets of "information theory."

Looking back we can now realize that the early '60's marked the beginning of a surge in all communication technology. We'd really just begun to lace the oceans with broadband telephone cables, not quite daring to wait for satellites. Microwave was the medium for the backbone of the trunk network and the first real broadband circular wave guide remained to be built.

1962 was a year of much retrospection, introspection, and prognostication. Lloyd Berkner, then president of the Institute of Radio Engineers, envisioned a communication outpost on the Moon. Still he couldn't confidently have predicted that this year's meeting on Space Communication would be held there. Electronics technology really did explode along with many others, but no longer is electronics confined to communications.

As interesting comparisons, we may look back at some of the facts and figures of 1962. Telegraph and data printing was still by mechanical movement of type. Electrostatic printing was used only in duplicating machines. Relays were still used by the million in so-called machine switching. The first electronic switching office had just been put "on trial." Revolving dials instead of push buttons were the mode of signaling for both telegraph and telephone. Electronic character reading, though ten years old in the laboratory, had not come into common usage. Packaging of electronic gear, with its hangover from "tube" days, left much to be desired in compactness. Instead of 60 channels per cubic foot of space in multiplexing equipment, we had 12 or less. For that matter, the whole idea of expendable subassemblies was still a fond dream. The Bureau of Standards was exultant at a frequency accuracy of 1 part in 10^{11}. Now nothing less than 6 more orders of magnitude deserves comment.

To bring Telex and high speed data systems from the meager beginnings of the early '60's to the present universal networks there have been many brilliant contributions in switching, automation, multiplexing, and transmission. All are well documented in the volumes of the Review. Those records have encouraged and spurred new workers in the field. Those records have prevented duplication of effort, false starts, and maintained the ever widening base on which progress has been made. All of the advances which have contributed to the explosion begun 15 years ago have been largely the result of well disseminated technical information. The Western Union TECHNICAL REVIEW has carried its full share.

July 1, 1977

A. F. Connery, Program Manager, Voice and Voice-Record Services

Introduction to Broadband Switching

WESTERN UNION plans to inaugurate, in early 1963, a switching network of advanced modern design and thus establish a new and unique service in the field of voice-data communications—The Western Union Broadband Switching Service. The performance specifications for the system were prepared by Western Union engineers. A contract for the detailed engineering and the manufacture of the switching equipment and the subscriber handsets has been awarded to Automatic Electric Company of Chicago. The initial plan for seven complete switching centers and a number of concentrator units will provide service to about 17 cities.

The system for this service, designed for optimum dependability and reliability, will be capable of automatically connecting any two subscribers over one of several varieties of transmission channels, according to the subscribers' communicative needs. The characteristics of these channels have been chosen to accommodate the various forms of analog and digital communications most likely to be required by business and industry.

Need for Expanded Facilities

The complexities of modern business life are rapidly exhausting the capabilities of existing communications systems. In many cases, it is no longer necessary for the forwarded intelligence to be printed, read, interpreted, and analyzed by human faculties. In fact, it is almost impossible to obtain efficient and rapid transfer of the increasing volume of information exchanged today by conventional manual handling methods. It is now desirable to have machines reproduce the intelligence as punched holes in paper tape, punched cards, or as signals on magnetic tape; and then, by means of these media, communicate with other machines where it is recorded at speeds much higher than heretofore even thought possible.

The vast increase in the volume of intelligence being communicated has greatly altered circuit requirements in transmission systems. For example, heretofore, teleprinter signals, transmitted over either metallic circuits or telegraph-type carrier circuits, rarely exceed speeds of 100 words per minute, or in the new terminology, 75 bauds (bits per second). One voice band of individual nominal 4kc bandwidth can easily accommodate a number of such channels. Today, however, modern data-processing machines are capable of operating at speeds of 180-, 1200-, 2400 bits per second and higher. These increased transmission rates obviously cannot be accommodated within the same narrow telegraph channels or voice bands as they were in the past. Wider paths must be made more generally available.

These wide communication paths have existed for some time, although they have not been readily available for general use, especially on a "call-up" basis. Ever since the common-carrier communications industry determined, some decades ago, that wide-band trunk facilities were most efficient for handling heavy traffic, main arteries have been designed to carry large "blocks" of communications channels. These large "blocks" are made up of groups of smaller "blocks" assembled and disassembled by one of several practicable channelizing systems. The end result has been a large number of individual voice bands or telegraph channels, as the need may be, operable between particular terminals of the channelizing equipment. Because these individual channels have sufficed until recently, for most communications requirements, the capabilities of existing switching systems for interconnecting subscribers have been restricted primarily to voice-bands or telegraph channels.

Although carrier-derived trunk voice bands are usually the equivalent of four wire circuits, they are ordinarily switched on a two-wire basis, and two-wire loops are provided between the central office and the subscriber's installation. This requires the use of hybrid coils, echo suppressors, and compandors that have an unfavorable effect upon the transmission of analog and digital data. This deficiency of ordinary telephone switching systems prevents full duplex (simultaneous two-way) operation and thereby reduces the effective transmission speed of certain data-handling methods which employ return signals for error-correction purposes.

Data-Handling Requirements

Only recently have the requirements for data-handling indicated a need for increased use of special bandwidth channels, operating on a two-way basis. In general, these types of channels have been available only on a leased, point-to-point basis. It is evident now that channels suitable for high-speed data-handling would be most useful to industry on a switched basis-available when needed. To this end, the system for Western Union's Broadband Switching Service has been designed with the capability of switching transmission channels of nominal 4-, 8-, 16-, and 48 kc bandwidths, all on a four-wire full-duplex or two-way basis. Provision has also been made for switching transmission bands of less than 4 kc bandwidths. Voice coordination will be available on all suitable channels.

New System Switches Several Bandwidths

This new switching system will not only introduce the concept of switching several different bandwidths on demand, but will also have other arrangements especially suited for optimum data-handling efficiency. Existing systems for switching voice-bands, intended primarily for handling speech transmission, lack certain characteristics essential for top quality data handling. For example, sharp clicks and rattles in telephone circuits do little harm to speech reception, however these same noises cause serious errors in data reception. Broadband automatic switching centers or exchanges will not use conventional step-by-step or crossbar circuit switching equipment in the transmission path. Instead, the contact-making devices will be of the "dry-reed" type.

In the dry-reed switch, shown in Fig. 1, the contact material is diffused with

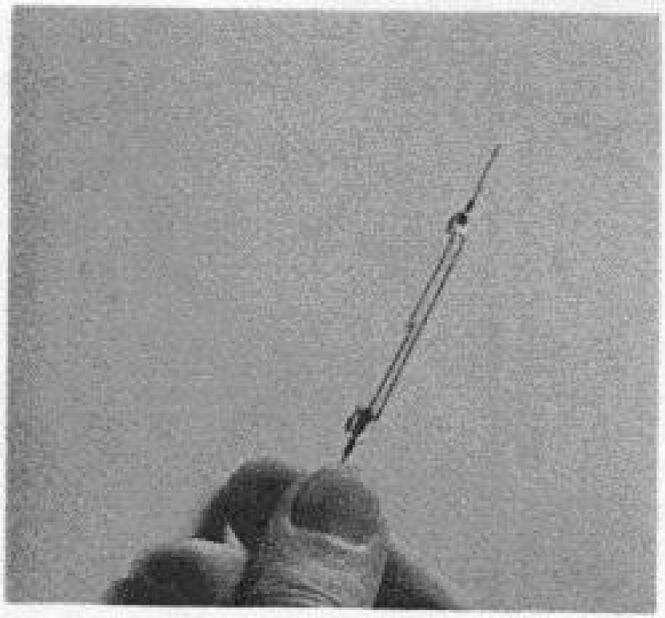

Figure 1. Dry-Reed Switch

gold. Each switch contact is individually enclosed in a hermetically-sealed glass cylinder operated by a small external electromagnet. With such an arrangement the "noise" caused by inductive transients or by vibration of the mechanical part of the switches is minimized; contact failure due to dust or changes in atmospheric conditions is virtually eliminated. Furthermore, in the wiring of the switches and auxiliaries, particular emphasis has been placed upon eliminating the cross-talk, and those distortion elements detrimental to data signals. These switching centers have also been designed to provide a higher than normal ratio of switching equipment-to-lines, in order to minimize the possibility of "busy" conditions due to equipment congestion.

Four-Wire System

Because the ear is insensitive to phase distortion, speech systems are practicable over circuits with phase delay differences that ordinarily cause serious difficulties in data transmission. The new system will be equipped with equalizers to correct the delay distortions to the degree necessary for the data service to be performed. In addition, the system from end-to-end will be so-called "four-wire" or "two-path" system. This requires "four-wire" exchanges throughout which is uncommon in a system designed for voice.

The advantages of a four-wire system are: 1) all echo and singing distortions disappear, 2) the quality of the data and voice signals is greatly improved, 3) because of having entirely separate paths in the two directions, the return path may be used for a parity check, or for synchronization of data or computer equipment, and 4) if the user so elects, the system will permit simultaneous transmission of data in two directions. The four-wire system that Western Union is installing has been referred to by engineers as a "Transmission Engineers Dream."

Transmission Over Microwave Radio

Most of the long distance transmission paths in this voice-data system will be over the Western Union's new microwave radio system. In this microwave system there are two separate radio paths, of different frequencies, assigned to each transmission direction. The transmitted signal is sent simultaneously over both paths. Electrical combiners join the signals from the two paths together at the terminals and thus minimize the harmful effect of frequency-selective fading, common to all radio beam systems. Current practice on radio beam systems, designed to carry voice circuits primarily, is to assign a relatively small percentage of spare equipment for protection against fading. Fast-acting electromagnet relays switch a fading channel over to the spare channel for the period of the fade. This method of compensating for fading, while adequate for voice communication, is quite impractical for accurate data transmission because many bits of data intelligence may be lost during the changeover interval of the relay.

It is recognized that not all communications will need exceptionally high-speed transmission capabilities. The Broadband Switching System has, therefore, been designed to accommodate services whose needs are less demanding. Also, the users of very high-speed data devices may utilize the lower speed facilities if they are equipped to do so. Thus, the choice of the circuit requirements remains under the control of the subscriber, and may be changed from one call to the next.

The Western Union Broadband Switching System will have the capability to accept communications having a wide variety of characteristics and will carry them to any desired terminus. It will be possible to interconnect, on a direct "call-up" toll basis, any compatible type of communications or data handling equipment, with voice-coordination service available.

For example, the system will be capable of handling the following forms of analog and digital data communication.

(a) Voice
(b) Voice, as coordination for data transmission.
(c) Analog data, such as facsimile, at both low speed and high speed.
(d) Digital data, such as contained in punched tape, punched cards or as signals from magnet tape or electronic storage devices.

Fig. 2 shows three Broadband Switching Centers with various types of subscriber equipments.

More Economical Use of Computers

Some firms might require the use of a very complex and expensive computer for only ten or fifteen minutes a day. The Western Union Broadband System will make it possible to use a computer at a remote point when it is needed. The same computer or computers could serve many companies. These computers could be located at strategic points in the United States and connected into the Western Union Broadband System. A processing plant such as a refinery might have a routine problem in connection with running the plant, which require an immediate solution. Through the Broadband Switching System the nearest suitable computer, at Point A, could be called into service. If this computer was unavailable, then computer B, located at a greater distance, away would be selected. If this also should prove to be occupied

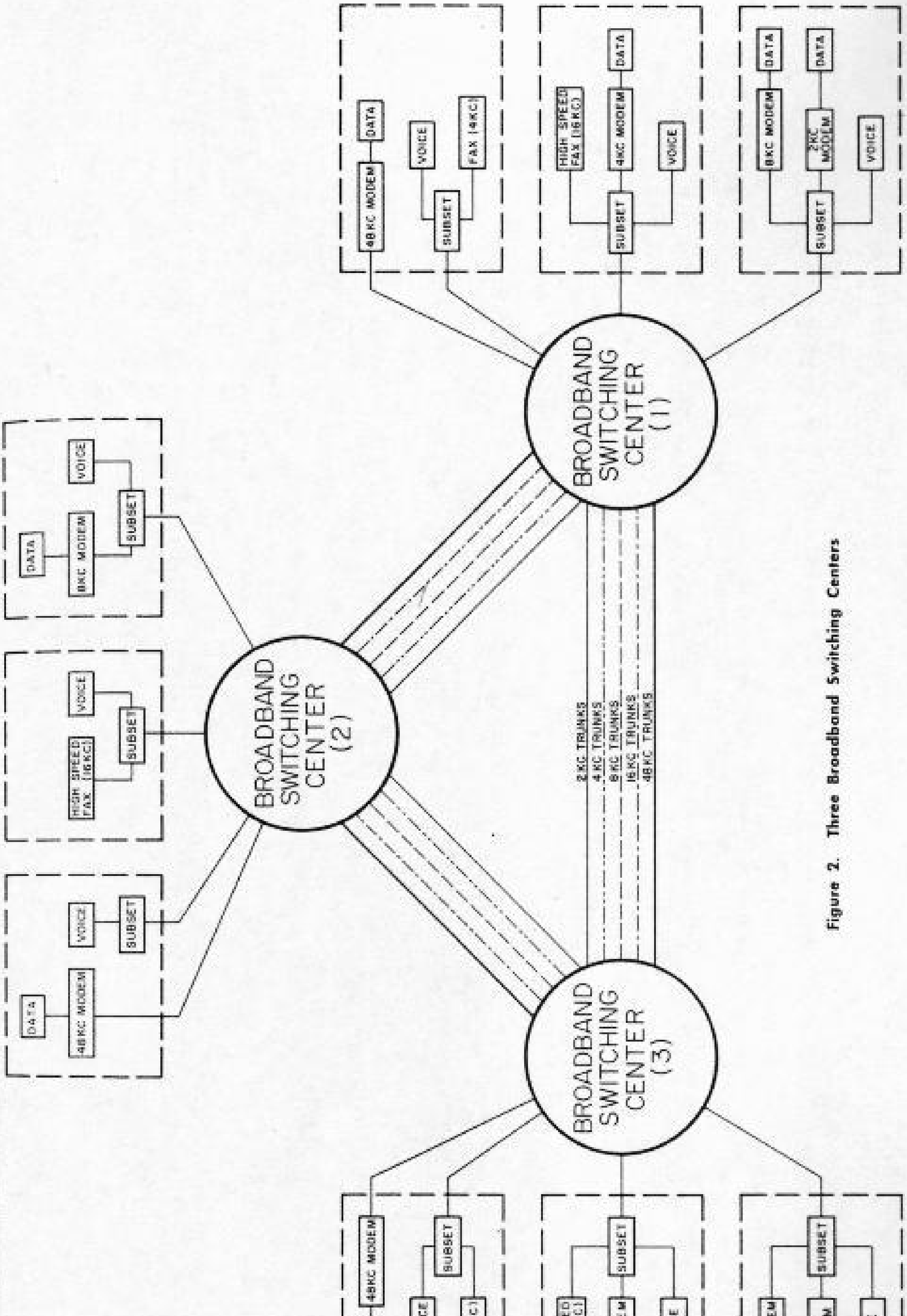

Figure 2. Three Broadband Switching Centers

then computer C would be called. With a comprehensive setup of this nature the problem of "real-time" access to computers on an economical basis could be solved. However there would be an input storage device, such as a magnetic tape, used for the very brief storage of input data. This would permit the computer to perform other tasks while waiting for a reasonable amount of data to accumulate from the 48 kc circuit.

As mentioned above, business machines and data equipment of many varieties may be interconnected over the Broadband Switching System for the exchange of information. It is necessary, however, that a device be associated with the digital machines to convert their output signals into a form best suited for transmission over the communications facility. These devices are frequently referred to as "Modems," an abbreviation for Modulator-Demodulator. Modems can simultaneously perform both transmitting and receiving functions on duplex facilities.

W.U. Modems

Western Union is developing a family of such modems. These compact units have been designed to complement contemporary office furnishings. The particular type or types to be used will be determined only after a careful analysis of the subscribers' requirements based on coordination of cost, data volume and available transmission time.

Voice-Data Handset

Each subscriber will be provided with a basic instrument embodying the most advanced concepts in Data/Voice control. This unit, shown in Fig. 3, is unique and modern in appearance. The older method of dialing has been replaced by a ten-pushbutton array that will transmit the address or number of the "called" party to the switching center by means of multifrequency tone combinations. This method of addressing will save time and labor for the user as well as reduce the possibility of obtaining a wrong number. Although the instrument provides for voice communication, it also contains the switching arrangement to enable the subscriber to change his mode of operation. Switching to the data mode is accomplished automatically when the handset is rested in a special data position provided for the purpose. The mode of operation is indicated by visual signals.

Figure 3. Voice-Data Hand Set

In the "voice" mode, the instrument functions as a four-wire, high-quality, voice set. When the handset is placed in the "data" mode position, the data equipment is automatically connected to the transmission channel. When the handsets at both the sending and receiving terminals are in the data position, data transmission may commence. As a safeguard in data transmission, a pushbutton is provided on each subscriber set to signal the distance end if further voice coordination between the terminals is desired. This feature will minimize operational delays and improve operating efficiency by allowing a request for voice coordination to be initiated at either end when operating irregularities or unforeseen conditions make it necessary.

When it is desired to initiate a call, the handset is picked up and the subscriber listens for the dial-tone. After hearing dial-tone, he pushes the digit buttons in proper order to obtain a typical voice-data number, such as listed in the directory, for example 437-3-589. In this seven-digit number the first three digits indicate the distant exchange; there may be several exchanges in a large city. The fourth or middle digit indicates the bandwidth desired for this call. The remaining three digits designate the particular subscriber in the distant city. Particular subscribers may contact each other by use of abbreviated 3-digit address codes instead of the standard 7 digits. The called subscriber will be alerted to an incoming call not by a ringing bell, but by a distinctive tone signal. An indication will be returned to the calling party that the called subscriber is receiving this signal. The party at the distant end will answer in the same manner as he would on a conventional telephone. The calling party might say "I have a fax message for you." The data device, in this instance, could be a Western Union facsimile transmitter-receiver. The called party would turn on his facsimile device and then tell the calling party to proceed. Both parties would place the handsets in the data position and the calling party starts his transmission. Upon completion of the transmission each party may signal a return to the voice mode, whereupon the receipt of the message could be verbally acknowledged through the handset.

The billing for this data-voice service will be based upon the bandwidth called up for each connection and distance. The charges per call will be determined from detailed information automatically recorded for each completed connection. This information will include the following:

a. Calling number.
b. Called number.
c. Time and date of connection.
d. Time and date of termination.
e. Bandwidth of service requested.
f. Special rate data (Day/Night/Weekend/etc.).

Computers will process this information and subsequently prepare the subscribers' monthly statements.

Western Union believes that when the Broadband Switching Service becomes available to business firms, its superiority over other available transmission services will be quickly recognized. The capability for fast and accurate transmission of data, on a "call-up" toll basis, will provide a new service commensurate with the expansion and progress of American business.

Mr. A. F. Connery, Director and Program Manager of the Voice and Voice-Record Services, received his technical education at Pratt Institute and Brooklyn Polytechnic Institute.

Prior to the merger of Western Union and Postal Telegraph Companies, he was Chief Engineer at Postal. During his previous employment with the Great North Western Telegraph Company of Canada, International Telephone and Telegraph Company, and Postal Telegraph-Cable Company, he made many technical contributions to the communications art. These include design and re-design of regenerative repeaters, ocean cable printing equipment, semi-automatic telegraph switching systems, and the development of techniques for neutralizing electrical charges on paper.

Mr. Connery holds a Professional Engineer's license in the State of New York and is a life member of the American Institute of Electrical Engineers. He has several patents issued in his name.

W. R. Francis and J. A. Hunt, Planning Department

Use of the Computer in Routing Messages

ROUTING is a major problem of the public message telegraph service and is also a dominant factor in the determination of the transmission network.

The routing problem does not exist to the same degree in telephone systems, TWX, Telex, or private leased wire telegraph systems. In these services, messages usually are addressed only to a limited number of destination stations,—the sender (calling customer) is expected to provide identification of the destination station by consulting a published directory. In the public message telegraph service, as in the postal service, we undertake to deliver messages having any reasonable form of address. Any change in our procedure which depends upon the sender's ability to furnish specific addresses which would incorporate a prerouting feature would fundamentally alter the nature of the service and limit its usefulness.

Intra-City versus Inter-City Routing

There are two aspects of our routing problem; the routing necessary for a message to reach the destination city, and the routing needed for delivery within the destination city. Although the former is relatively simple, it presents minor difficulties when routing to small communities which are not well known. Routing within the small destination city is not difficult (effort to locate an addressee because of inadequate address is not considered "routing" in this discussion) but in large cities it is a major problem. It is principally that aspect of routing which causes the overall question of message routing to be a controlling element in determining the nature of the public message transmission system.

Before discussing the major problem in more detail, let us dispose of the lesser problem of intercity routing. This matter was greatly simplified, when the reperforator switching system was installed, by the introduction of "block state routing." Under this concept, substantially all destinations in each state were relayed by one reperforator office. Thus, the trunk routing information that is needed for domestic messages is limited to one route for each state, with some exceptions, plus the routing for destinations included in one reperforator office area. Most of it is remembered by experienced personnel and reference to written information is relatively infrequent. The routing instructions in written form are not bulky and can be consulted easily when necessary.

Even without "block state routing" it would be feasible to preroute each message to its destination city. All destinations are listed in the tariff book and it would be a simple matter to print a routing indicator for each destination in the tariff book or in any other record of comparable size. Further discussion of the advantages and disadvantages of applying routing indicators at the origin, which make it possible that messages reach the destination city automatically, is beyond the scope of this paper.

The routing information needed, in a large city to direct messages to the point where delivery takes place, must be considerably detailed. In the largest cities, the complete routing information usually cannot be displayed in a form that permits ready reference. In New York, for example, there are 141 branch offices, 2900 teleprinter tielines, 3600 Desk Fax tielines and approximately 130 other tielines. Most of the branches and tielines are connected to the central office at 60 Hudson Street and the remainder are connected to the CD office at 26 Broadway. There are more than 4000 streets, many of which are served by more than one branch office. There are many named buildings, hotels, piers, hospitals, and other similar identifications that are used as addresses. In addition, there are more than 20,000 non-tieline customers who sometimes receive messages with no street identification.

The same conditions prevail in a lesser degree in Chicago, Los Angeles, Philadelphia, Detroit, Baltimore, Houston, Cleveland, Washington, St. Louis and other large cities. If the necessary routing information for all of these cities were combined and made available at all originating offices, manual "lookup" for prerouting would be a tedious and time consuming task at best.

Computer Techniques Applied to Routing

The use of electronic devices to store routing information and apply it automatically to incoming messages has been considered for many years, but, until recently, available equipment was too cumbersome to provide a useful system. In the past few years great advances in computer design have made possible increased speed, versatility, and accessibility of stored information. About a year and a half ago, a new study was undertaken at Western Union to determine whether or not computer techniques could now be used in message routing to reduce cost and improve service.

Our investigations thus far indicate that we probably can program a computer to route successfully a large percentage of messages and that questions of speed, accessibility of stored information, program capacity, and computer cost probably also can be resolved satisfactorily. A more detailed study is needed before firm conclusions can be reached as to overall economics. In particular further investigation of the problem of interconnecting low speed telegraph circuits with a high speed computer at a reasonable cost will be necessary.

The basis of our approach has been one using a commercially available, medium-size, stored-program, general-purpose computer with random access disk file storage. By starting with an already designed general-purpose computer we can develop a program that will fit into an already known set of specific capabilities. It probably would take considerably longer to determine whether computer routing is feasible if we were to consider a whole range of possible computer capabilities rather than to assume one set of available capabilities.

By using a commercially available computer we avoid design costs and furthermore we may use it for other computer work as well as for message routing.

Message Format

Data to be processed by a computer usually are organized in a rigid format so that the computer can be instructed precisely as to where to find any desired portion of the information. In this application, we have resisted all suggestions that the message form be any more rigid than at present. We also have avoided any requirement that the various parts of a message, such as addressee's name, street address, or destination, be identified by special indicators.

We recognize that it would be much easier to program the computer if each message part could be found in a precise location on the message form or was distinctively labeled, and that computer time could be used more efficiently in such circumstances. However, we believe that any program which depends upon rigid organization of the component parts of the message for successful operation would create more problems than it would solve in practical application. Addresses are supplied by customers. In many cases they are sent directly from customers into our transmission network. Customers are not likely to observe consistently any artificial requirements which we might prescribe. Nor is it likely that our own operators will consistently rearrange addresses supplied by customers into a rigid format without a continual and expensive check of their work.

We have set as our goal a computer program that will route any message that is addressed in the form commonly used for letters. Such a program will accommodate our standard message form and normal variations of it encountered in usual practice. Rather than have people accommodate the computer, we propose to use the high speed capability of the computer to avoid requirements for additional manual preparation. The computer will search, at very high speed, for the message parts until it finds them or concludes that it cannot find them.

Verifying Destination

One feature that we usually can depend upon in the message form is carriage returns and line feeds (CR-LF) (or equals signs in messages sent on tape printers by our operators—which are converted to CR-LF in tape to page translation). The "name-to" and "street address" usually are preceded by CR-LF and the "destination" usually is followed by CR-LF. Ordinarily these features are found whether the message is in our standard message form or whether a customer merely addresses a message as he would a letter.

In routing a message, the first thing we check is the destination. The message may be a misroute, or it may be addressed to a suburb rather than to the central city itself. With our standard message form, as received on page printers, the destination usually appears just before the 4th CR-LF. It may appear just before the 5th or 6th CR-LF, however, if either the "top-line" or address is unusually long or if false CR-LF has occurred. In RQ's, BQ's, service messages, and similar types of messages, the destination may be at the end of the 2nd or 3rd line.

A fundamental difference between human routing and computer routing is that a person can pick out the destination, almost at a glance, regardless of its location on the form and regardless of what the destination may be. However, the computer can look at only one word at a time, compare it only with a prearranged list, and then, if no match is found, try other words in succession. It makes these successive comparisons at very high speed.

The computer will be programmed to establish the locations of the CR-LF's in the message heading. Following this, the message heading will be analyzed according to the block diagram in Figure 1.

If the message heading contains at least four lines, a search will be made for a destination. Our studies have established that messages containing less than four lines are usually "Bust This," "RQ" or other types of administrative traffic. Messages containing less than four lines will be processed in a special "routing," which we call the "Short Message" routing. It will be discussed in a subsequent paragraph.

The search for the destination will begin with the word preceding the fourth CR-LF. The computer will determine the length of the word and compare it with the appropriate word or words in Table I. As a result of this comparison and when the same word is found, the next step will be determined by the information stored in the computer with each destination. If the word is not found, the process will be repeated with other words in the following order; (1) end of 5th line, (2) end of 3rd line, (3) end of 2nd line, (4) the remaining words on the fourth line, (5) end of 6th line, (6) end of 7th line.

When a valid destination is found, a reference point is established which facilitates additional processing. A message which does not contain a valid destination will be processed further to determine if it is some type of administrative message to which special "routines" will be applied.

Street Address

The search for the street address will begin when it has been determined that a valid destination has been found. In general, the end of the street address will be identified by finding the word ST, or STREET, AVE, AVENUE, etc., although there are a number of other words that can serve the same purpose. We refer to such words as "street indicators."

The computer will count the characters in the word immediately to the left of the destination. The word will then be compared to the appropriate subgroup listed in Table II by means of a standard table lookup operation. Table II will contain all known street indicators and their accepted variations, arranged in subgroups according to their number of characters.

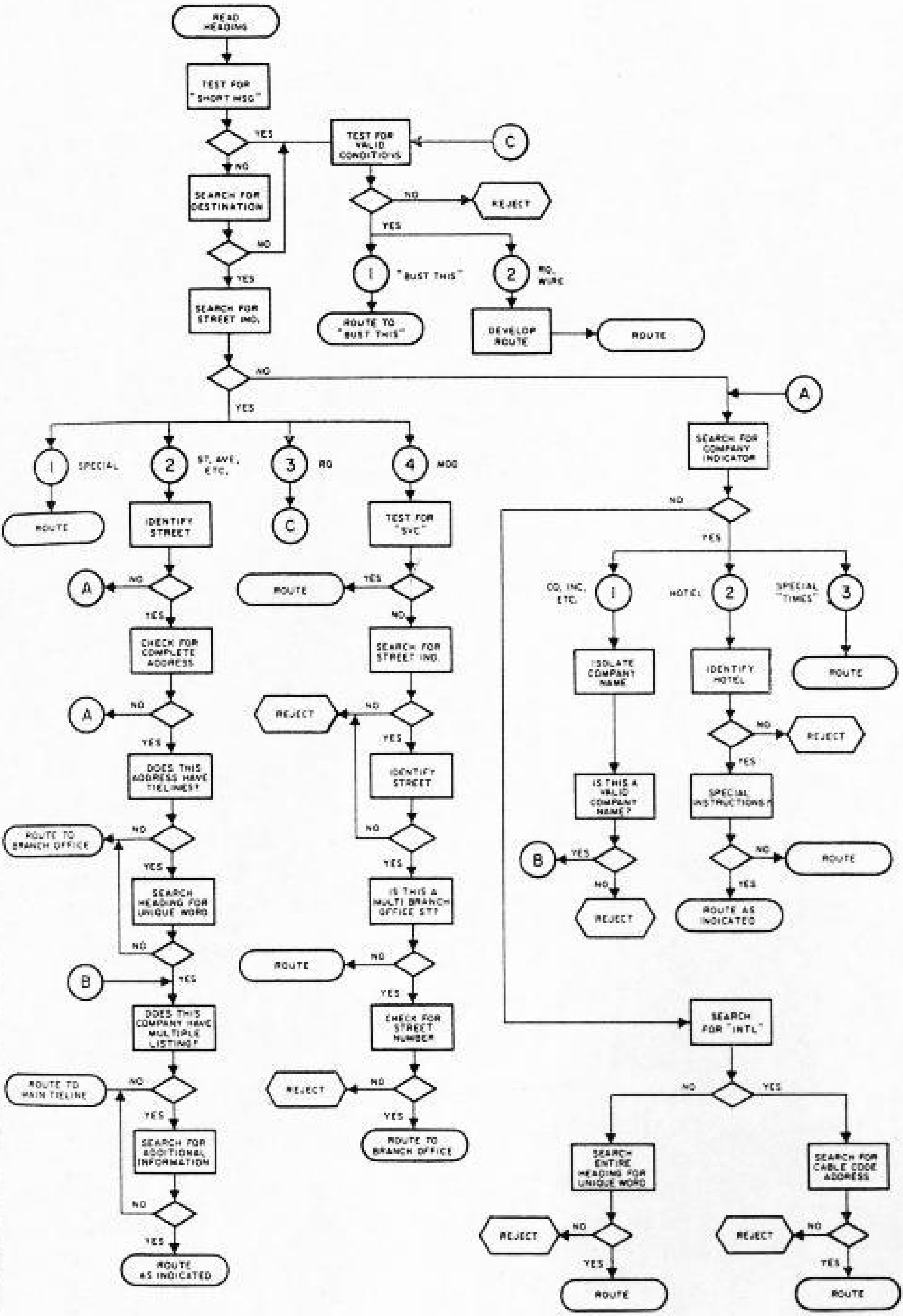

Figure 1. General Diagram Of Routing Procedure

TABLE I

VALID DESTINATION INDICATORS

Group I	Group II
NYK	BRONX
NEW YORK CITY	MASPETH
BROOKLYN	FOREST HILLS
BKLYN	RIVERDALE
BROOKLY	MOD
	D AND A
	NEW YORK
	NY

NOTE:

The indicators in Group I are valid alone or followed by New York or an acceptable variation of New York.

The indicators in Group II are valid only when followed by New York or an acceptable variation of New York.

In the "table lookup" operation the computer quickly searches a table to find the word and specific information associated with it. For example, comparison of a word in the address of a message with the four letter subgroup of Table II, may be accomplished within 1 millisecond, even if it is necessary to search the entire contents of the table.

If no match is found, the next word to the left will be processed. This will continue until a maximum of ten words have been checked for a street indicator. An unsuccessful search for a street indicator will take about .02 second. The computer will then search for a company name.

The four major classifications of street indicators are: special; regular; RQ type; MOD. They are processed as follows:

Special—Messages containing this type of indicator are: PLANT NYK; CASHIER NYK; etc. When the words "Plant," "Cashier," etc. are encountered in a significant number of messages, they will be added to the Table II of street indicators, with appropriate routing codes. When the computer recognizes one of these words during its search for a street indicator, the message will be routed to the proper location.

Regular—When a regular street indicator (ST, DR, etc.) has been recognized, the word to the left of it is usually the street name. The computer will compare that word with a list of street names. If a valid street name is found, the search will continue to the left for a house number. A disk file storage address will be

TABLE II

PARTIAL LISTING OF STREET INDICATORS

(GROUPED BY NO. OF CHARACTERS)

2	3	4	5	9
BQ	AVE	ARCH	ALLEY	BOULEVARD
CT	HWY	BDWY	BEACH	CONCOURSE
DR	INN	BLVD	COURT	ESPLANADE
PL	MOD	BUSH	DRIVE	LAFAYETTE
RD	ROW	BWAY	FIELD	
RQ	SVC	CAMP	GREEN	
SQ		EAST	HOUSE	
ST		HALL	MANOR	
		HILL	NORTH	
		MEWS	PLACE	
		NECK	PLANT	
		OVAL	PLAZA	
		PARK	SOUTH	
		PKWY	TRAIL	
		ROAD	UNION	
		SLIP		
		WALK		
		WEST		
		WIRE		
		WOOD		

developed from this information and the record for the street address will be extracted from the file. The file record will be coded to indicate whether or not a tie line exists at the specific street address. If a tie line does exist, the message heading will be searched for a unique word in the company name. The message will be routed to the tie line if all conditions are satisfied; if not, it will be routed to the branch office serving that street address.

The foregoing procedure will be modified depending upon the type of regular street indicator found. For example: AVE requires that the search for the avenue name be made to the left and right of the indicator, as in LEXINGTON AVENUE or AVENUE OF THE AMERICAS; BROADWAY is a street indicator which requires only a house number as additional information; a numeric street name, e.g. 112 ST., requires a search for EAST or WEST before searching for a house number.

RQ Type—When the computer recognizes the indicators, RQ, WIRE, etc., a switch will be set in the program and the program will branch to a routine where a routing code for the message will be developed.

MOD—Money order messages are unique in that the name and address of the person to whom the message is being sent always occurs after the destination. When the computer recognizes this indicator, it will begin searching for a street address at the last word of the seventh line and work back to the destination. If a street address is found, it will be routed to the appropriate branch office, if not, it will be sent to a manual switching position.

Short Message Routine

In the "Short Message" routine, the last two words of the heading will be checked for BUST THIS, if an "end of message" indicator has been found. Upon recognizing BUST THIS, the message will be routed to a terminating teleprinter position. The second line of the remaining messages will be searched for: RQ, BQ, SVC, WIRE unless one of these indicators had not already been found during the search for a street indicator. A routing code will be developed from the word following the indicator if one is found. The remaining messages will be sent to a manual switching position.

Company Name

If no street address is found, a search will be made for a company indicator. The general approach to identifying the end of the company name is to look for such words as CO, CORP, INC, BROS, etc., but again there are other words that serve the same purpose. The search will begin with the word immediately to the left of the destination. The computer will count the characters in the word, and then compare the word with the appropriate subgroup of Table III. This search will continue to the left until ten words have been processed.

When a valid company indicator has been recognized and the end of the company name presumably has been found, the beginning of the company name will be sought. This will be done by search-

TABLE III

PARTIAL LISTING OF COMPANY INDICATORS

(GROUPED BY NO. OF CHARACTERS)

2	3	4		12
CO	BRS	ARMY	....	LABORATORIES
RR	CTR	BLDG		PUBLICATIONS
RY	INC	CLUB		
	IND	CORP		
	LTD	HOSP		
	SON	INST		
		LABS		
		LINE		
		SONS		

ing to the left of the company indicator for: CR, CARE, DIVISION, or DEPARTMENT. When the company name has been isolated, the following items will be eliminated, THE, AND, &, OF, and all punctuation marks and spaces. The remaining characters will be mathematically manipulated to produce a disk-file storage address of a record pertaining to the company.

The record will be coded to indicate whether or not additional information is required. This is necessary because some companies have more than one tie line, some want messages addressd to certain individuals delivered through the branch office, and other reasons.

A message, with no street address, which is destined for a hotel, will be handled in the following manner. When the word HOTEL is recognized during the search for a company indicator, the computer will check the word to the left of HOTEL against a list of the most important hotels. If a valid comparison is not made, the word to the right of HOTEL will be checked against the same list. If a valid comparison is not made with this word, a series of records containing the names of the minor hotels will be extracted from the disk file. The words previously tested will be checked against this list. When a valid comparison is made, the computer will interpret the routing code and route accordingly. If a valid hotel name is not found, the message will be sent to a manual switching position.

International Messages

If no street indicator or company indicator is found in the message, the second line of the message will be searched for the indicator INTL. The presence of this word would indicate that possibly the message may contain a registered cable code address. The word immediately to the left of the destination would be checked against a list of all registered cable code addresses in the city. If the word is found in the list, the message will be routed to the proper location, if not, the message will be directed to a manual position.

If the indicator INTL is not found, the message will be subjected to one more routine before it is routed to a manual switching position. This last routine is designed to route messages of the following type:

BC076
B BVA009 PD HAMILTON MASS
31 1021 A EST IBM NYK

In order to route this type of message, it will be necessary to keep a list of companies receiving a substantial amount of traffic addressed in this form. The table will be kept to a minimum size because of space and timing restrictions. Every word in the message heading would be checked against this list as a final resort.

Collect Messages

After the routing code has been determined, all tie line messages will be checked to determine if they are COLLECT messages. Following this check, the message will be transmitted to the tie line, and will be simultaneously monitored at a special position to produce a hard copy for accounting purposes.

The output from the computer will consist of only a routing code because the message will have been stored in its entirety outside of the computer while the processing was taking place. When the computer has completed the processing, it will transmit the 4-7 digit routing code to an automatic switching system. The first four digits will be used to establish a connection through the switching equipment. The other three digits, if they are present, will be transmitted ahead of the original message. These routing characters will obviate additional manual lookups for messages destined for facsimile tie lines.

Conclusions

It is estimated that the logical operations that have been developed would enable the computer to route successfully 90% of the New York load at an average rate of one message per second. Most of the messages that the computer is unable to process are not necessarily difficult to route manually. They usually contain errors that are obvious to human beings, but because of computer limitations, routines cannot be developed to handle them.

A general-purpose computer is most satisfactory for this application, because the use of such a computer would enable us to utilize the spare computer time for non-telegraph operations. The selection of computer capacity is dictated, in part, by the magnitude of the peak hour loads. Hence, during non-peak load periods the computer system will have time available to process secondary applications which have less urgency. In order to insure continuity of service, it will be necessary to have a complete fallback computer system. It is assumed that the secondary computer system would be available for non-telegraph operations for at least a standard eight hour shift per day. Preliminary studies indicate that we may be able to utilize this secondary computer system in conjunction with our new Broadband Switching Service to provide computer service to small business firms that have only a periodic need for data processing equipment.

In order to conduct a simulated test of this method of routing, a computer program is being written based upon a city that is smaller than New York, but having a routing problem similar to the problem in New York. Studies are also being conducted into the methods of interconnecting telegraph circuits to a high speed computer. It is estimated that it will require several more years of study before all remaining problems will be solved.

The successful development of this concept of message handling would be a major improvement in the art of telegraphy. It would offer the possibility of truly automatic service with no delays for manual routing at the origin, intermediate switching points or destination, except in isolated cases.

MR. W. R. FRANCIS, Director—Planning—Operations, has been involved in the introduction of various new methods, including teleprinter tie lines, facsimile tie lines, varioplex, direct connected tie lines, Plan 34, revised speed of service standards, "burster printers," Telex, and broadband switching.

Mr. Francis started working for Western Union as a messenger in 1919 at Brockton, Mass. Subsequently he worked in the Commercial Department as clerk, Morse operator and branch manager. After taking an electrical engineering course at MIT, and receiving BS and MS degrees, he came to the Traffic Department in New York in 1926 as an Engineering Apprentice.

He has held staff positions in the Metropolitan Division and headquarters offices of the Traffic and Operating Departments and served as Chief Operator at Newark, N. J. From 1951 to 1955 he was General Operations Engineer and from 1955 to 1957 General Planning Supervisor in the Operating Department. Since 1957 he has been Director—Planning—Operations in the Planning Department.

MR. J. A. HUNT, Assistant Planning Engineer, has been a member of the Operations section of the Planning Department since 1957. He has been involved in the overall planning of various systems improvement programs, including Telex and broadband switching.

Mr. Hunt, a native of Pennsylvania, attended the University of Mississippi under the NROTC program. He received a BS degree in 1952 in Engineering Administration in the industrial engineering course. Upon graduation, he entered the U. S. Navy where he served for three years as an engineering officer aboard the USS Cambria (APA 36).

Following his release from the service, he joined Western Union in the Systems Planning section of the D&R Department where he was involved in statistical research and a study of switching and other system developments.

R. L. Lowe, Project Engineer, Transmission Systems Division

A Frequency-Shift Data Set For Voice Coordinated Asynchronous Transmission Up To 1200 Bauds

THIS PAPER describes a frequency-shift data transceiver capable of transmitting serial binary data over normal voice-frequency bands at speeds up to 1200 bauds. The set is capable of alternate voice operation and contains variable networks which afford a simple, exact means of compensating for phase and amplitude distortion encountered in transmission media. Part of the description deals with the operating features of the subset as used on a point-to-point basis between customer offices.

Introduction

In the general field of voice frequency data communication systems there has developed a need for high speed, voice coordinated carrier transceivers suitable for installation on the customer's premises and capable of reliable operation over ordinary voice-frequency bands. The basic design of the subset has been derived from past experience in the development and operation of a complete family of frequency-shift transceivers, ranging in operating speeds from telegraph to 2400 bauds. The packaging is unique, however, in that it is designed specifically for a customer's location and not for central office installation. This is reflected not only in the general physical appearance of the unit but also in concepts which provide for simplifications in installation, maintenance and testing procedures. The general intent was to provide a package which would conform with modern office equipment design and, at the same time, offer operation at optimum error rates with a minimum of maintenance.

Design History

In designing any commercial carrier transceiver one of the first decisions made must be one designating the type of modulation scheme to be utilized. The two most important criteria to be considered are transmission media and economics. The scheme chosen must not "crowd" the band limits of the expected transmission media and should also be able to cope with the deterring parameters of these media. Since the design does represent a commercial venture, relatively unsophisticated methods should be employed wherever possible.

At speeds in the order of 1200 bauds, double side-band modulation may be used since the total bandwidth required is well within that of a typical voice band. The major source of errors in sending data signals over voice bands is interference due to spurious noise bursts. Frequency and phase modulation schemes are superior to amplitude modulation techniques in their ability to operate through such interference. For this particular application, the relatively simple techniques employed in frequency modulation and the vast backlog of experience in that area led to its choice as the modulation scheme.

Past experience in the design of frequency-shift devices has shown that high modulation frequency to carrier ratios result in excessive distortion. For this reason the modulation-demodulation processes are accomplished at a high frequency, with product modulators in both transmitter and receiver operating from a common oscillator, translating the signal to the line carrier frequency. The total back-to-back distortion figure is approximately 5 percent.

This conference paper was presented at the summer General Meeting of the A.I.E.E. in Denver, Colorado on June 17-22, 1962.

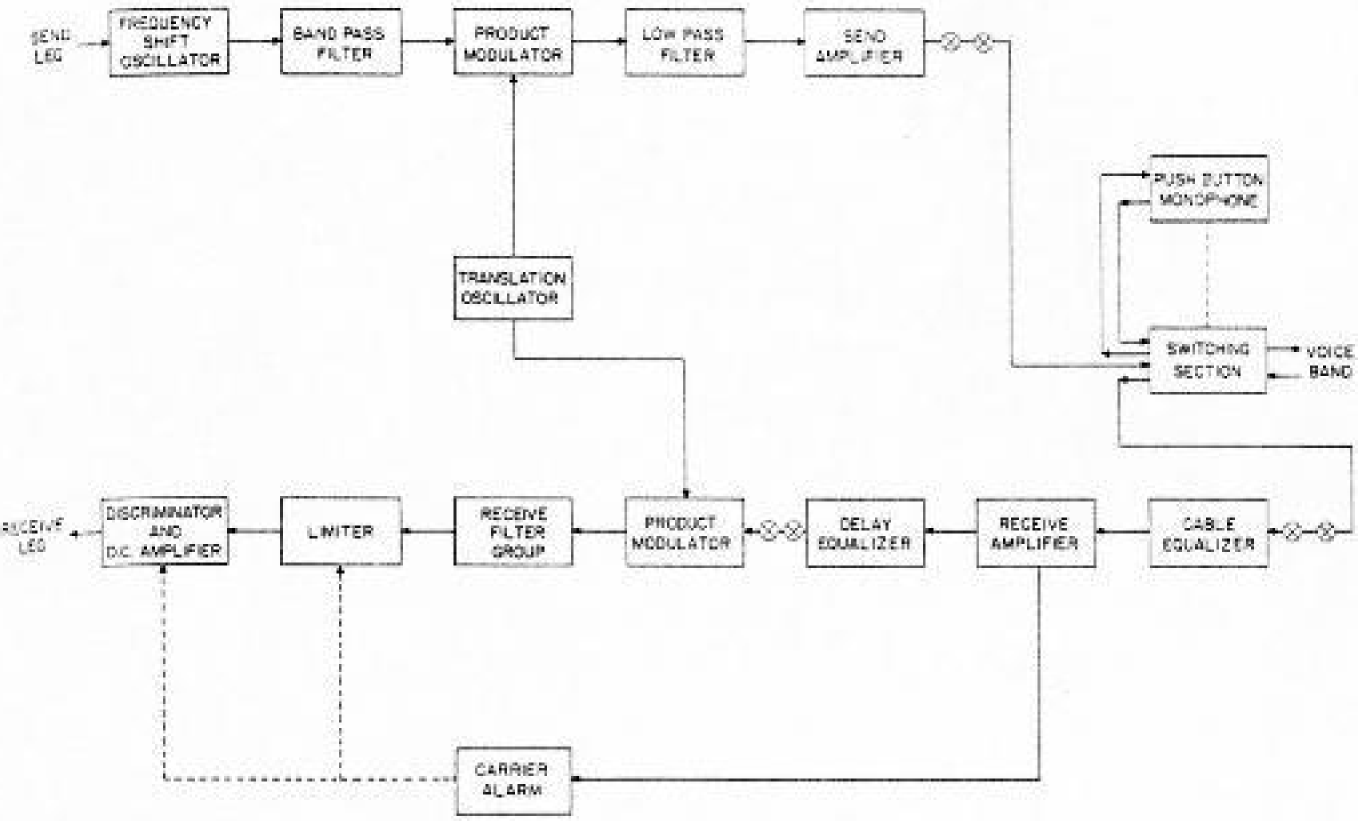

Figure 1. Block Diagram of Transceiver

Although the spectrum of frequencies necessary for transmission is well within the limitations of normal voice bands, there are line factors encountered which can cause distortion in the received signal. The factors are envelope delay and amplitude distortion of the band in question. To compensate for these distortions a variable active delay equalizer and a variable passive cable (amplitude) equalizer are provided. These equalizers will compensate the line characteristics so that little or no distortion will result from delay or amplitude response of the facility. The total distortion over a typical circuit, for causes other than noise hits or temporary line opens, will not exceed 10 percent.

Transceiver Description

The transceiver is comprised of five major functional sections. These sections and their functions are:

Transmitter — convert digital data to carrier signals

Receiver — condition line, provide carrier alarm and convert carrier signals to digital data

Switching — provide means for switching mode of operation (voice/data) and proper control voltages for the associated data terminal

Push Button Monophone — provide means for voice operation and initiation of switching operations

Interface — provide path for all interconnections between the transceiver and the data terminal

Transmitter—Binary data signals enter the transmitter section on the send leg as shown in Figure 1. Depending on the polarity of the signal voltage, either an inductor or a capacitor is coupled into the tank circuit of the Frequency-Shift Oscillator. This coupling is accomplished by means of two diode bridges and a dual primary transformer in parallel with the oscillator tank circuit. A positive (spacing) signal causes one of the bridges to couple in the inductor and the other bridge to isolate the capacitor. The result is an increase in the output frequency of the Frequency-Shift Oscillator. A negative (marking) signal couples in the capacitor, isolates the inductor and causes the Frequency-Shift Oscillator to decrease in frequency. The oscillator has a center or unkeyed frequency of 7500 cps and the keying action causes a shift of ± 400 cps, see Keying Characteristics in Figure 2. The oscillator is a conventional push-pull type using NPN transistors with the tank circuit between the collectors. A buffer amplifier consisting of a single transistor is used to isolate the oscillator from the sending band-pass filter.

The Band-Pass Filter is used to suppress the higher order side bands of the FSK modulation process and to prevent foldover when translated to the voice-frequency band. First order side-bands at 1200 baud speed only are selected and fed into the product modulator.

The Product Modulator serves to translate the modulated band of frequencies down to a frequency range suitable for transmission over voice bands. The translating carrier frequency is provided by the translation oscillator (9300 cps). The modulator output consisting of sum and difference side-bands are fed to the send low-pass filter which passes the lower side-band to the send amplifier and suppresses the unwanted upper side-band. The resulting mark and space line frequencies are 2200 and 1400 cps respectively.

The Translation Oscillator is a conventional push-pull type using PNP transistors with the tank circuit between collectors. The oscillator is follow by a single transistor buffer and a four transistor parallel, complementary symmetry configuration. This configuration is necessary since the oscillator must drive both the send and receive product modulators. As the name implies, its function is to provide the translating or switching carrier for the product modulators.

The Send Amplifier consists of two transistors in tandem. The circuit has both current and voltage negative feedback and is capable of a maximum output level of plus 7.5 dbm. The send level is adjusted by means of an input potenti-

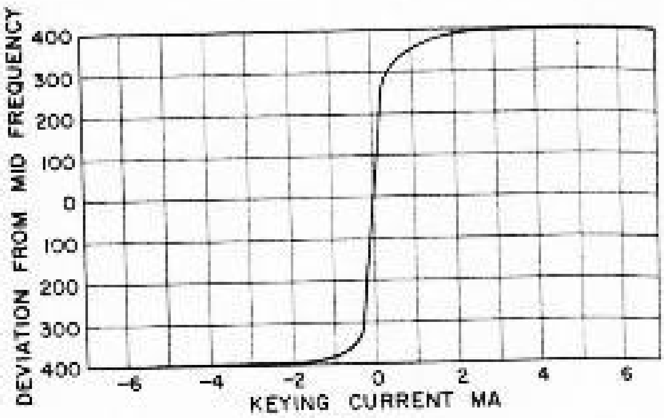

Figure 2a. Keying Characteristics

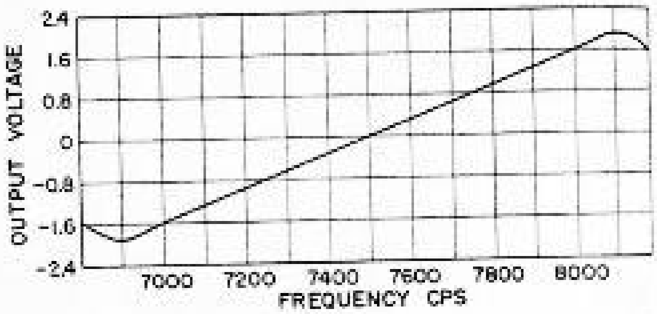

Figure 2b. Discriminator Response

ometer to the required level for the particular circuit. Output impedance to the line is nominally 600 ohms.

Receiver—Carrier signals from the line enter the receiver through the Amplitude Equalizer. This equalizer consists of a fixed pad for isolation purposes and an adjustable passive network to compensate for amplitude distortion. The network is a standard shunt type cable equalizer and has four switched positions.

The signal at this point is at a level lower than that which was transmitted due to losses in the line and the amplitude equalizer. The function of the Receive Amplifier is to amplify these signals to a level suitable for driving the receive product modulator and the carrier alarm. The amplifier is similar in design to the send amplifier and will handle signals down to minus 30 dbm.

The function of the Carrier Alarm is to report instances of line level decreases greater than 20 db from normal. When this occurs, the data terminal is alerted, the monophone buzzer activated, the receiving limiter disabled, the alarm lamp activated, and the receive leg locked to steady mark or space as desired. A level return to within 10 dbm of normal automatically restores conditions to normal.

The alarm circuitry itself consists of a two stage carrier amplifier, a rectifier and filter, a Schmitt trigger circuit, emitter follower and a miniature relay.

The output of the receive amplifier also drives the Delay Equalizer. The Delay Equalizer consists of five tuned, two transistor, amplifier stages in tandem plus an output stage. The delay of each stage is adjustable and each peaks at a predetermined frequency. These frequencies are located so that the overall Delay Equalizer response can be made to represent an inverse function of the voice band delay characteristic. The addition of this delay response to the line creates a transmission path essentially free of delay distortion. The Delay Equalizer will suitably equalize all circuits normally encountered in the field.

The function of the Receive Product Modulator is to retranslate the received band of frequencies to the same band (7500 cps) at which the original modulation took place. The modulator is similar to the send product modulator and is also driven by the common translation oscillator. The output, consisting of sum and difference side-bands, is fed to the receive filter group.

The Receive Filter Group consists of three filter networks. The first section is a band-pass filter which eliminates all unwanted modulation products for the receive modulator. The second section is a translation carrier rejection filter which eliminates any carrier leak coming from the modulator. The last section is a fixed passive delay equalizer which compensates for all delay distortion introduced by the transceiver circuitry. Figure 3 shows the equalization of this delay distortion.

The translated signal is applied to a five transistor Limiter section. The purpose of this Limiter is to remove any amplitude variations in the signals and provide the correct level for driving the discriminator section. The Limiter consists of three stages of single ended amplification driving an output circuit comprised of a complementary symmetry transistor pair. The Limiter has an effective range of 45 db.

The final section of the receiver is a balanced linear slope Discriminator and a d-c Amplifier. The section consists of two series-tuned resonant circuits which feed a pair of complementary transistors through differentially connected diode-

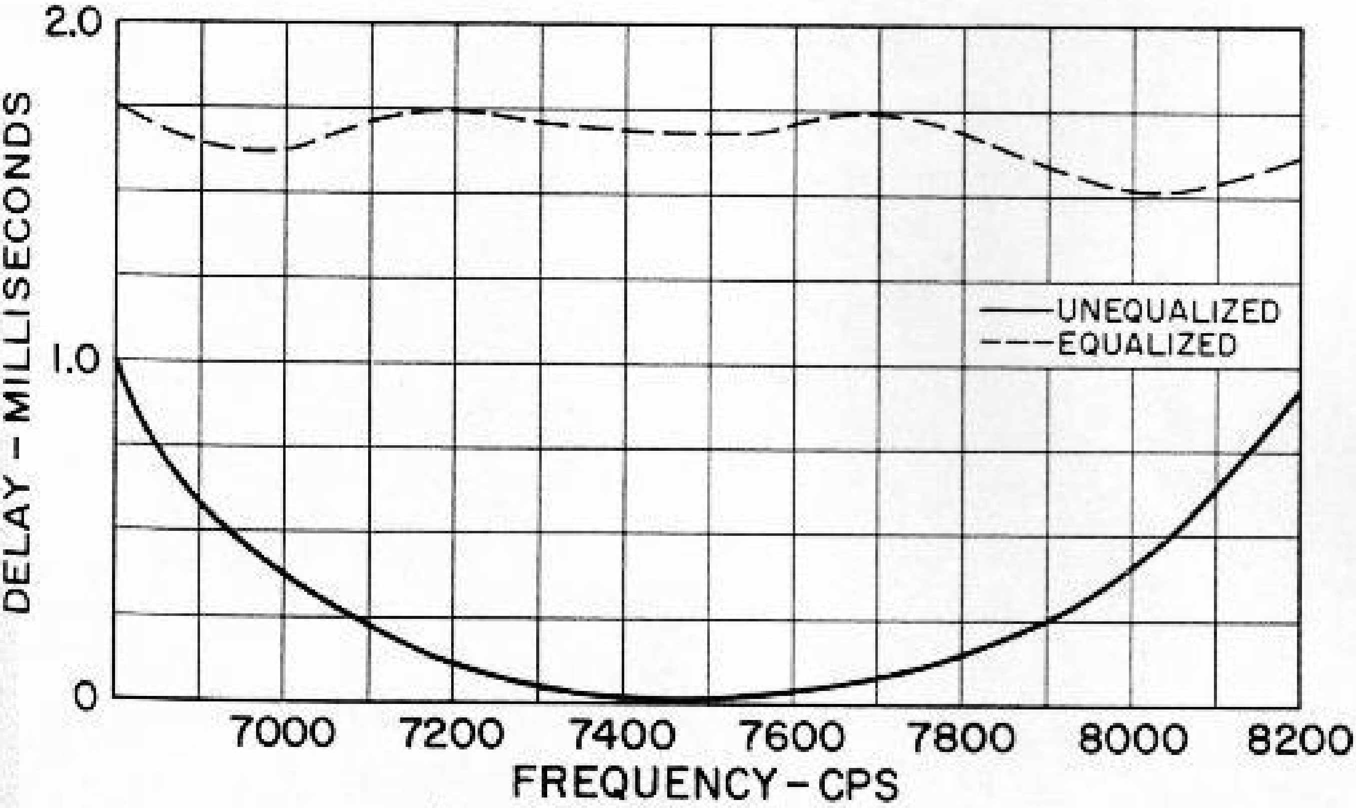

Figure 3. Transceiver Delay Equalization

bridge rectifiers. The two resonant circuits are tuned so that the total response of the discriminator is linear over the band occupied by the first order sidebands. The spacing section of the discriminator drives a positively poled diode bridge and the marking section a negatively poled bridge. The two bridge outputs are combined through a bias adjusting potentiometer which in turn is connected to the input of the d-c amplifier. The amplifier consists of two complementary pairs of transistors, one side applying marking battery to the receive leg and the other side applying spacing battery. The rise time of the d-c square-topped signal output of this section under normal operating conditions is in the order of 30 microseconds. See Figure 2 for the discriminator response.

Switching—The Switching section consists basically of two relays. The main relay is responsible for changing the mode of operation from voice to data. In performing this function the following actions take place:

1. On command, switch the line to either the monophone or the carrier transmitter and receiver.

2. Connect the carrier transmitter output to the carrier receiver output in the phone mode. This is done to accommodate the ringing method used.

3. Provide send/no send and interlock signals to the data interface depending on the mode of operation.

The other relay provides the means for disconnecting the ringing apparatus in the event of a line interruption.

These functions will be covered further in the following section dealing with the monophone.

Push Button Monophone—The Push Button Monophone is a standard three-wire handset provided with special applications switches. The monophone initiates the voice/data switching and ringing operations and provides a ringing knockdown switch. The operation of the monophone is as follows:

1. Voice/Data Switching

With the handset resting in the cradle, the transceiver is in the (normal) data mode. By removing the handset from the cradle and depressing the voice button, the main switching relay is energized and the transceiver goes into the voice mode. The set can be returned to the data mode either by depressing the data button *or* by returning the handset to the cradle (there is a mechanical interlock between the data switch and the cradle). It should be noted that the set will not switch to voice operation if the handset is accidentally removed or displaced from the cradle.

2. Ringing

When in the data mode ringing is accomplished by depressing the ring button which puts a short circuit across the data carrier transmitter output. At the distant end this loss-of-carrier is detected by the carrier alarm and a ground is connected to the phone buzzer through normally closed contacts on the ringing knockdown relay.

It is obvious that if the line were to open, the buzzer would be activated until the line was restored. By depressing the carrier knockdown button on this handset the ground is removed from the buzzer and the knockdown relay locks up on the carrier alarm ground. When carrier is restored the knockdown relay automatically resets.

This ringing procedure takes place with the transceiver in the data mode. When the switch to voice operation is made the send carrier output is shorted to the receive carrier input, thus preventing ringing until the next sequence of operations begins.

Interface—The data Interface is the point of embarkation between the transceiver and the data terminal equipment. The transceiver is equipped with a female Cinch Connector (DB-19604-433) which carries all necessary interconnecting leads.

The pin assignments on this connector are:

(1) Frame Ground
(2) Data Send Leg
(3) Data Receive Leg
(5) Clear to Send
(6) Interlock
(7) Signal Ground
(8) Carrier Alarm

The control voltages meet EIA RS232 Standards. The data signal required on the send leg is ± 6 to ± 10 ma and the receive leg will deliver up to ± 10 ma into 600 ohms. These legs can be adjusted to meet special applications.

Installation and Operation

The transceiver has been designed to simplify installation, operation and testing procedures.

Initial physical installation requires only that the telephone pairs be soldered to a terminal strip, the a-c power cord connected to a local power source and

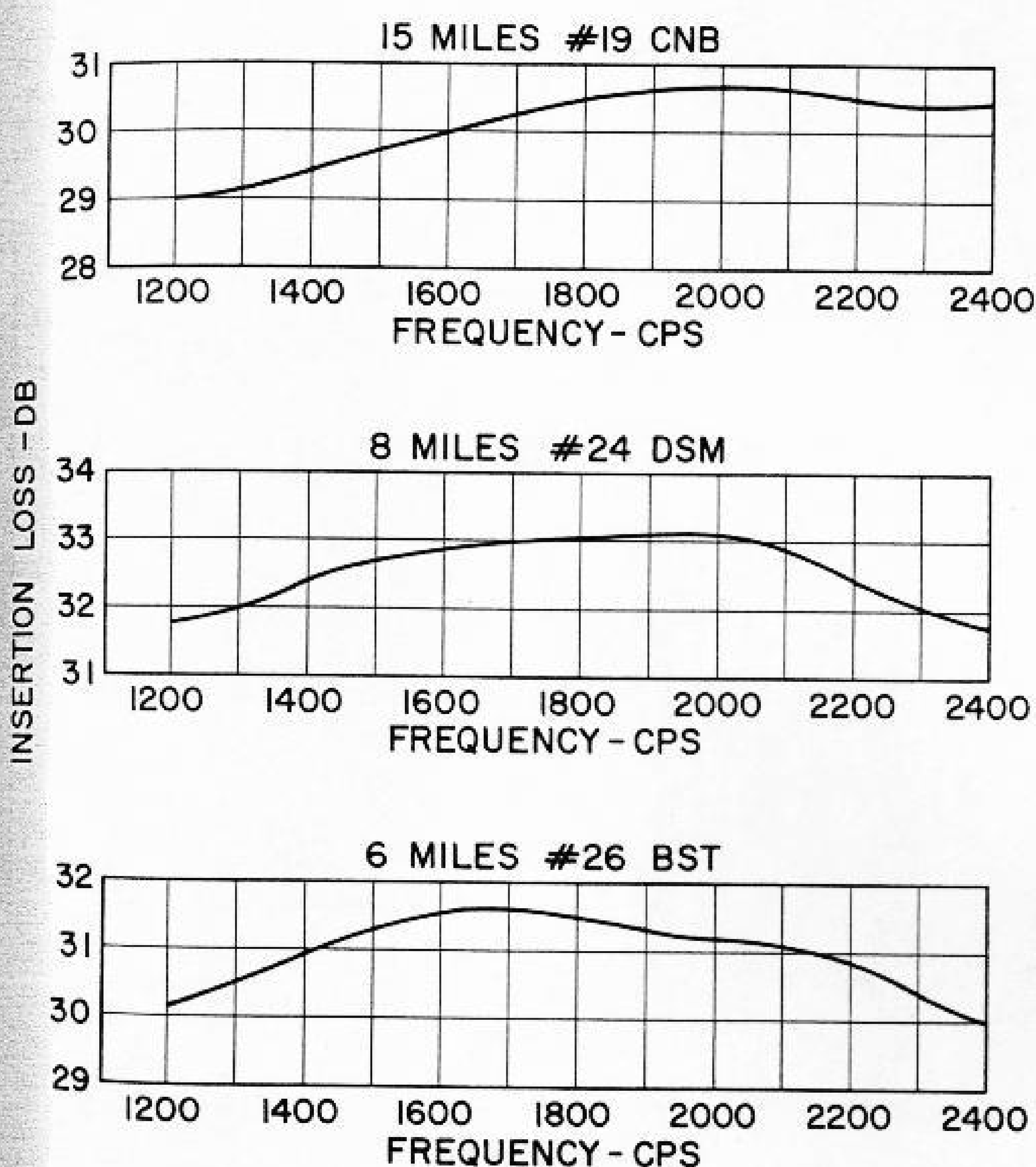

Figure 4. Line Amplitude Equalization

the interface connectors mated. The unit is designed to mount on a desk or suitable table. The physical characteristics are:

Weight	45 pounds
Dimensions	16" W x 15" D x 9" H
Power Source	117 Volts AC
Power Consumption	25 Watts

At the time of installation the delay and amplitude distortion of the circuit is measured and if necessary corrected by the compensating networks built into the transceiver. Limits on this correction will be ± 200 microseconds of delay and ± 2 db of amplitude distortion. See Figures 4 and 5 for typical equalization results. It is also necessary to adjust the carrier send and receive level to fit the particular transmission path. A fine bias adjustment is provided in the receiver and this may have to be adjusted depending on the particular line. Once these adjustments are set they need only be changed in the case of a permanent change in transmission path.

To facilitate fault location and maintenance, a system of jacks and test points have been provided. The jacks enable the operator to measure send and receive carrier and to provide carrier "bust-back" for his terminal and a voice band "bust-back" for the distant terminal. All transistor circuitry is mounted on plug-in cards. These cards have test points brought out to facilitate fault location

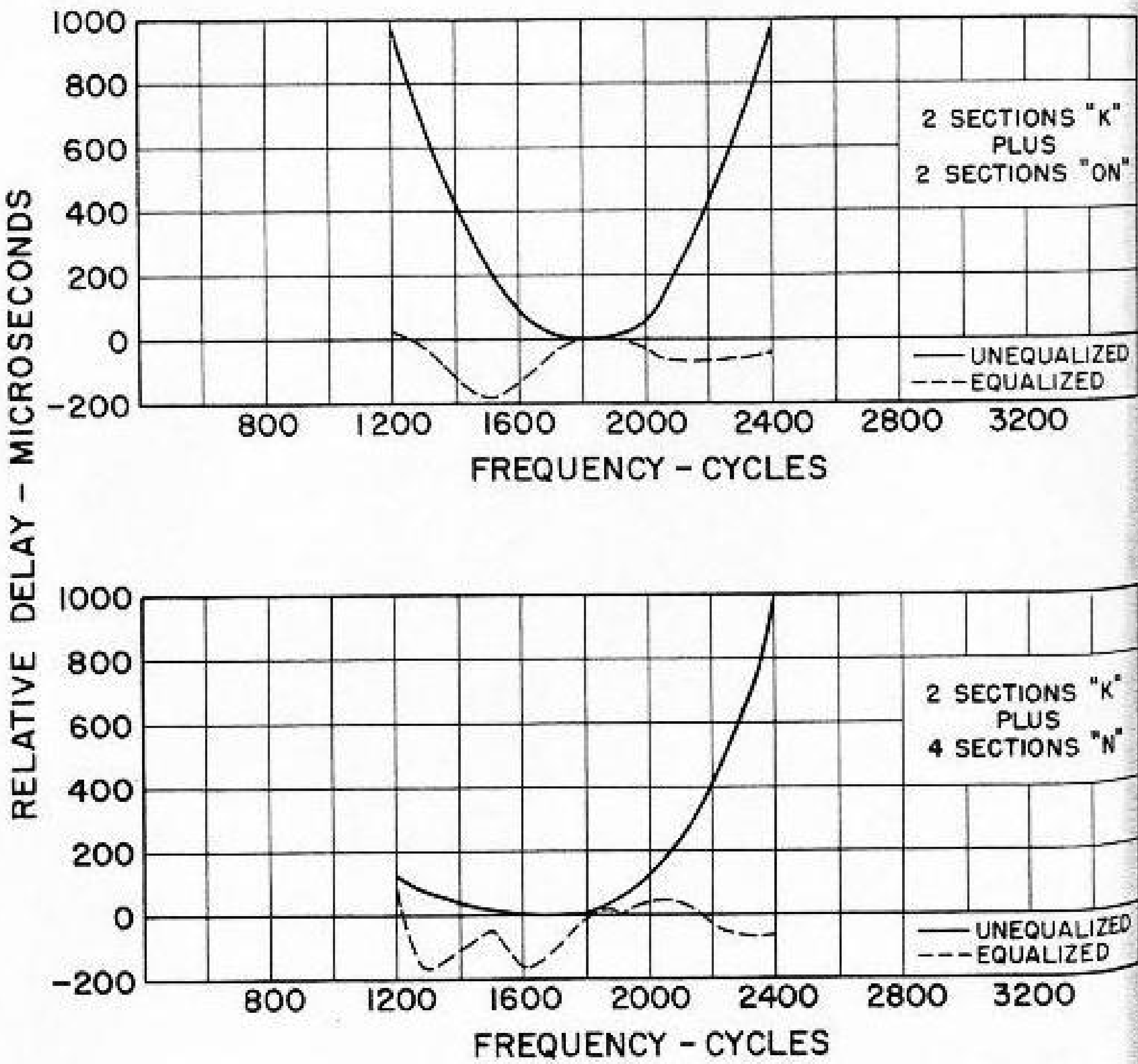

Figure 5. Line Delay Equalization

measurements. The combination of the jacks and test points provides a quick means of locating and clearing faults on a two-point system.

Performance Characteristics

Up to date very little on line testing of this transceiver has been performed. However, since the basic design is very similar to that used in previous 1200 baud models and since this transceiver shows superior bench performance as compared to previous models, it is felt that past line performance data can be safely quoted. On leased voice facilities equalized to the limits stated previously,

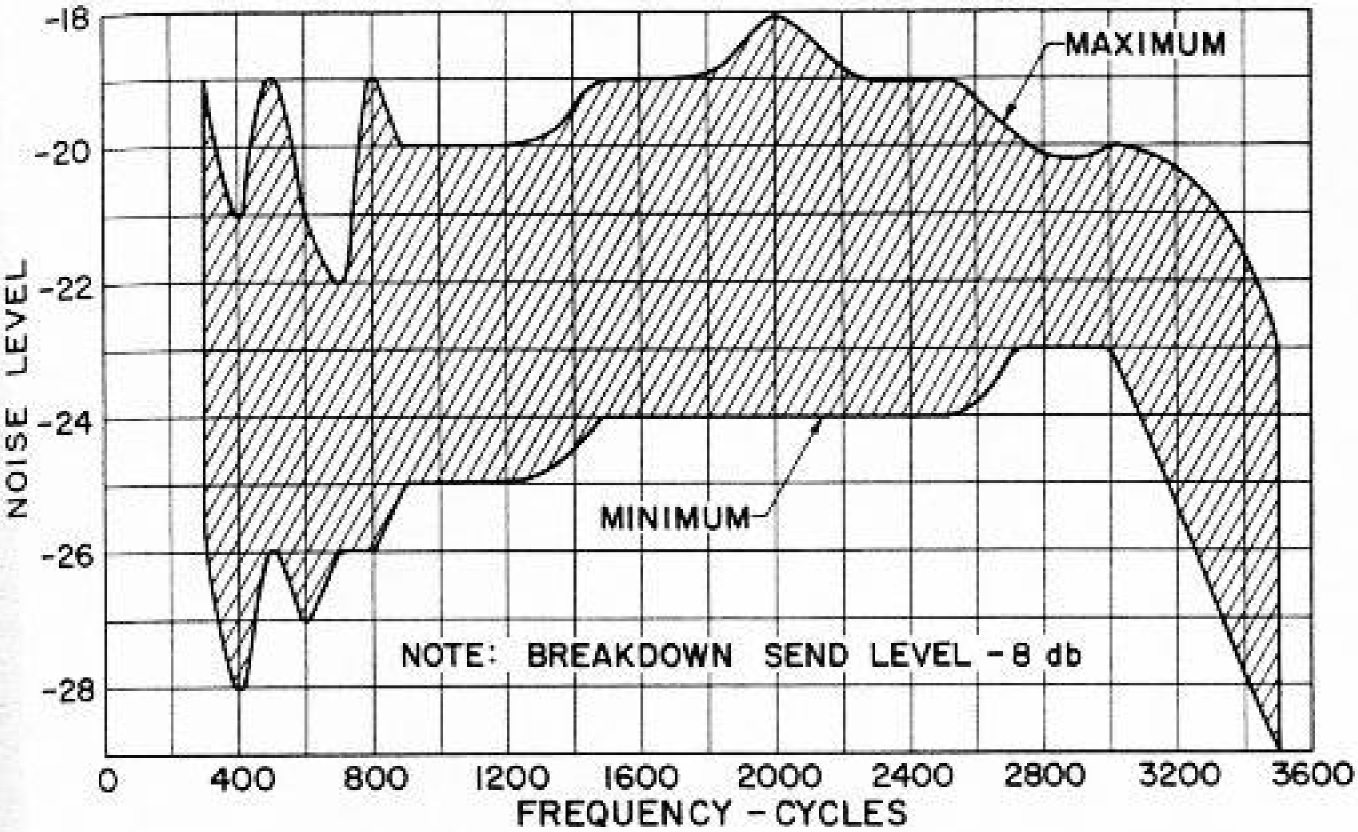

Figure 6. a Interference Effect of Noisy Metallic Cable

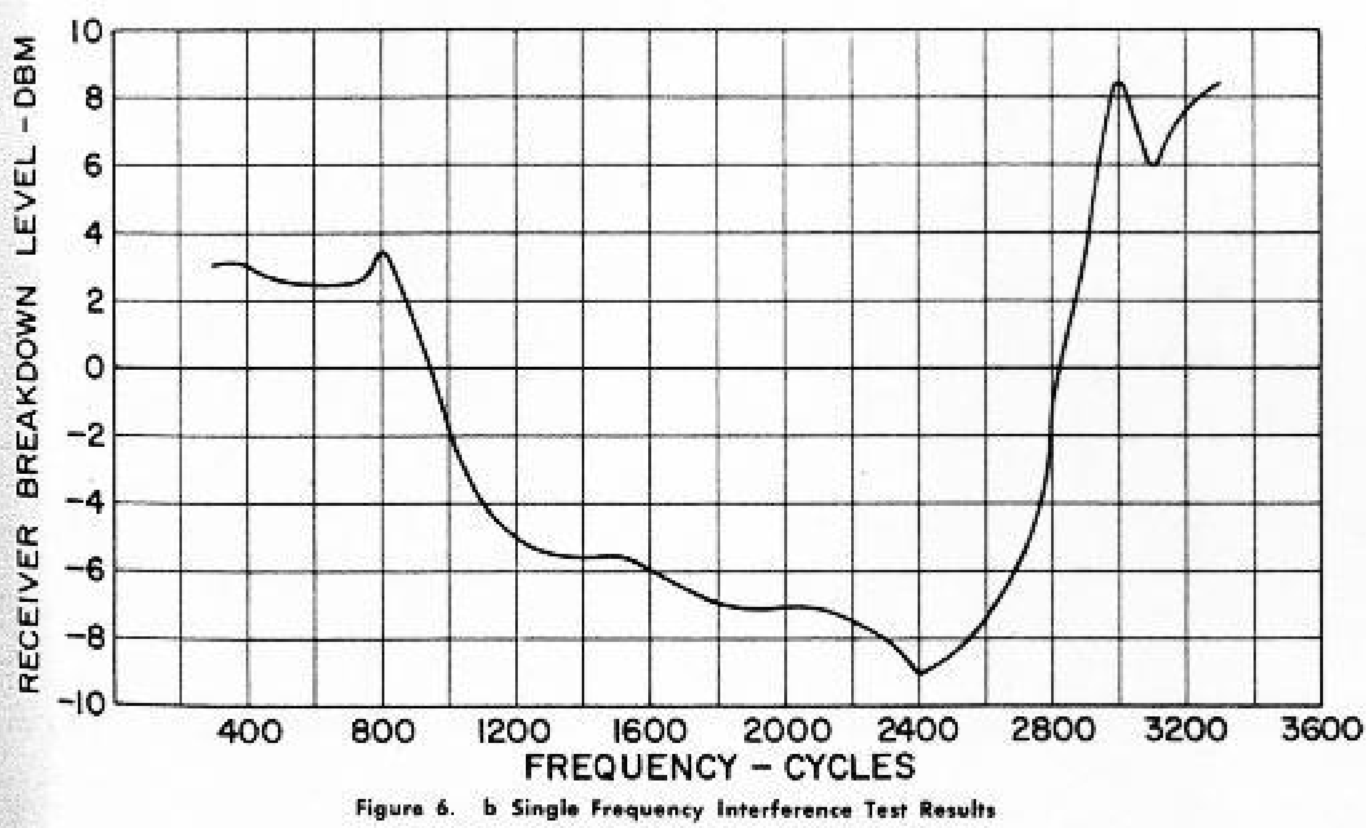

Figure 6. b Single Frequency Interference Test Results

the bit error rate will fall between 1 in 10^5 and 2 in 10^7.

As previously stated, a major contributor to errors on leased voice bands is impulse noise. For this reason, tests were devised to investigate the susceptibility of the transceiver to this type of disturbance. In one case signals were transmitted over a particularly noisy cable pair and in the other an oscillator was used to insert single-frequency interference into a normal voice band. In both cases, a breakdown level of approximately one error in two minutes was used as the limits of operation. In the case of the noisy cable, the signal level transmitted into the loop was decreased until breakdown occurred. In this latter test, the interference level was increased until breakdown occurred. The results are shown in Figure 6.

Bench tests of the transceiver were performed and the results showed that an increase in total distortion of not more than 5% can be expected in the presence of any one of the following conditions:

1. ± 250 microseconds delay distortion and a signal to noise ratio of 20 db.
2. ± 20 cycle frequency translation
3. Level variations of ± 10 and -20 db from normal
4. ± 3 db amplitude distortion (All measurements with reference to the 1800 cycle center frequency.)

It is felt that under normal conditions no line (after equalization) will exhibit wider variations in characteristics than those shown above. Past experience would indicate that the contribution of a typical line would not exceed a maximum increase of 5% in total distortion (excluding momentary interruptions and noise bursts). This level of performance is considered to be more than adequate for this type of operation.

Mr. Ronald L. Lowe is a Project Engineer in the Transmission Systems Division. He has been concerned with the design of data carrier transceivers for customer office installations.

He received a degree of BS in EE from the University of Connecticut in 1957 and joined Western Union the same year. He was assigned to the Radio Wire Transmission Division, where he engaged in work involving high speed facsimile transmission. Subsequent assignments involved the Air Force-Weather Bureau 433-L Project and high speed data transmission systems and equipment.

M. I. Borsella, Patent Attorney, Patent Department

Trademarks and Copyrights

Early History

THE origin of trademarks is probably as old as the origin of commerce itself. What motive would be more logical than the desire of men to affix some mark, or symbol, or sign of identification upon their goods, not only as a simple effective means of avoiding disputes, but also to gratify their desire for recognition. It is safe to conjecture that trademarks antedate writing, for men were making marks long before they knew how to formulate those characters known as ideographs, collectively into an orderly pattern called writing.

Some evidences of the antiquity of "marking" have occasionally filtered down to us. Pieces of ancient pottery unearthed were frequently found to contain certain marks or symbols suspected of being affixed by the maker as his trademark. By 1400 the Coopers of London had a regular scroll at their Guild Hall upon which their trademarks next to their names were enrolled, a procedure surprisingly similar to our "Registration" of today. And indeed the concept of marking to indicate origin or quality was not simply limited to goods, for may not the parallel be extended to the centuries long practice of marking or branding humans to indicate the characteristic of criminality?

The first movement in the United States of the movement for some sort of statutory enactment to insure the orderly use of trademarks appears circa 1790. The sail makers of Boston found themselves in a chaotic competitive market and their trademarks were being infringed. Whereupon they petitioned the then Secretary of State, Thomas Jefferson, for some legislative protection. The Secretary devoted his not inconsiderable talents to formulating a report on the problem, which read in part as follows:

> *"That it would in his opinion, contribute to the fidelity in the execution of manufacturers to secure to every manufactory an exclusive right to some mark on its wares proper to itself . . . and that this may be done by permitting the owner of every manufactory to enter in the records of the Court the name with which he chooses to mark or designate his wares, and rendering it penal in others to put the same mark to any other wares."*

Importance of Trademarks

Trademarks have been defined as a means of identifying one man's goods or services as distinguished from those of another.

Though this definition seems simple, great industries have been built up and flourished upon the good will of a name. M.G.M., some years ago, was reported to value its "roaring lion" trademark at $15,000,000 and Coca-Cola trademarks are intangibles of almost inestimable value, probably running into many tens of millions of dollars.

In medieval England not only were trademarks already used by various Guilds but in some instances the use of a trademark was obligatory by law. A 1365 statute relating to bakers reads:

> *"that every loofe of bread be marked with the mark of the baker of whom the sayd bread was bought, to and intent that everye person may know that the bread is of the right assize, of such value as it should be, and if he did not do this he shall be greviously amerced."*

Neither were infractions taken lightly. In 1632 one Thomas Jupp, a cloth worker of London was punished for counterfeiting the trademark for Colchester cloth, which had a particularly enviable reputation, and affixing the mark to another cloth of inferior condition.

Jupp was fined and condemned to stand in the pillory "*upon several market days with a paper on his head, wherein shall be inscribed words declaring the nature of his offense. At which time it is also thought fit and ordered that this decree shall be publikely read and severall copies be thereof printed, and set upon postes and other imminent places about and neere the said pillory, to remaine there, so as the cause of his punishment may be generally knowne and other like lewd persons deterred from committing the like offenses.*"

While today's judgments may not be as earthy and direct as the above, a trademark infringement suit is still a matter of grave concern because of the large amounts of money it is possible to recover. A lost infringement suit has spelled the end of more than one going business.

Definition of Trademark

While we agree that a trademark is a word, or a name, or a symbol, or any combination of these adopted and used by a business man to identify his goods and distinguish them from those manufactured or sold by others, there are also related functions. A trademark serves to indicate to purchasers that the quality of the goods bearing the mark remains constant. The trademark of course generally implies some degree of excellence in the goods, otherwise it would not be there. Hence, it also serves as the focal point in advertising to create and maintain a demand for the product. During times when it is not possible to produce or export the product due to war or political upheaval, advertising the trademark helps to keep alive the memory of the product until such time as its resumption in commerce is possible.

A well-advertised trademark is so closely associated, in the public mind, with the manufacturer that the mere mention of it immediately brings the manufacturer to mind. For example "Dacron" at once brings to mind the duPont Company, as "Coke" does the Coca Cola Company; or the symbol of a bell in a circle brings to mind the Bell Telephone Company. And yet like all good things this can be overdone. The pitfall is ever present—that too zealous or indiscriminate advertising will popularize the trademark so much—make it (to not coin a phrase) "a household word" so that the public will begin using the trademark to describe the product itself or even similar products.

Product Tie-in

More simply stated, the mention of the mark will immediately create a mental tie-in with the "product"—not the manufacturer.

The trademark has thus become generic—a species of name and therefore it has no further trademark use. All advertising monies spent over the years, as well as hard work in building up the mark, have been wasted. Take for example "Ping-Pong." Here one thinks of the game itself, not of the Parker Brothers Company. Yet "Ping-Pong" is a registered trademark of Parker Brothers for table tennis equipment, and the name of the game is "Table Tennis"—not "Ping-Pong." "Kleenex" although a registered trademark of the Kimberly Clark Corp., has become synonymous with facial tissues. More often than not people tell the druggist they wish to purchase a box of Kleenex and then soberly pick up any one of a variety of boxes of facial tissues, by other manufacturers.

Kleenex, Frigidaire, Celophane, Nylon, Aspirin, Teletype are all words loosely used to describe a product when in fact all of them are or were registered trademarks, and hence someone's exclusive property. It is necessary therefore to use a trademark with some circumspection in advertising material, brochures, pamphlets or similar publications otherwise it may become just another word in our language and it may lose its distinctive value to the owner of the mark.

We sometimes hear it said, "let us think up a good descriptive mark for our product. Then we will not use it until we have it copyrighted so that no one will steal it."

Legal Requirements for Trademarks

To begin with, the law says you cannot have a trademark that describes your product. It should "suggest" it, but "not describe" it. Hence "Crystal" is all right for salt but "Journal of Medicine" was rejected for a medical magazine, as being descriptive. There is a reason for this. If your trademark describes your product, it follows that it also describes all products like yours, including those of your competitors. It would not be equitable to confer exclusive proprietary rights upon one, in a term that describes all other products such as the original. It should be available for use by others as well. Thus the term, "loose leaf" as applied to notebooks, refers rather to a feature or peculiarity of the notebook instead of being a means of identification for it. Hence the term is descriptive. Since so many manufacturers make loose-leaf notebooks, the term cannot be monopolized by a single user but should be available to all.

Secondly, if a good distinctive trademark is registered for one's product, there is a legal requirement that it must have been in use prior to registration.

Trademark rights themselves depend on use, not on registration. The rights in a trademark can only be established in this country by adoption and actual use of the mark on goods moving in trade, and use ordinarily must continue if the rights are to be maintained. No rights can exist until a trademark has been in actual use; and a trademark cannot be registered until the goods bearing the mark have been sold or shipped in interstate, foreign or territorial commerce. Indeed trademark rights are so dependent upon use rather than registration, that registration is not even essential.

Trademark rights can be protected indefinitely under common law. However registration results in many material advantages to the trademark owner. For one thing it gives the trade notice of the claim to ownership of the mark and it creates a presumption that the mark is valid and indeed owned by the registrant. The registration itself is valid for twenty years provided the mark is used continuously, and it may be renewed for like periods indefinitely, as long as the mark is "in use."

Thirdly, the expression "have it copyrighted," in connection with the trademark, as so frequently heard, is badly misused. A trademark is "registered" not copyrighted. The difference is more than one in semantics, because copyright is an entirely different bundle of proprietary rights for more tangible matters. By law, a trademark cannot be the subject of copyright.

Copyright

The fundamentals of copyright are both simple and brief. It is, in short, "the right to copy" as the word literally implies. Whosoever owns the copyright is the only one who can copy the work. In order to secure a copyright, the work protected should reflect at least a minimum of intellectual effort. Hence this protection is generally extended to authors of literary, dramatic, musical, artistic and a considerable variety of other works. Such things as maps, photographs, jewelry, enamels, glassware, technical works, engineering drawings, and motion pictures, among others, are all subjects entitled to copyright protection. On the other hand, mechanical devices, names, titles of books or stories, ideas, business forms, works consisting of information which is common property, such as calendars, multiplication tables, rulers, and the like, to mention a few, cannot be copyrighted. But just what sort of rights do you have if you have a copyright? The owner of a copyright is granted certain exclusive rights in his work. These include the exclusive right to make copies of the work; to sell or distribute copies of the work, and also the right to revise or make other versions of the work.

Thus the difference is substantial between copyrights and trademark rights, the latter being confined to a proprietary interest in a word or symbol which is used in connection with one's goods moving in commerce. In order to claim copyright it is only necessary to place notification on the work itself that copyright is claimed and it must be done when the work is first published. However, the notice must be precise and it should appear in this form: "© John Smith 1962 or "Copyright 1962 by John Smith." Nothing further is required. "Copyright pending," or "all rights reserved," which we see all too frequently, are not proper notification and are considered meaningless.

Copyright versus Trademark

A copyright once secured is good for 28 years in contrast to 20 years for a trademark. However the copyright may only be renewed once for a maximum possible protection of 56 years whereas the trademark may be renewed indefinitely as long as it is used.

The difference then between a trademark and a copyright is both specific and substantial as well, but mainly it concerns two entirely different subject matters of protection. Since 1946 it has also been possible to acquire trademark proprietary rights in connection with a service.

Service Mark

A service mark is a mark that denotes a service used in commerce rather than goods that are manufactured or sold. The statute says, "A Service Mark is used in the sale of advertising of services to identify the services of one person and distinguish them from those of another." Service marks may be composed without limitation, of symbols, marks, titles, slogans, character names, and the like. Trademarks for such concerns as insurance companies, banks, hotels, telephone, and telegraph companies are generally service marks since these concerns are primarily performers of services rather than manufacturers or vendors of goods.

Often in the performance of a service certain systems or equipment are necessarily employed in the performance of the service. It is important then, to avoid using the service mark in advertising and promotional material in such a manner that it identifies the system and equipment used in performing the service; that is to say, the means for providing the service, rather than the service itself. When this occurs the mark is being used in connection with the system, not the service or its origin, and hence this tends to invalidate the mark.

Up to 1946, registering a trademark had been a privilege available only to goods moving in commerce. Organizations that had been rendering substantial and valuable services to the public, and as a result had built up an enviable reputation as performers of services, were barred from having a badge or emblem to symbolize such services. The 1946 "Lanham Act" first permitted performers of services to register a trademark for their services.

Some service marks registered by Western Union since the passage of the Lanham Law in 1946 are shown in Fig. 1.

Figure 1. Service Marks

While the service marks illustrated are primarily designs, there is absolutely no requirement that they need be so. The Western Union International Division service mark, "ALL AROUND THE WORLD," is an excellent example of a trademark which combines a design with a slogan.

The following on the other hand, are Western Union trademarks which are not used for services, but for goods moving in commerce. Can you identify these product marks shown in Figure 2?

T E L E D E L T O S

Desk-Fax

Lithofax

Figure 2. Product Marks

TELEDELTOS is for electrosensitive recording blanks, and Desk-Fax is for telegraphic facsimile transmitting and receiving apparatus, while Lithofax is the trademark for electrosensitive or thermosensitive recording blanks, adaptable for reproduction by lithographic printing methods. Clearly then, these are all goods and not services.

It might be noted that not only are the words themselves trademarks, but also the "appearance" imparted to them by the distinctive script employed. The script is part and parcel of these trademarks and when used in advertising they should appear in their original script rather than in block letters.

Markings ®

Whether trademarks are marks for services, or marks for goods, there is one thing they ought to have in common when they are used, in literature or ads, and that is the familiar little R in a circle, ®. It should appear next to the mark at least on one occurrence on each page. This marking gives notice to one and all that the trademark so designated is a registered mark. The importance of the marking lies in the fact that if the marking is omitted it might not be possible to sue an infringer and recover money damages.

Under today's arduous business conditions, a good and distinctive trademark is an invaluable asset in the constant and continuous struggle for recognition, and recognition of one's wares over those of others, in that complicated intangible maze known as the competitive market.

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In 1950 he was admitted to practice as a Patent Attorney and since then his legal activities have been basically concerned with patents, trademarks and copyrights in both domestic and foreign practice.

Prior to joining the Legal Department of Western Union as a Patent Attorney in early 1961, he was connected with Republic Aviation Corporation, Bendix Aviation and the Ingersoll Rand Company where he served as Assistant Chief Patent Counsel.

He is a member of the New York State Bar and of various Federal Bars, and is admitted to practice before the Supreme Court of the United States.

He is a member of the international legal fraternity, Phi Delta Phi.

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Data Transmission and the Common Carrier

This article describes data transmission from the aspect of the common carrier of telecommunications. It will be confined to the problem of large multipoint leased digital data systems rather than the more numerous point-to-point "dial-up" systems.

A common carrier of telecommunications has certain responsibilities to the public users of the services provided. These responsibilities include: The establishment of communications networks for such services as voice, facsimile, data or combinations thereof; the prompt restoration of service when circuits are unavoidably interrupted; and a policy of plant maintenance and improvement to insure continued satisfactory operation. These responsibilities present no particular problems for a non-critical service such as voice transmission and current standards permit a quite satisfactory service. Nor is the common carrier unfamiliar with digital transmission, in fact, it preceded voice and is with us today on a large scale in the form of the telegraph. In this area also, current standards permit a service that is very satisfactory for speeds up to 100 words per minute.

Common carriers are well aware that modern technology, at an accelerating pace, will require the interchange of vast quantities of data at high speeds and are working to perfect the communication tools and methods to make this possible. One such tool is the modulator-demodulator or modem.

The Modem

When one contemplates the vast complex of modern communication systems now covering the face of the earth and soon to invade the reaches of outer space, the modem may seem mundane and of small import. However, it is basic to the communications process and the interchange of information between people would be impossible without it.

A system concept, by definition, is a complex of ideas, principles, and equipments forming a coherent functional unit capable of accomplishing certain definite objectives. In the communication system, the modem unit accepts information in one form and translates it to a different form as demanded by the system concept. Although the modulation process may be accomplished mechanically, acoustically, or otherwise, it is generally assumed to be electronic in nature. The telegraph key, in every sense of the word, is a modulator; and the sounder—a demodulator. However, the modem connotation today implies methods for impressing information on a carrier frequency wave at the transmitter and the detection of this information at the receiver. Within this framework, the development of the modem as a basic link in communication systems has a long and interesting history.

The development of digital computers and their application in various technical and business fields soon raised the problem of communication between such units in widely separated geographical locations. The interchange of digital information was required at various rates from that obtainable with ordinary telegraph channels up to many thousands of characters per second. Such a large potential market prompted numerous organizations to initiate development of high speed digital modem equipment. Various ways were devised for impressing intelligence on a carrier wave to best meet system requirements. The wave was systematically mutilated in every conceivable way to achieve the desired end. Various new modulation schemes both synchro-

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nous and asynchronous were tried and old ones revamped.

It is not the purpose here to list the many modem forms that have appeared in recent years. It should be noted, however, that new approaches were found and often hailed as the "ultimate" and the closest possible to theoretical perfection only to be superseded by another claimed to be one or two db superior. As a result, the search for the "ultimate" modem has been tortuous and often vociferous with conflicting claims as various proponents extoled the virtue of their particular mixture of the ingredients constituting the communications art. It is, of course, quite obvious that there is no "ultimate" system, that a concept ideal for one communication system may be far from ideal with a different system. It is not so much a matter of what can be done as a matter of what should be done in a given situation.

Today a large number of data subsets, both analog and digital, are available. Most of these are intended for use on the switched telephone network with alternate voice coordination and at speeds up to perhaps 3000 bauds. Wide-band facilities are rapidly becoming available throughout the country as are data sets and error corrective devices for their efficient utilization. Such facilities will permit the interchange of computer traffic using magnetic tape terminals at speeds approaching 15,000 characters per second. The employment of data transmission channels will have a profound effect on the use of computers by industry.

As to the future, prediction is a risky business at best, particularly so in the field of modulation and detection techniques. The field has been full of surprises in the past and no doubt will continue to surprise us in the future. The search for new electric symbols and means for their recognition to permit greater efficiency continues. Who can tell, for example, what new concepts might be inspired by the detailed study of neurological processes through a blending of the communications and biological sciences? This we may well leave to the future and confine ourselves to the problems already created for the common carrier of telecommunications by the present requirements for data transmission.

The Common Carrier

When we consider what has been written and debated about the philosophy of data systems design and the responsibilities assigned to the various subsystems contained therein, there appear to be as many possible solutions as there are applications. In any case, the common carrier appears as a subsystem in all of the data systems utilizing its facilities. If no restrictions are placed on the types and varieties of terminal equipments for data transmission, not only do the number of possible speeds become large but also the types of signals, coding and modulation schemes, word lengths, and other pertinent parameters become large. Under such conditions the modem may take weird and complex forms and be required to perform tasks not rightly associated with modulating and demodulating functions. Such things as character or word recognition could be required, a task which properly should be performed elsewhere than in the transmission path.

For data transmission the basic responsibility of a modem is to convert the digital signals from the encoding device or buffer to a form compatible with the transmission medium and to reconvert them at the receiver for processing by the decoder. Even when so restricted, many modulation methods are available and the degree of sophistication in design that may be economically justified for a given application, could result in a wide variety of modem types. Basically, this is quite legitimate and provides the flexibility to cover a wide range of system requirements.

Consider for a moment the situation faced by a common carrier who attempts to establish a nationwide network suitable for data transmission. Two alternatives are immediately apparent; either transmission can be monitored for signal quality control throughout the network or circuits can be furnished on a "we hope it works" basis. In the latter case the patron will have the responsibility of initiating corrective action whenever performance is unsatisfactory. In the absence of any restrictions as to system standards, the problems associated with the orderly handling and monitoring of data circuits become appalling. It would seem axiomatic, therefore, that the data equipment manufacturer, the user, and the common carrier would strive for system standards permitting the uniform quality control of signals in transmission. Additionally, the inability to measure signal quality could lead to controversy between the patron and the common carrier as to what element in his data system was responsible for substandard performance. These standards should apply to baud speed, modulation scheme, and code format. If the variations in each category could be sufficiently restricted not only could the common carrier adequately supervise transmission quality but other techniques for the improvement of service become available.

With respect to baud speed, an analogy of what may happen in the data field already exists today on a small scale in the telegraph field. It is the custom of the common carrier to monitor telegraph circuits at regular intervals or when requested to do so by the patron in order to determine that the quality of the signals as received and delivered are satisfactory. In order to do this the transmission speed in bauds of the individual circuit must be known. When all teleprinter circuits were operated at 60 words per minute only a single speed monitor instrument was necessary. However, commercial speeds of 75- and 100 words per minute are now quite common. If the special requirements of the military are included, a total of nine telegraph speeds must now be measured and additional ones are imminent. The meter used for measuring telegraph distortion must be manually set for the particular speed desired. This constitutes an operational hazard since false readings will be obtained if the meter is incorrectly set, resulting in a misalignment of the circuit. To avoid this hazard, circuit speeds must be known either by labeling or by special designating tags. However, even this is of little value when a circuit must temporarily operate over other than its normally assigned facilities.

Much effort has been expended in the development of modulation schemes to achieve greater protection against disturbances in the transmission medium. Within limits this is an admirable objective but, again, the complexity of equipment versus the improvement in error rate must be carefully considered. For example, two modems having a 3 db difference in tolerance to noise may show a difference of a hundred-to-one in error rate under controlled laboratory conditions and yet perform almost identically on the general run of commercially available communication circuits. Would it not then be reasonable, for systems operating over domestic common carrier facilities, to select a modulation scheme capable of efficiently utilizing the transmission medium and imposing as few restrictions as possible on the design of associated encoding and decoding devices?

The significance of code format as a factor in the operations of a common carrier can best be illustrated by the following example. Figure 1 illustrates a domestic data network covering the entire nation and comprising some 30 stations. The desired speed of operation is 2400 bauds. The mode of operation is half-duplex wherein each station can transmit into the network one at a time, under control of a central computer, and be received by all other stations. The transmission facilities are leased four-wire voice circuits interconnected to form a large party line network. Each station is equipped with a modem unit and associated control equipment. The normal status of each modem unit is transmitter OFF and receiver ON to read information passing over the network. At any given instant, 29 idle and one operating transmitting loops are connected to the network.

There are two hazards involved in this type of network: One, the network is exposed to the accumulative effect of the relatively high noise level associated with transmitting loops. This places a limit on the physical size of the network which it

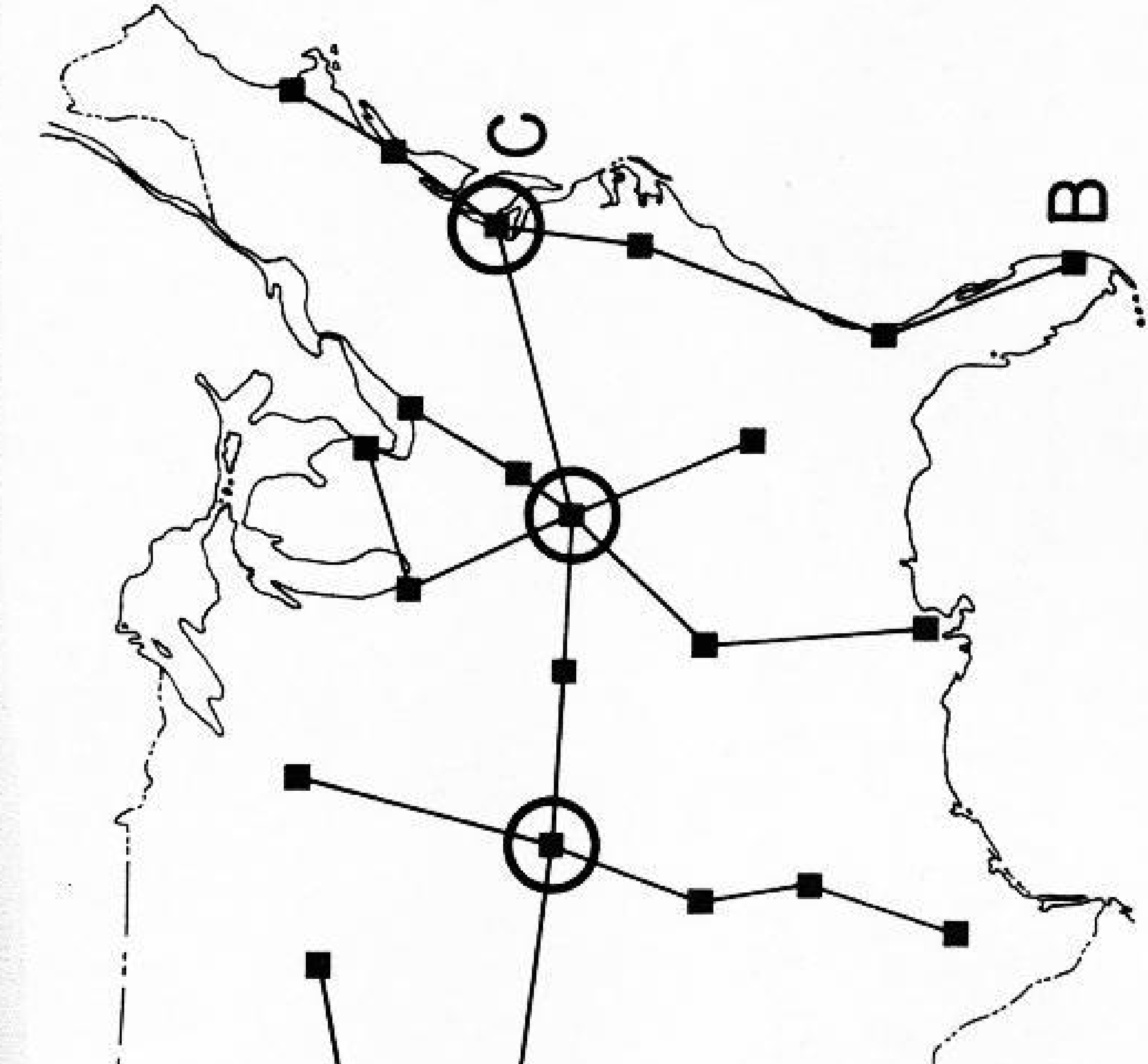

Figure 1. Typical Data Network (Half-Duplex Operation)

is possible to operate successfully; two, the maximum speed of operation of the network, as limited by envelope delay distortion, is usually determined by the two stations having the greatest number of carrier sections between them. In Figure 1 this occurs between Station A in the northwest and Station B in the southeast between which a total of 11 voice band sections in tandem are interposed. Since the amplitude and delay characteristics of the circuits between each station and every other station must be adequate to support a transmission speed of 2400 bauds, the problem of circuit equalization becomes quite costly. Alternatively premium grade, wide-band circuits could be used again at increased cost to the patron.

This situation is one in which the ability to regenerate data signals pays off handsomely. By the use of four regenerators located at strategic common carrier offices, shown encircled on the map, the largest possible number of tandem sections encountered before regeneration is reduced to a maximum of five. The regenerators effectively break up the large network into five independent subnetworks. The problem of delay distortion correction is greatly simplified or eliminated since all signals entering or leaving a subnetwork through a regenerator are no longer influenced by their previous history. In addition, the noise associated with transmitting loops is confined to the subnetworks and no longer accumulates throughout the entire system. As a result, the complexity of the network and its speed of operation are, to a large degree, independent of the circuit mileages involved.

Figure 2 shows one of the common carrier regenerator offices. It corresponds to C in Figure 1 in detail. Main line circuits to the north, south, and west and a drop to a local patron are "repeatered" and hubbed together. Signals entering from one branch are "repeatered" to all other branches. Signals entering or leaving the hub by way of the west branch are also reformed and retimed by the network regenerator, thereby preventing the interchange of

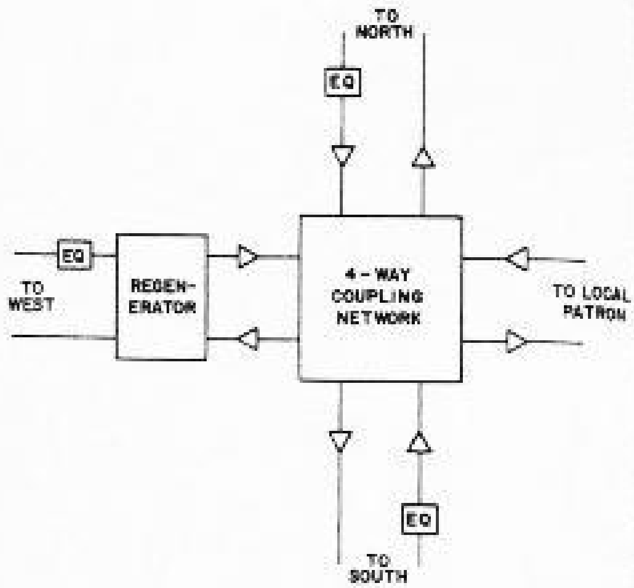

Figure 2. Carrier Regenerator Office

signal distortion between east and west sections of the network.

Regenerator Repeaters

Figure 3 is a block diagram of the network regenerator as designed for operation with frequency or phase modulated signals. Signals arriving from the west activate the west carrier detector which in turn conditions the west modem for reception. The incoming signals also operate the east carrier cut-off, permitting the east modem to transmit. Data signals from the receiving leg of the west modem enter the receiving side of a network repeater module and pass through a regenerative repeater to the sending modules. Regenerated signals thus enter the sending side of the east modem for transmission to the east. Since no carrier is being received from the east, the east carrier

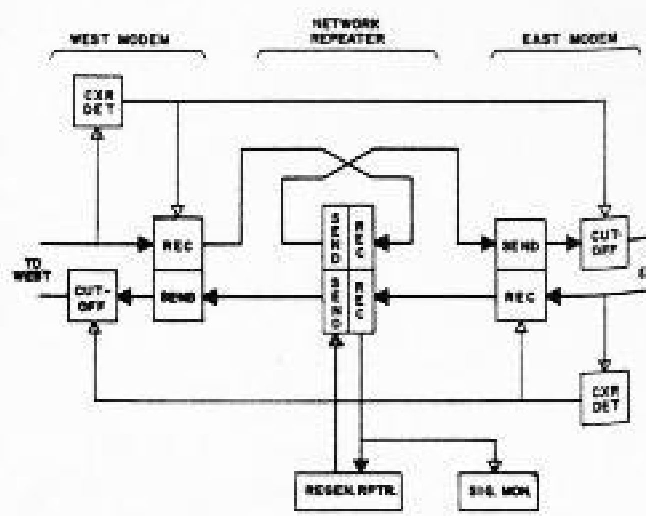

Figure 3. Network Regenerator

detector is de-activated thus inhibiting the transmission of carrier signals from the west modem through the west carrier cut-off back to interfere with the distant transmitting station. A bias and distortion instrument or a channel monitor connected to the input of the regenerative repeater will monitor the quality of data signals arriving from east or west. Such an arrangement permits rapid isolation of system troubles to a given section of the overall network for quicker corrective action.

Regenerative repeaters may be of the bit-by-bit type for use with synchronous systems or the character-by-character type for start-stop systems. For the former it is only necessary that the code used contain no fractional signal elements and that the signalling speed be compatible with the regenerative repeater. However, it is necessary that each station in the network precede its transmission with a series of reversals so that all network repeaters lock in synchronism and that receiving stations attain character or word synchronism. In character-by-character operation, each character transmitted is preceded by a start pulse and followed by a stop pulse one or more elements long. To initiate transmission it is only necessary for a sending station to send carrier for a few milliseconds to switch all receivers on the network from the idle to the receive condition before sending traffic. In this case it is necessary that the character code format and signalling speed used be compatible with the regenerative repeaters. It is obvious that this is a small price to pay for the advantages it affords.

Not all data service requirements involve high speed transmission. In some large networks, regional centers may collect and disseminate data at relatively slow speed. These data may then be transmitted between regional centers at high speed. Figure 4 is a typical example of how a regional center provides service to representative outstations in its geographical area. In this application, transmission is at 150 bauds and only four slow speed outstations are involved. Nominally eight 150 baud FSK data channels

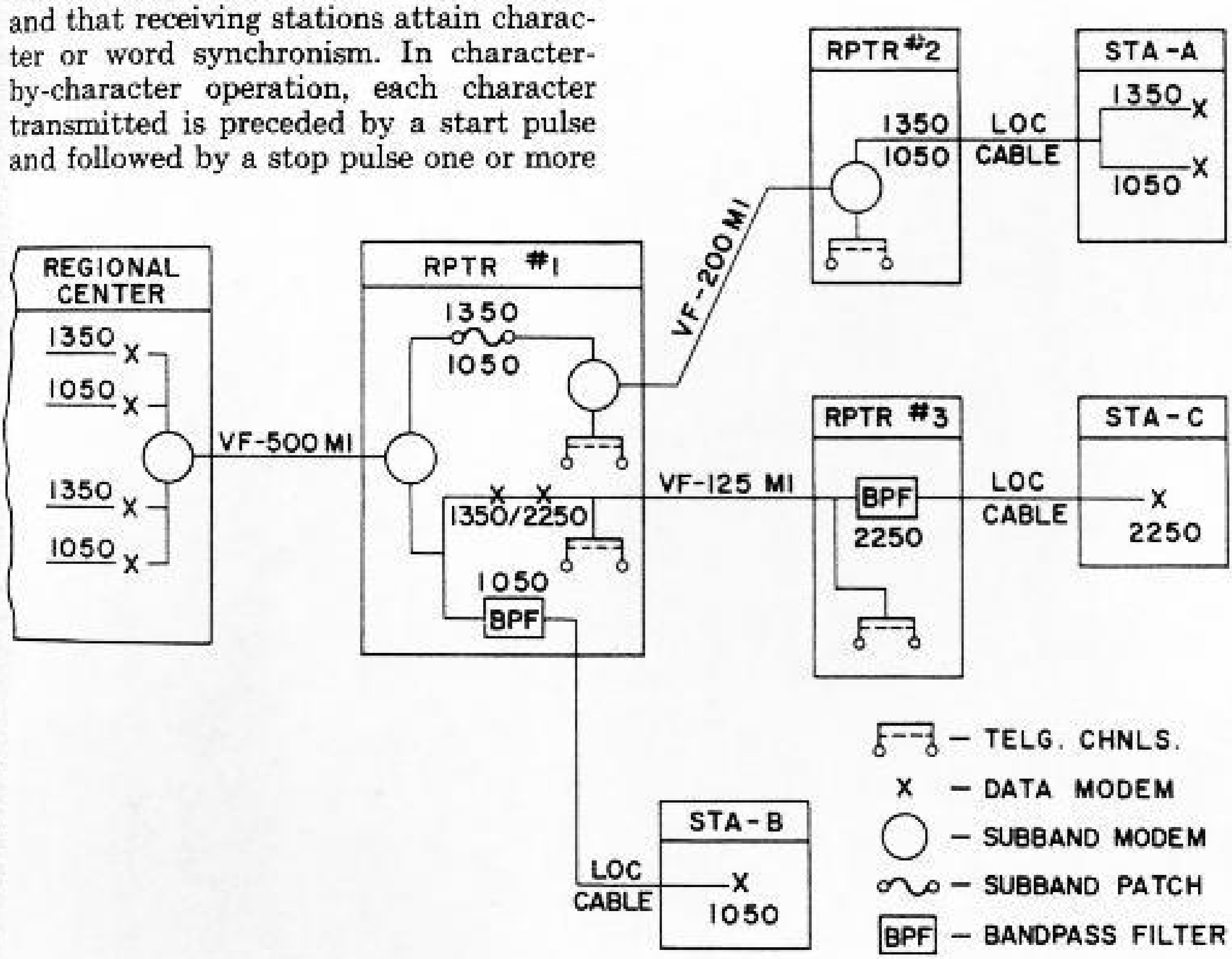

Figure 4. 150 Baud Data Network (Full-Duplex Operation)

can be operated in a voice band starting at a center frequency of 1050 cps and continuing at 300 cps intervals up to 3150 cps. For the case illustrated, two circuits are required from the Regional Center to Station A and one each to Stations B and C. The example is chosen primarily to show how data facilities may be combined with ordinary message telegraph facilities in a common voice band. It is customary in the Western Union Telegraph Company to divide a voice band into two subbands for telegraph services. The voice bands between the Regional Center and Repeater Office #1, and between Repeater Offices #1 and #2 are so divided. One subband from the Regional Center carries two data channels at 1050 and 1350 cps through a subband patch at Repeater Office #1 to Repeater Office #2 where the subband is extended to modem units at Station A over local cable facilities. The second subband between Repeater Offices #1 and #2 carries a normal complement of ten 75-baud message telegraph channels operating in the range 375 to 1725 cps. These are used in regular telegraph service and have no relation to the 150 baud data circuits. The second subband from the Regional Center carries two data channels to Repeater Office #1 where the 1050 cps channel is selected by a bandpass branching filter and extended to a modem at station B over local cable pairs.

The remaining 1350 cps channel is terminated in a modem at Repeater Office #1. A d-c, back-to-back, channel patch at Repeater Office #1 continues the data circuit on a 2250 cps data channel to Repeater Office #3 where it is selected by a branching filter and extended to a modem unit at Station C. Ten 75 baud telegraph message channels in the 375 to 1725 cps range also operate in the voice band between Repeater Offices #1 and #3.

Although the arrangement shown may seem somewhat complicated it is quite economical with respect to circuit usage. In addition, it permits access to data circuits at intermediate points for monitor-

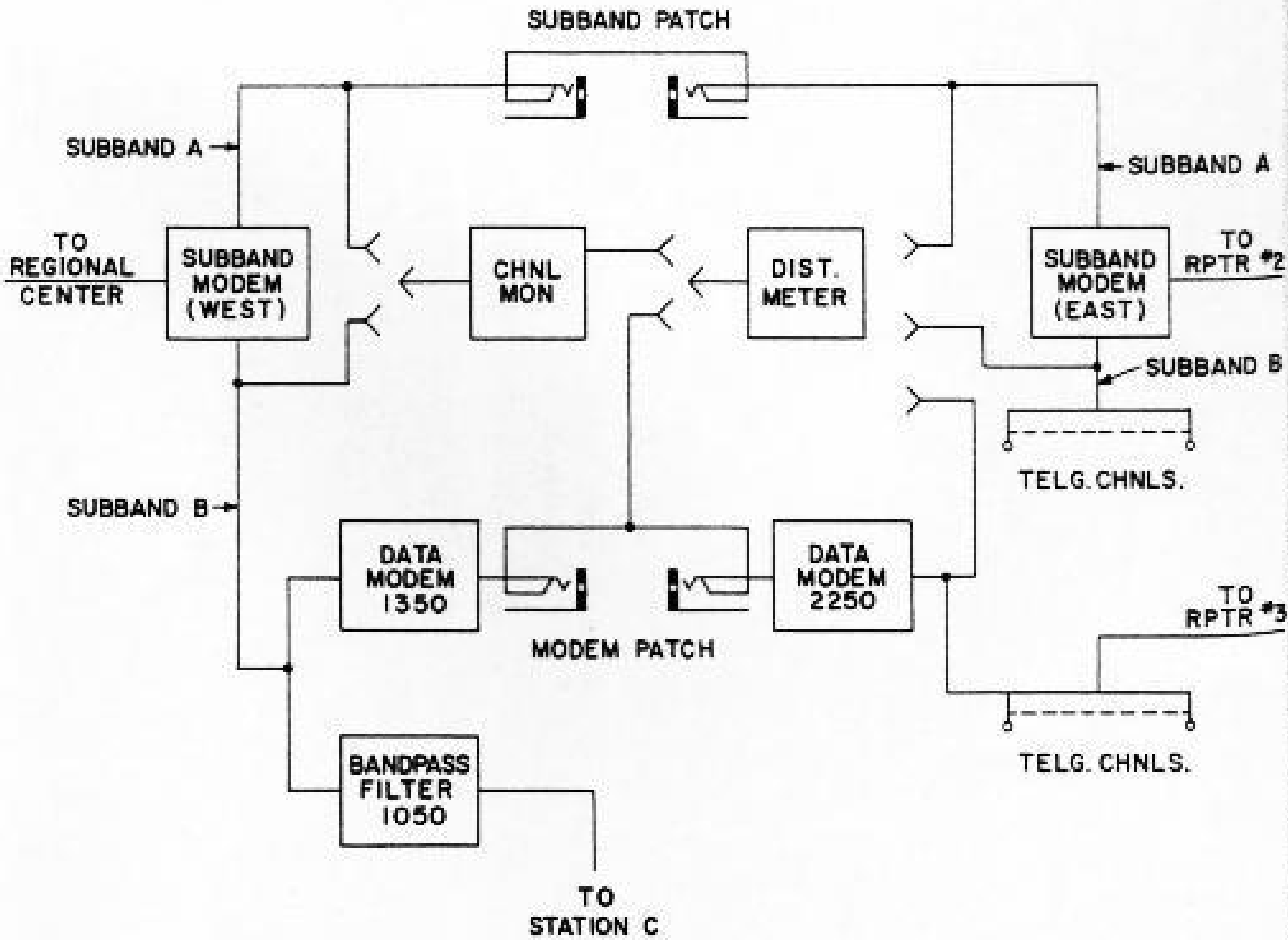

Figure 5. Repeater Office #1

ing and maintenance purposes as shown in Figure 5. Here, Repeater Office #1 is shown in greater detail to illustrate the application of testing and monitoring equipment for signal quality control. The subband modems perform the function of dividing the 300-3300 cps voice facility into two 300-1800 cps subbands designated A and B. Data signals received from or transmitted to the Regional Center on either subband can be monitored at the east subband modem by a channel monitor and bias and distortion meter. The channel monitor can selectively demodulate any 150 baud data channel in the subband and feed the demodulated signal to a bias and distortion meter for measurement of signal quality. Where modems are patched back-to-back on a d-c basis, the bias and distortion meter can be bridged directly on the circuit.

It is not to be inferred that circuits should be demodulated at intermediate points simply for purposes of quality control. However, when such demodulation is necessary for regeneration, circuit grouping, intermediate drops, or other legitimate purposes, the ability to also measure circuit performance is of great value. The common carrier is prepared to go to great lengths to supply features to insure superior transmission performance but, again, these features cannot be universally available without a degree of compatibility between the data equipment manufacturer, the user and the common carrier.

Conclusions

Inasmuch as a common carrier of telecommunications is a vital part of many data processing systems currently in use throughout the nation, its capabilities and characteristics should be considered by those who plan and organize these systems. The advantages and economies to be realized by the intelligent use of common carrier facilities, as an integral link in the data system, should not be overlooked. A realization of what these capabilities are and how they may be used can result in superior performance and reliability. Since it is a practical impossibility for a common carrier to be all things to all users of its services, except at prohibitive costs, it would seem logical for all segments of the data processing and handling industry to draw the ground rules now in order to successfully cope with the automation explosion about to engulf us.

This article has touched but briefly on a few of the problems faced by the common carrier. If, in the hectic development of data processing systems and associated equipment, this article causes some consideration to be given to those who must establish and operate the communication highways of the nation, then it will have accomplished its purpose.

MR. J. EDWIN BOUGHTWOOD is head of the Transmission Systems Division of the R&E Department. He is responsible for the development of telegraph, high speed data, and facsimile transmission systems for government and commercial use.

His early work in d-c telegraph transmission resulted in increased speed and reliability in time-division multiplex working. Since 1937 he has been concerned with the development of carrier current methods and systems for wire line and radio relay applications, and has made numerous contributions in these fields.

Mr. Boughtwood received his degree in Electrical Engineering from Northeastern University in 1930 before entering Western Union. In 1957 he was awarded the F.E. d'Humy Medal "for fundamental scientific explorations and basic inventions in the field of frequency-modulated carrier telegraphy systems." He holds many patents in his field and has written numerous technical papers. He is a member of the AIEE and the IRE.

Robert Steeneck, Acting Data System Engineer

Error Detection, Correction, and Control

ERROR control although desirable in any type of communication becomes most necessary in the field of data communications. It may be well to first point out that not all data system errors are due to transmission faults. Humans and machines also contribute errors that are often a far more serious problem than errors due to transmission. Consequently, most data systems require a certain amount of error protection included in their data formats.

For example, where numerical information such as catalogue numbers, customers identity numbers, or credit card numbers, have to be handled they are often protected within their structure by a single digit, derived through an arithmetic process involving all of the digits comprising the number. The arithmetic may be quite complex and sometimes slightly cryptographic to establish a certain element of security to a credit card system.

The development of a check digit from a simple sum of the digits comprising the number to be protected, however, is not adequate. Such a process affords no protection against the most common of human errors; namely, the transposition of digit pairs during the process of transcription.

Although check systems vary, the protection digit in general is derived by doubling every other digit in the number to be protected, adding the results to the undoubled digits, and using the last digit of the sum as the check digit, as shown in Fig. 1.

In some cases, additional arithmetic is performed to avoid such things as reading a carelessly written 7 as a 2 thus producing an errored number that may check, since both 7 and 2 when doubled each contribute a value of 4 toward the development of the check digit. This is but one of many methods of checks and balances that are used in data processing systems primarily to protect against the most common of all errors namely human errors.

When the transmission error rate is low, the error control introduced to protect against human errors will often also serve to adequately protect the system against transmission errors.

NUMBER	8	2	3	4	5	
	X1	X2	X1	X2	X1	
	8 +	4 +	3 +	8 +	5 =	28
PROTECTED NUMBER	8	2	3	4	5	8

Figure 1. The Check Digit

In systems where this protection through format structure does not exist transmission error control would probably be desirable even though the error rate is low. When the error rate is high, however, for example, on overseas high frequency radio circuits automatic error control is vital to successful data communication.

Error Detection

One of the first problems in error control is that of error detection. Error detection requires redundant information applied to each character, transmitted or applied to a block of characters after they have been transmitted.

With the advent of digital computers came the first widespread use of parity error detection codes. In parity codes at least one extra bit level is provided exclusively for the purpose of checking the validity of each code combination used.

"This article has been condensed from a paper presented at the 16th Annual Convention of the Armed Forces Communications and Electronics Association in Washington, D. C. on June 12, 1962. Complete text of this presentation will be published in the August, 1962 issue of SIGNAL, official journal of the AFCEA."

The presence or absence of a bit in the check level serves to make all code combinations contain either an odd number of bits if odd parity is desired, or an even number of bits if even parity is desired, see Fig. 2.

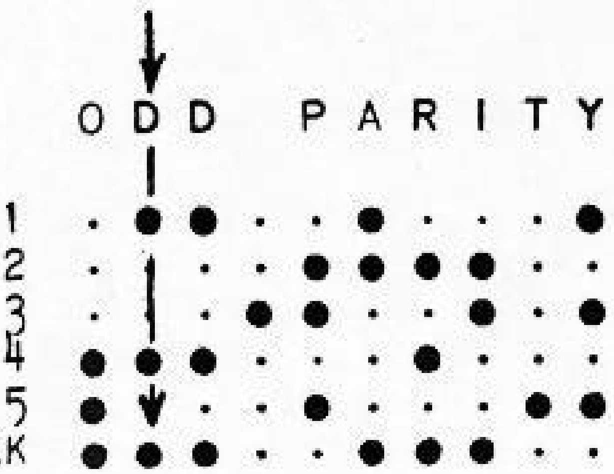

Figure 2. Odd Parity Check

Although a single parity bit included in each character provides adequate protection against undetected errors in computer operation, where parallel transmission under more or less locally controlled conditions is used, transmission tests show that at teleprinter speeds the simple parity code fails to detect about 10% of the errors when serial transmission over typical telegraph circuits is employed. This failure is due to the fact that in serial transmission about 10% of the errors involved an even number of bits.

In some systems error detection is accomplished by using only code combinations in which the selecting and non-selecting bits always occur in a fixed ratio.

This provides a good means for detecting errors since both gains and losses of an equal number of selecting bits must occur within an errored character to produce an error detection failure.

The chart of Fixed Ratio Codes, in Fig. 3, illustrates the number of different fixed ratio combinations available in various binary codes up to 9 bits length. It is interesting to note that the numbers found on this chart exactly duplicate Pascal's triangle of binomial coefficients discovered by this famous French scientist a little over 300 years ago.

There is undoubtedly some sound mathematical reason that makes the coefficients of the terms, obtained when $(X + Y)^5$ is expanded, exactly coincide with the number of 1-, 2-, 3-, 4- and 5 bit combinations available in the Baudot code. However, the reason is obscure at the present time.

The distribution, however, does suggest that perhaps an improvement in coding efficiency might be obtained by making use of more than one fixed ratio code group when handling data in a given binary code.

Whenever error control is obtained through the use of single-character error-detecting codes, at least one extra bit must be included in every character transmitted.

To improve transmission efficiency block checking systems have been devel-

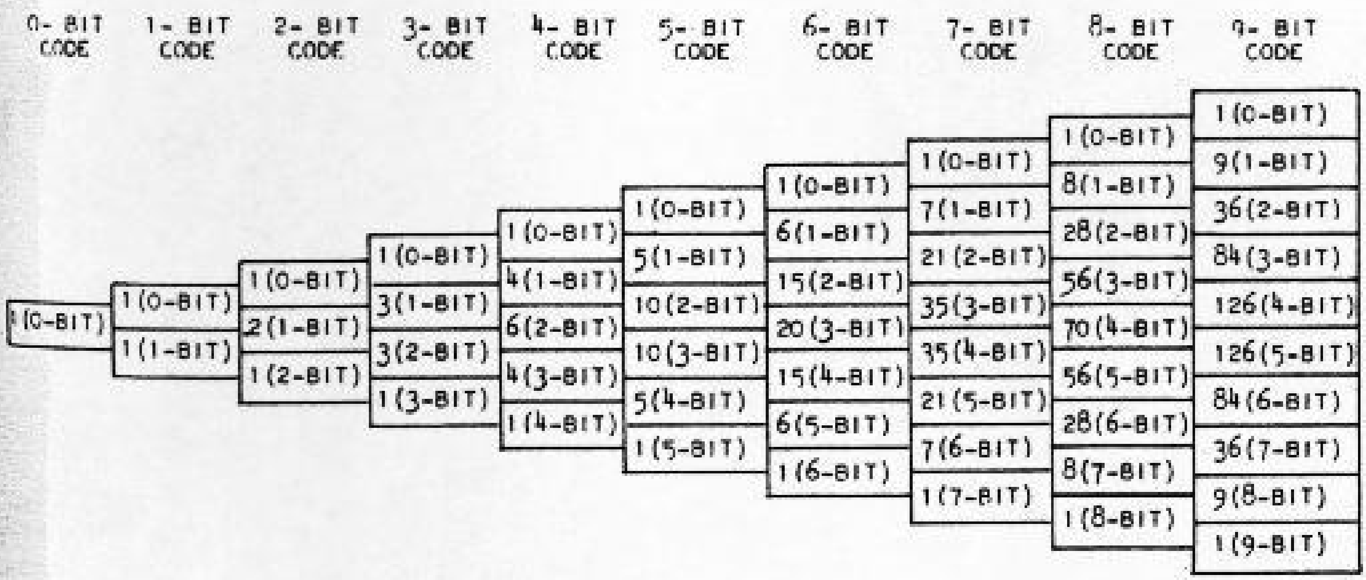

Figure 3. Fixed Ratio Codes

oped in which the check information is added only after a block of information has been transmitted.

Several block checking systems have been developed; block parity being perhaps the first. In block parity a single character combination is added to the end of each block of information. This

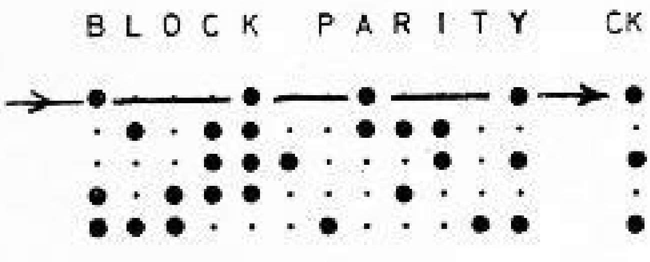

Figure 4. Block Parity Check System

added character serves to make the total number of selecting bits in each level either odd or even as desired. In the illustration shown in Figure 4 odd block parity is shown.

When block parity alone is used to protect information it is quite vunerable to failure whenever serial information is converted to parallel information and directed through circuits individual to each code level. A fault in any of the individual code level circuits will then produce errors that tend to be confined to a particular code level. Under such conditions the chance of detection failure rises to 50%.

When parity is applied to both the individual character and to the block of characters as illustrated in Figure 5. However, the chance of failure is reduced to an insignificant figure.

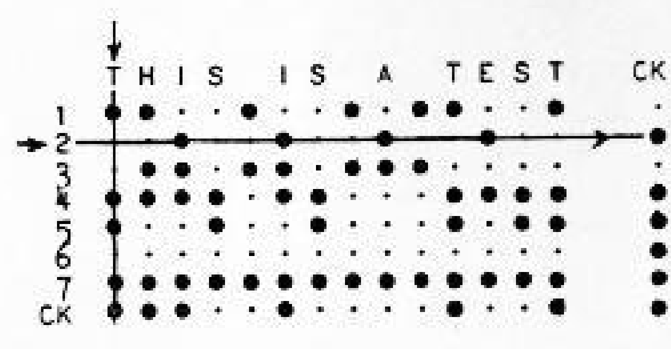

Figure 5. Cross Parity Check System

Chances of block parity failure can also be reduced by the use of spiral parity. In spiral parity bits applied at the end of a block of information are not assigned individually to one code level throughout the block but are shifted one level for each character transmitted. Errors that occur on only one level are then not apt to influence only one code level of the check parity character. Thus the error detection probability is greatly increased. Fig. 6 shows the shifting of levels in the spiral parity system.

The shortcomings of simple block parity may also be avoided by considering first of all, that code combinations are in reality nothing more than binary numbers. As binary numbers it is obviously possible to add code combinations together, as illustrated. The binary number that results may then be transmitted as check information and compared with a similar binary total, developed at the receiving terminal. In actual practice comparison is more easily accomplished by transmitting the compliment of the

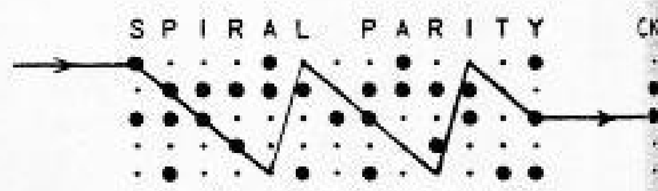

Figure 6. Special Parity Check System

block binary total. The compliment when added to the block binary total at the receiving terminal results in an overall binary total containing no zeros at all as shown in Figure 7. The presence of a single zero thus indicates a non-check condition. It is not necessary to use the entire

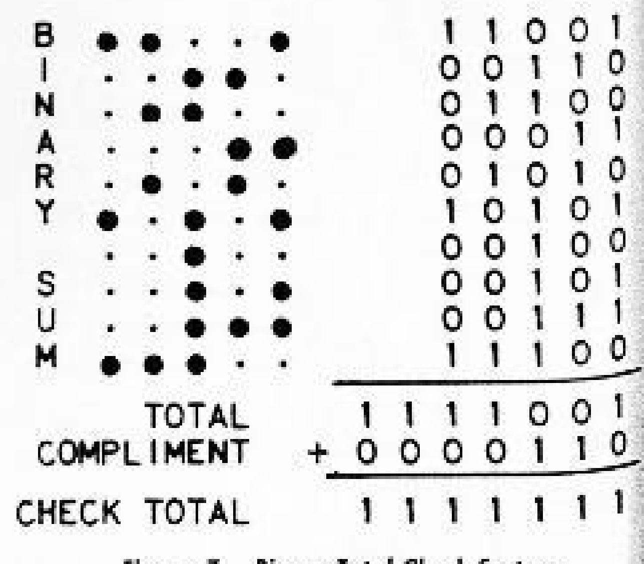

Figure 7. Binary Total Check System

binary sum for check purposes although it is quite obvious that the number of bit levels in the binary sum cannot be less than the number of bit levels in the code.

At this point it would be well to analyze the protection to five-unit code data that is provided by using only 5 digits of the binary sum as check information.

Whenever transmission errors occur they are generally quite consistent in nature. Most frequently circuits consistently lose information bits, less frequently bits are consistently gained, and the least frequently occurrence of all is the mixed loss and gain of bits of information under the same transmission difficulties.

In the first analysis we will consider the behavior of a five-digit check when consistent losses of information bits are experienced. Consistent gains, of course, will produce the same effect.

5 Bit Check

The basic 5 bit binary counter at a given starting condition when stepped through a cycle of 32 counts or any multiple thereof always returns to that starting point.

In code level #1 each bit has a value of 1 unit in the binary counter and consequently 32 bits in this level would have to be lost in order to lose one complete cycle of the binary counter and thus produce a false check. Therefore, it would seem that this level has more than adequate protection against lost bits as shown in Fig. 8.

CODE LEVEL	VALUE	DROPOUTS TO FAIL
1	1	32
2	2	16
3	4	8
4	8	4
5	16	2

Figure 8. 5-Bit (32 Count) Binary Sum-Check System

In code level #2, however, the bit value rises to 2 units and the drop-out protection falls to 16 bits, which is still more than adequate.

By the time we examine the fifth level of the code, however, we find that the steady 50% loss in protection for each level has reduced the protection level to only 2 bits. The fifth level thus has only the protection of block parity.

Protection could be improved of course, if more than a 5 bit total were used for check information, or if a spiral system of binary addition were employed. There is, however, a much simpler solution to this problem.

If the 5 bit binary counter is slightly altered so that it goes through a complete cycle in 31 counts instead of 32, we obtain some unusual results.

CODE LEVEL	VALUE	DROPOUTS TO FAIL
1	1	31
2	2	31
3	4	31
4	8	31
5	16	31

Figure 9. 5-Bit (31 Count) Binary Sum-Check System

The first level with a bit value of one unit now requires 31 drop-outs to produce the loss of a complete cycle and thus produce a detection failure. Its protection level has thus been lowered by 1 bit as shown in Fig. 9.

The second level, however, with a bit value of 2 units will not evenly divide into a 31 unit cycle but will divide into two cycles having a total of 62 units. This results in a drop-out protection of 31 bits for this code level as well as for the first code level.

If we now examine each code level in turn, we find that they all require 31 bit drop-outs for check failure.

Thus, with this simple change in the binary counter error detection protection is equalized on all code levels.

With a 31 bit drop-out protection on all code levels it is safe to say that more than adequate protection is provided for consistent error conditions with this system. If we examine the system now for operation under the least frequent error condition, namely when both bit losses and bit gains are experienced within the same block, we find that not only are both losses and gains necessary to produce a check failure, but we find that the gains and losses must exactly compensate each other.

Since errors involving both gains and losses under the same transmission conditions are in themselves rare, and since there are many more gain and loss combinations of unequal value the chances of compensation within a block of information are extremely remote.

Error Correcting Codes

Some attempts have been made to design codes that not only detect errors but pin point their location so that correction may be made. In 1950 Dr. R. W. Hamming suggested a system of coding that could detect and also correct an error if that error involved only one bit of information within the code. The illustration in Fig. 10 shows four check bits designated by x's protecting 11 information bits from single bit errors.

The four check bits of the Hamming code each add parity to selected combinations of information bits arranged in four levels resembling a binary progression pattern. With this pattern of parity generation any single information bit, when errored, will produce non-check parity in at least two of the four parity bits of the code. The errored combination of parity bits then becomes a four level binary code system that can pin point the errored bit and allow correction to be automatically made.

Failure to check in only one of the 4 parity levels indicates the parity level itself is in error. No parity bit failure of course indicates a valid condition, thus all 16 binary combinations of the four parity bit levels are used in the Hamming check.

Other error correcting codes have been proposed in which errors involving more than one bit can be corrected. They require more redundant bits within their structure and more complex error correcting procedures.

Perhaps the simplest error detecting code involves the transmission of every code bit three times. At the receiving end code correction is affected by accepting only bits that agree at least twice in the three transmissions. It might be noted in the Hamming code that although four parity bits can protect 11 information bits, four parity bits are also required to protect only 5 information bits.

Unfortunately, no error correcting code can function on the complete drop-outs of information that often occurs on overseas high frequency radio circuits. Here error correction can only be accomplished by retransmission of the errored information itself.

About ten years ago Hendrick C. A. Van Duuren developed a synchronous system that does just that. In the Van Duuren system traffic must first be converted into a fixed ratio seven-unit code for error detection purposes. Upon detection of an errored character the entire system is stopped and the errored character repeated from storage. The accept-

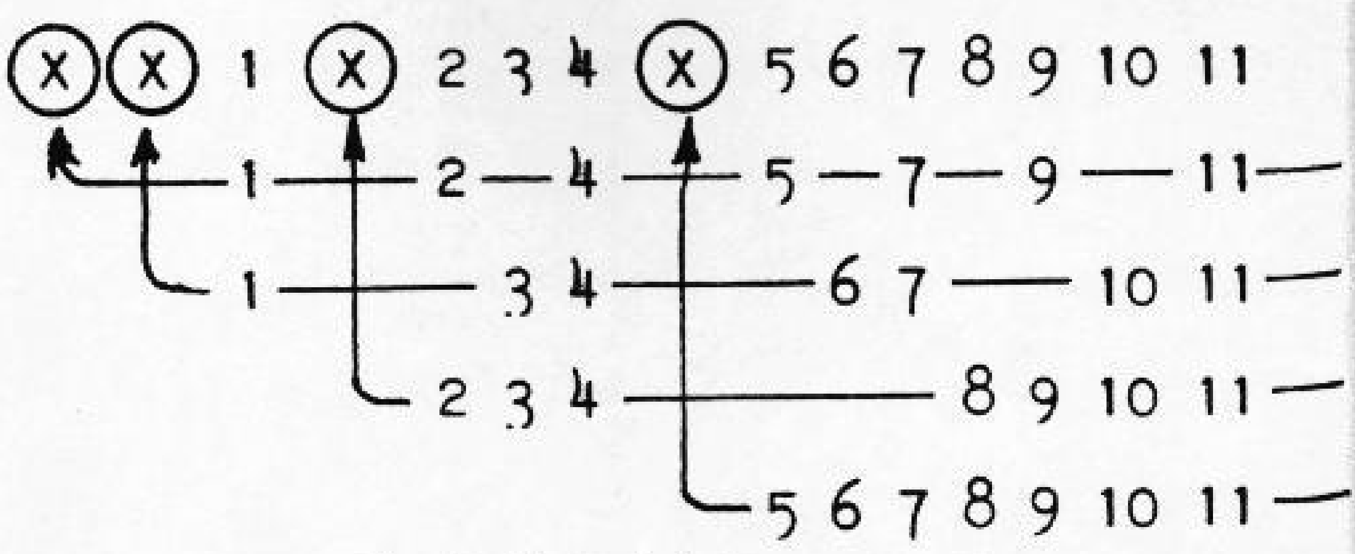

Figure 10. Hamming Single Bit Error Correcting Code

ed information is then converted back to the original code for delivery. Many versions of the Van Duuren System have been developed, including a Japanese system using an 8 level fixed ratio code. The American version is the well known A.R.Q. system.

Western Union is now in the process of developing an error detecting and correcting system that will not require code conversion to function.

In most data systems numerical information is of far greater importance than alpha information and consequently should receive top priority if only a limited amount of protection is available. The five-unit teleprinter code can provide just this amount of protection within its own structure; for concealed within the five-unit code are just ten combinations with a fixed code ratio of three selecting and two non-selecting bits.

By assigning the ten digits to this fixed ratio code group errors that occur in numerical information will produce meaningless symbols that can be easily recognized as errored numerical data. This was covered in an article "Error checking Possibilities Concealed Within The Five Unit Code" in the April 1960 issue of the Technical Review.

Such a code has been used with some German teleprinters and is available to Western Union subscribers who may wish their equipment converted to this code. The code has been christened the L code; L meaning logical. It is the only error control code having zero redundancy.

There are many ways in which error control may be affected. We do not feel that this is the end of the line. Much can be done to improve error control through data format structure. With increased cooperation between data processors and communication engineers much will be accomplished in the future.

MR. ROBERT STEENECK, Acting Data Systems Engineer, is presently engaged in the development of error checking and correction devices for data transmission. He developed the Telecard system in which telegraph signals are directly converted into punched card information, or vice versa.

After receiving his M.E. degree from Stevens Institute of Technology in 1926, he joined Western Union as an apparatus engineer. He was responsible for the design of components for the Radar Contact Trainer which was one of the first predecessors of analog computers. After World War II, he concentrated on the development of automatic switching systems.

He holds 22 patents and has received many singular honors. In 1961 he received the F. E. d'Humy award for his achievements in electro-mechanical developments during his 35 years with Western Union. The sponsor of the "Dingbat" project, in which he was Project Manager, was awarded a citation from the Department of Defense.

Patents Recently Issued to Western Union

Message Accumulator for Recorders

D. M. Zabriskie, W. F. Moore

3,010,717—November 28, 1961

An accumulator for random length message sheets issuing from a facsimile or telegraphic recorder. The outer edge of a cam operated plate, pivoted near its inside edge, lifts the issuing message sheet to join the accumulated stack on the underside where it is supported by lugs protruding from both sides. The plate then lowers to receive the next following sheet to guide it beneath the stack in the same manner. The severed message sheets are held by a clamp at their trailing edges until the stack attains a predetermined weight when the clamp releases to allow the downwardly depending leading edge of the stack of messages to follow a curved guide into a receptacle.

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Telegraph Tape Transmitter Distributor

A. A. Steinmetz, H. C. Isaacs

3,012,096—December 5, 1961

An all electronic distributor embodying an 8-stage ring counter in which alternate stages are triggered respectively by alternate, or 180° displaced, groups of pulses from a common oscillator. Stages 1 to 7 thus produce pulse lengths equal to two periods of the oscillator but at stage 8 a phase advance switch shifts to the alternate group so as to reverse the trigger pulse to that stage to turn it off after a single period, thus yielding a 1½ length rest pulse for a 7½ unit code. A push button in conjunction with the tape controlled auto-stop lever permits manually controlled transmission of single or multiple group characters. As shown, the distributor is entirely transistorized, the tape reader is of the optical type employing photo-diodes and by means of a switch on the oscillator tank circuit different sending speeds may be accommodated.

Single Channel Auto-Synchronizing Telegraph System

R. Steeneck

3,012,097—December 5, 1961

A single channel electronic telegraph system is automatically phased by first sending a series of "blanks" (all spacing pulses) to momentarily condition a starting tube at the receiver to fire at the next signal reversal from spacing to marking. Next follows a "letters" signal which releases the receiver ring counter in phase with the transmitter. Thereafter intelligence signals produce a pip at each reversal which when applied to the grid of one of the tubes of the multivibrator which drives the receiving distributor serves to maintain it in synchronism with the transmitter.

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Tape Reading Punch

F. J. Haupt

3,016,186—January 9, 1962

A tape reperforator provided with tape sensing pins for reading the last punched tape perforations. If an error is detected such as an incorrect ratio in a parity code the tape automatically back steps and then over punches the errored combination with the blank code whereupon the correct code may be re-punched. Illustrated is a reperforator for 8-element parity code wherein the bases of the punch pins are normally beyond the travel reach of the armature of the punch magnet except as the associated code magnets project the ends of one or more individual sliding bars into the intervening spaces between the armature and the selected pins.

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Frequency Shift Modulation Receiver

J. E. Boughtwood, T. M. Grybowski

3,017,464—January 16, 1962

A discriminator for frequency shift signals of the type which employs a series resonant circuit and bridge rectifier combination respectively for both the marking and spacing frequency to provide a conventional linear discriminator characteristic. By a single variable capacitor joining a like point in the two resonant circuits the characteristic can be bodily shifted upward or downward in frequency in order to center it at the mid-frequency of the channel and thereby achieve symmetry of the marking and spacing signals. The discriminator output then energizes a symmetrical transistor amplifier provided with a unitary adjustable bias control.

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Ferrite Inductance Cores

R. C. Taylor
3,028,570—April 3, 1962

An inductance coil having a ferrite core bearing a positive temperature coefficient of permeability and composed of two cup shaped halves disposed to present a central and a peripheral air gap, this latter gap being cemented with an epoxy resin having a positive temperature coefficient of expansion. Hence an inductance variation due to a permeability change in the ferrite is compensated by a like opposing variation due to a dimentional change in the two air gaps. The resin may include intermixed iron particles and one of the cups includes distributed radial exit slots in its planar surface to conveniently accommodate the coil leads whether near the inner or outer turns of the winding.

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Loop Gate Transmitter

P. F. Recca, O. W. Swenson,
W. V. Johnson
3,033,925—May 8, 1962

A transmitter designed to repeat the transmission of the routing or other initial characters punched in a perforated tape, and without limitation on the number of characters. This is accomplished by the cooperative action of a forwardly located tape pulling and a rearwardly located tape pushing sprocket wheel, tape sensing pins positioned therebetween, and a slidable shuttle, including a rectangular opening, arranged to shift lengthwise along the tape. With the pulling wheel locked, the pushing wheel advances the tape over the pins beyond which it rises through the shuttle opening to form a vertical loop. Then, under control of characters punched in the tape or otherwise, the pushing wheel stops, the shuttle slides rearwardly past the sensing pins and the pulling wheel advances the tape over the pins for the repeat transmission.

IN MEMORIAM

It is with deep regret we announce the death of Mr. HOWARD P. CORWITH, retired Vice President Research and Engineering, on June 10, 1962. Many of our readers will recall that through his leadership research and development played a prominent role in revolutionizing Western Union's operations during the decade in which they became automatic, electronic and ultra modern.

During his 43 years with Western Union, Mr. Corwith contributed substantially to its advances in research, especially in the fields of microwave beam, facsimile, and submarine cable communications. His passing is a great loss to his associates and the readership of the Western Union TECHNICAL REVIEW.

Modern Trends in Data Communication

"MODERN TRENDS IN DATA COMMUNICATIONS" was the topic of a panel discussion at the 16th Annual Convention of the Armed Forces Communications and Electronics Association, held in Washington, D.C. on June 12 thru 14, 1962. Admiral J. R. Redman, our Western Union consultant in Washington, introduced the panel. Mr. T. F. McMains, Vice President and Assistant to the President at Western Union, was the moderator.

The two articles by Mr. J. E. Boughtwood and Mr. Robert Steeneck were extracted from the papers presented at this meeting. They are published here with the permission of SIGNAL magazine where they will appear in their entirety. Additional papers from this meeting will be extracted and published in the October issue of the Western Union TECHNICAL REVIEW.

WESTERN UNION ENGINEERS AT AFCEA CONVENTION

Panel Members and Moderator (from left to right) J. E. Boughtwood, RADM Joseph R. Redman, U.S.N. (Ret.), G. G. Light, J. M. Reardon, R. Steeneck, and T. F. McMains.

Book Review

Information Theory, edited by Colin Cherry, published by Butterworths' Inc. 1961, Washington, D. C., 1961 (476 pages).

Thirty-six papers relating to information theory and presented in 1960 at the fourth London symposium on that subject make this an unusual book. Not many books in this area touch on so many facets of this relatively new field. The papers are complete with discussions and are notable for the great variety of topics presented.

This variety extends from predominantly mathematical contributions to reports of experiments in psychology. Some require superior mathematical training from the reader as well as superior type setting from the printer while others require little more from the reader than a knowledge of simple arithmetic. Most of the papers are from the United States and England but papers from Italy, Austria, Czechoslovakia and Poland are included.

Some of the topics presented are Error Correcting Codes, Congestion in Telephone Exchanges, Machine Reading of Cursive Script and subjects pertinent to language translating machines. An unexpected bit is the reproduction of eight pages of cartoons from the *New Yorker* in a study of Hesitation and Information in Speech.

Considering the speed with which the scope of Western Union's communications services is broadening, the reader would be well advised not to neglect this material.

—R. C. Taylor

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COMING EVENTS—in Future Issues

The following articles will be included in future issues of the Western Union Technical Review:

PERT—A Management Tool . . . . by E. R. Adamkiewicz and A. Marra

New Techniques in Measurement of Discontinuities in Waveguide Runs . . . . by E. Arnoff

A Synchronous Adapter . . . . by E. J. Chojnowski

The Regulator Invertor . . . . by F. L. O'Brien

The 2AL Recording Paper . . . . by B. L. Kline