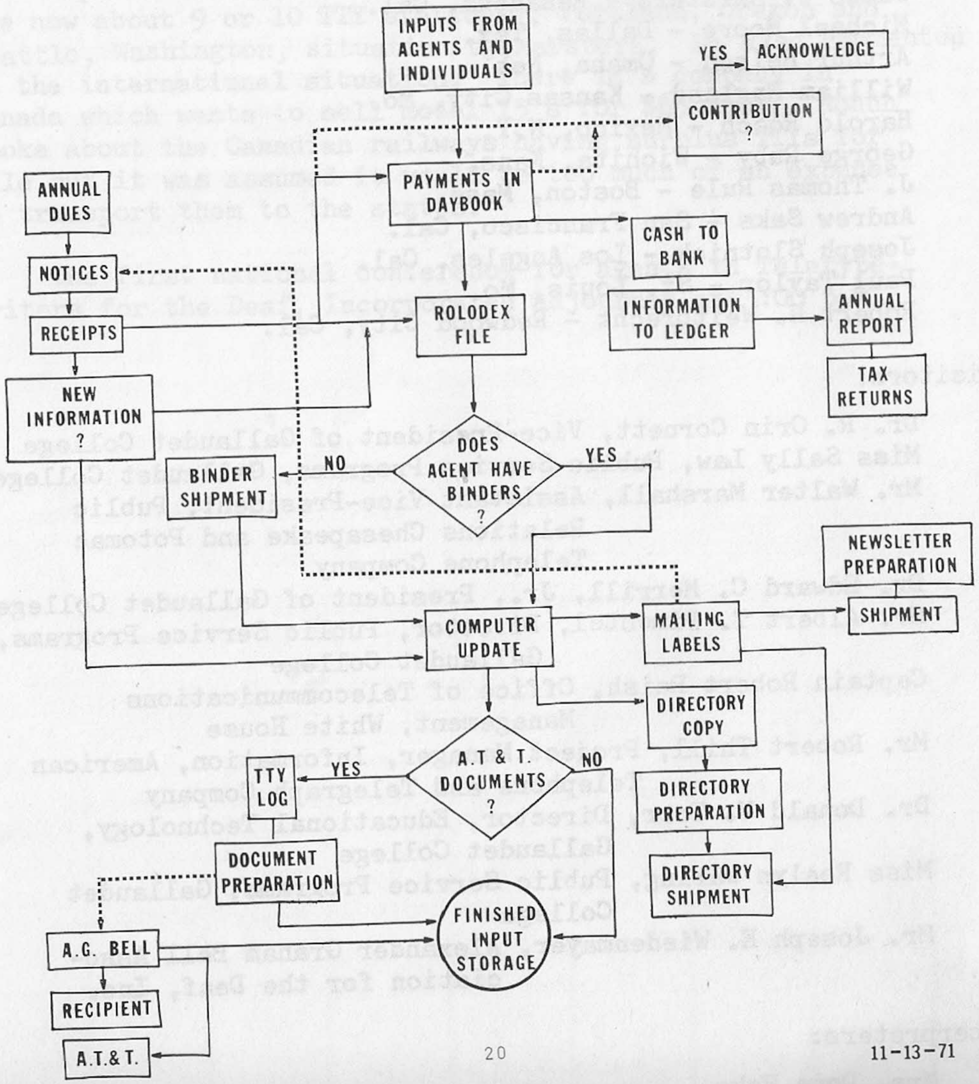
Appendix A

TELETYPEWRITERS FOR THE DEAF, INC.

INPUT PROCESSING ROUTINE



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Appendix B

A TELEPHONE-TELETYPEWRITER SYSTEM

By: Robert H. Weitbrecht

Introduction:

Due to the limited time for presentation at the Teletypewriters for the Deaf conference, it will suffice to present basic principles of a telephone-teletypewriter system. Literature is abundant in this direction, and appropriate references will be given.

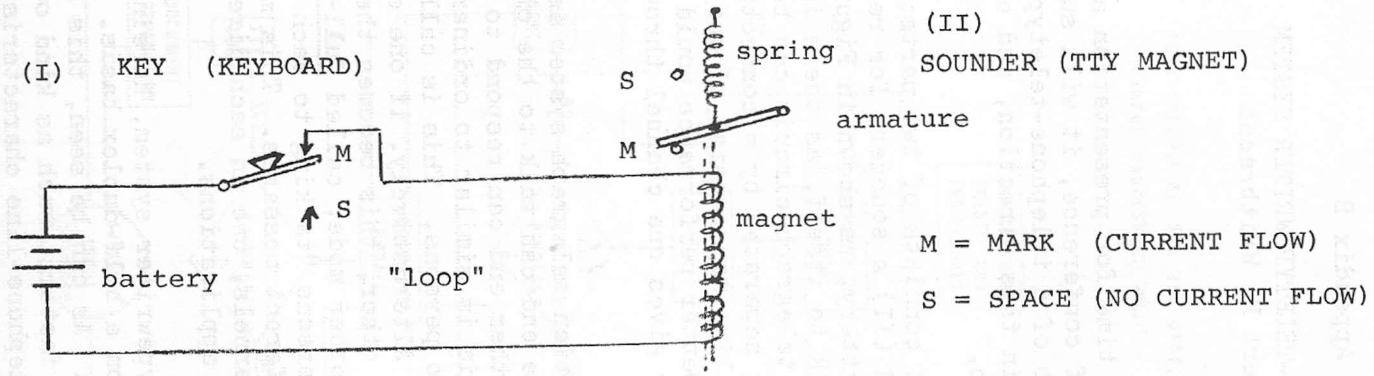
A telegraph circuit consists of two parts; (I) a key, for sending signals, and (II) a sounder, for receiving signals. Connected to a battery, as shown in Figure 1, this arrangement can only talk to itself, as there is only one station. Now, the same telegraph circuit can be expanded to include two stations, separated by a connecting "line". As Figure 2 shows, this line may consist of one copper wire plus a ground return. Better performance would require two wires. Either way, this gives one channel through which messages can pass.

Normally, a two-station telegraph system is operated in such a manner that one end can talk to the other end at one time, and then the other end can respond to the first end at another time. This is similar to ordinary conversation going on between two persons. This is called the simplex mode or method. Alternatively, if one end has the ability to interrupt the other, this becomes the half-duplex mode. Then, there is another mode, called full-duplex; briefly it is like two persons "talking to each other at the same time", with different messages. This mode, however, requires two separate channels, one in each direction. It is much used in computer applications.

The telephone-teletypewriter system, herein described, is capable of operation on a half-duplex basis. Timing considerations are involved. As can be seen, this also involves consideration of various factors, such as kind of messages, signaling speeds, and telephone-line characteristics.

The Teletypewriter:

The teletypewriter is a telegraph system with a built-in code, so that the equipment takes on the appearance of an ordinary typewriter, quite usable by anyone who can at least



Note: This is inverse to actual Morse telegraphy; it is illustrative for teletypewriter operations only.

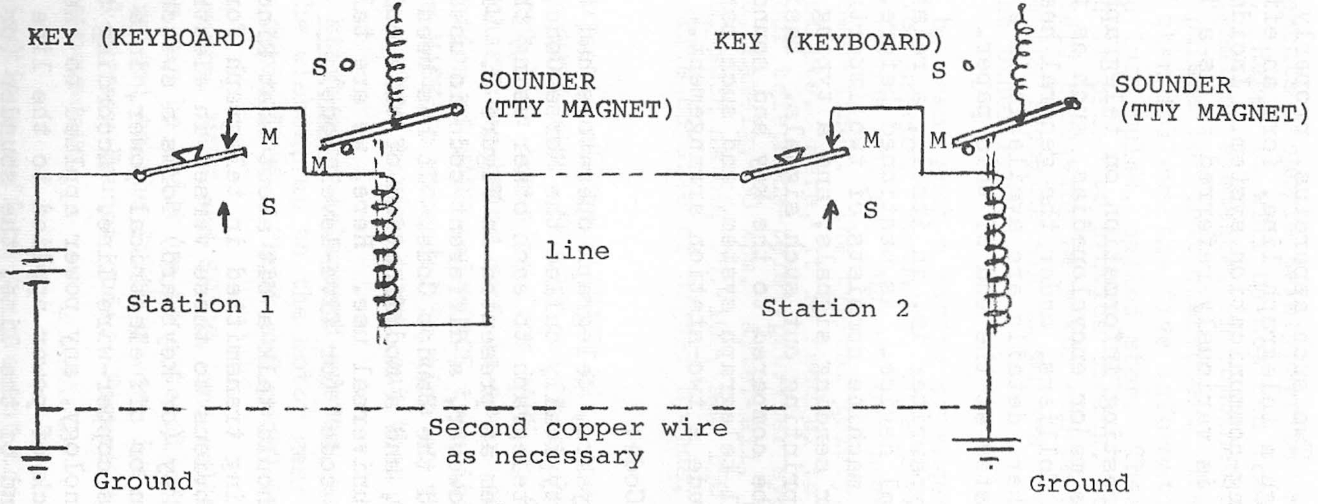


Fig. 2

read and write. Two such apparatus, properly connected together through a telegraph line, form an effective two-station printing-communication system. Incidentally, a teletypewriter is variously referred to as a Teletype or a teleprinter.

Much interesting information on telegraph systems can be found in the major encyclopedias, such as the Britannica, Americana, and Colliers, under the general heading "Telegraphy". Further, details are available in a number of references, listed at the end of this paper.

The teletypewriter is, in itself, a relatively complicated mechanical device. As mentioned before, a code is built in. The machine consists of two important parts - a keyboard, for sending signals, and a typing unit, for receiving and printing out such signals. Basically, these two parts can be compared to the key and sounder combination in the Figure 1 telegraph system, and such parts can be extended to include a two-station arrangement.

The Signaling Code:

For many years, telegraph operators had to know a certain code, typically called the Morse Code, in order to be able to telegraph to each other using the simple telegraph system as presented in Figure 2. With the teletypewriters, however, a different code is used; it is commonly called the Baudot Code. It has been in existence over 100 years, and a modification of this code, called Murray, is in universal use. Here, we are talking about the "five-unit code" (or five-level code).

Now, we should talk a bit about what kind of signal is actually being transmitted in telegraph form over a copper wire. As is obvious to those versed in electrical matters, the telegraph key (or keyboard) forms a switch which is operated to turn on or off electrical power, in a time sense, applied to this copper-wire line. According to telegraph-industry terminology, any power applied to the line is called MARK, while lack of power applied to the line is called SPACE. At the other end of the line, the sounder (or teletypewriter magnet) receives these power pulses, in a corresponding time sense; the magnet operates to pull an armature on MARK, and releases the armature (pulled by a spring) on SPACE. This magnet may operate a clapper to generate a distinctive sound to the telegraph operator, or it may operate a selector mechanism in a teletypewriter.

Figure 3 presents a sample teletypewriter signal, say, for the letter A. Here, it will be noticed that there are two additional signaling elements, in combination with the five information pulses for that character. The first pulse is called start, then follows the five information pulses, and, finally, the last pulse, called stop. These two extra pulses are needed in order to provide timing, so that the TTY (teletypewriter) receiving selector can be properly started to decode the incoming signal pulses from the keyboard (or from the other end).

As will now be seen, such a timing arrangement requires very accurate motor speeds. Normally, this means the use of electric synchronous motors, run off our present-day, well-regulated power lines. The typical teletypewriter speed is 60 words per minute. Here, it is needful to know that all machines in our telephone-teletypewriter system be geared to the same speed, namely, 60 wpm. After all, there are many other gear speeds, such as 66, 75, 100, and 150 wpm. In fact, there exist some TTYs capable of higher speeds, such as 1200 wpm.

The start pulse is always a SPACE bit, and the stop pulse is always a MARK bit. Should only one character be sent, the telegraph line transits from MARK to SPACE to indicate that the character being sent is about to start; then follows a combination of MARK and SPACE transitions for the stop pulse. This MARK is extended in time so that the machine now rests quietly, after having typed out that one character.

With such a start-stop telegraph system, an operator can type as fast as he wishes, up to the motor gear limit, 60 wpm or as slow as is typical of a "hunt and peck" typist.

The two elements, MARK and SPACE, are called permutations. Such permutations can be built up to a total of 32 different combinations (2 raised to the fifth power, i.e., 2x2x2x2x2), as in the 5-level Murray-Baudot code. Figure 4 presents the code as is in use nowadays.

The 32 combinations suffice to present the 26 letters in the alphabet, plus certain stunt signals, such as carriage return, line feed, spacing, blank, and, finally, letters shift and figures shift. The latter two functions enable sending numbers and punctuation marks in the FIGS position as well as letters in the LTRS position. Thus, it can be noticed that the keyboard of a TTY resembles that of an ordinary office typewriter in many respects. The stunt

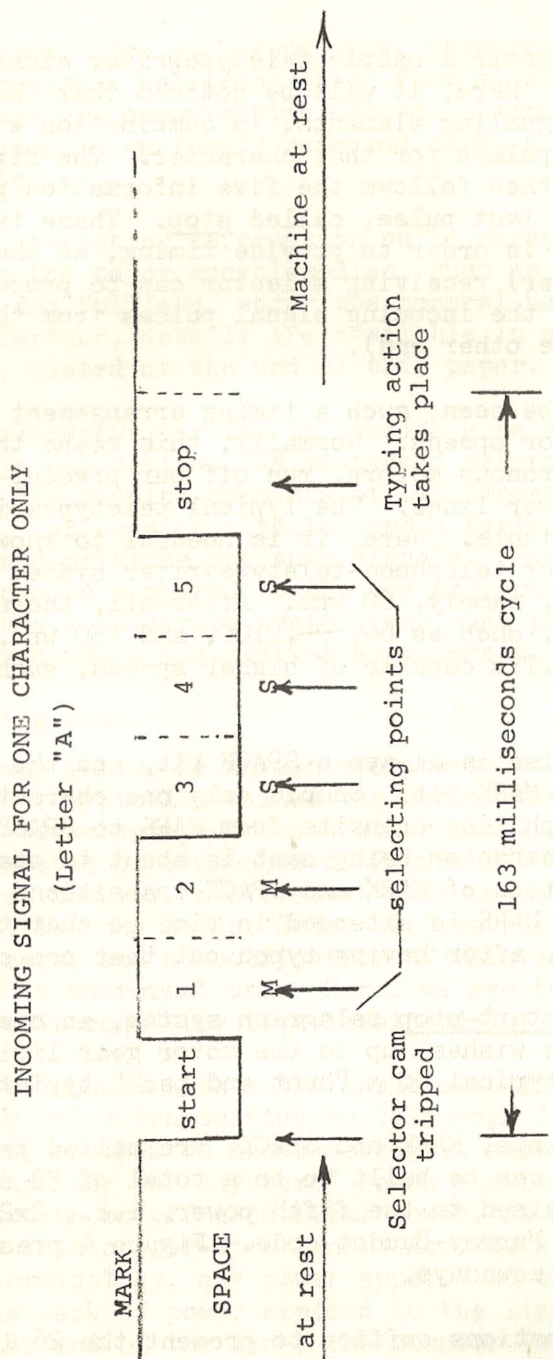


Fig. 3

fig.4

BAUDOT CODE

○ SPACE ● MARK

A	●●○○○	N	○○●●○
B	●○○●●	O	○○○●●
C	○●●●○	P	○●●○●
D	●○○●○	Q	●●●○●
E	●○○○○	R	○●○●○
F	●○●●○	S	●○●○○
G	○●○●●	T	○○○○●
H	○○●○●	U	●●●○○
I	○●●○○	V	○●●●●
J	●●○●○	W	●●○○●
K	●●●●○	X	●○●●●
L	○●○○●	Y	●○●○●
M	○○●●●	Z	●○○○●
BLANK	○○○○○		
CAR. RET'N.	○○○●○		
LINE FEED	○●○○○		
SPACE	○○●○○		
LETTERS	●●●●●		
FIGURES	●●○●●		

functions are fairly obvious, and are easy to learn by anyone, let alone the experienced typist.

The Telephone Line:

There are millions of miles of telephone lines all over the country. Many calls are made daily in voice by hearing people. Voice consists of much higher frequencies than those of telegraph signals. Therein lies a problem of generating and receiving telegraph signals in suitable form over such voice facilities. It is well solved by the use of suitable tones, which are easy to generate, turn on-and-off, and to shift in frequency. Such tones can then pass through the regular telephone lines, using suitable couplers, or, as variously called, terminal units or modems. Such devices can be acoustic-inductive coupled in conjunction with regular telephone handsets, or else be hard wired directly to telephone lines, as were the earliest modems for the deaf. For obvious reasons, the acoustic-inductive coupler is most convenient and directly applicable for use by deaf people in operating TTYs in conjunction with regular telephones. Hence, the Telephone-Teletypewriter System.

The Telephone-Teletypewriter System:

A coupler or terminal unit was designed some years ago with particular application to a suitable telephonic communication system for the deaf, making use of the teletypewriters available as surplus from the various operating telephone and telegraph companies. It operates on a single-channel basis, somewhat like the telegraph system in Figure 2; only in this case we substitute a tone in place of an electric current; such tone energy now passes through the voice facility offered by the telephone line. Now, see Figure 5.

In as much as the pulses from the TTY keyboard must be converted into tone bursts of suitable frequencies for passing through the telephone line, the coupler has a modulator. Simply, it is an electronic oscillator which is not only turned on-or-off, but also is frequency shifted by the MARK and SPACE pulses from the keyboard. The power output from this oscillator drives a small loudspeaker which is a part of a cradle box. This part delivers a sound into the mouthpiece of a telephone handset lying therein. The resulting tone now travels over the telephone line to the far end. In a sense, this is a transmitter (sender).

At that end, there is another telephone handset, lying in another cradle box. A pickup device, in that box, receives

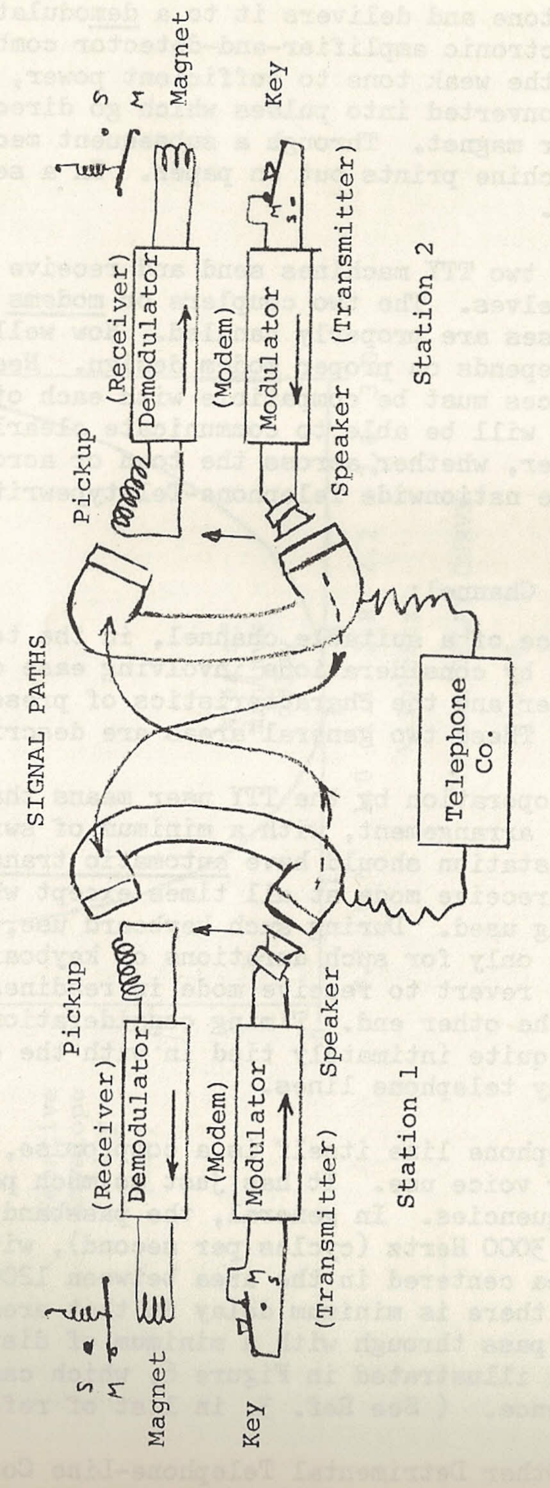


Fig. 5

the incoming tone and delivers it to a demodulator. It is really an electronic amplifier-and-detector combination. It amplifies the weak tone to sufficient power, and then it is properly converted into pulses which go directly to the TTY's selector magnet. Through a subsequent mechanical cycle, the machine prints out on paper. In a sense, this is a receiver.

Now, the two TTY machines send and receive pulses between themselves. The two couplers or modems see to it that such pulses are properly handled. How well such pulses are handled depends on proper modem design. Needless to say, all such devices must be compatible with each other, so that any TTY owner will be able to communicate clearly with any other TTY owner, whether across the town or across the country, as in the nationwide Telephone-Teletypewriter Network for the Deaf.

The Signaling Channel:

The choice of a suitable channel, in the telephone line, is determined by considerations involving ease of operation by the TTY user and the characteristics of present-day telephone lines. These two general areas are described below.

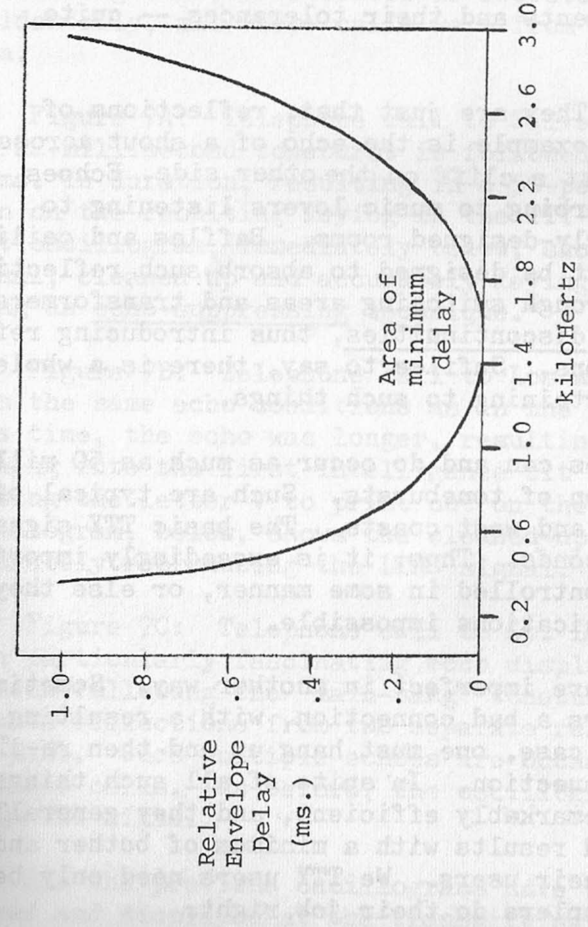
Ease of operation by the TTY user means that he should have a simple arrangement, with a minimum of switching problems. Each station should have automatic transceive -- that is, it is in receive mode at all times except when its keyboard is being used. During such keyboard use, it is in transmit mode only for such durations of keyboard use, afterwards it must revert to receive mode in readiness for any answer from the other end. Timing considerations are involved here, quite intimately tied in with the characteristics of present-day telephone lines.

The telephone line itself is a compromise, designed primarily for voice use. It has just so much passband in terms of frequencies. In general, the passband runs from about 300 to 3000 Hertz (cycles per second), with a most sensitive area centered in the area between 1200 and 1800 Hz. Furthermore, there is minimum delay in that area, so that TTY signals will pass through with a minimum of distortion. This is quite well illustrated in Figure 6, which came from a Bell System reference. (See Ref. 3, in list of references)

Echoes, and Other Detrimental Telephone-Line Conditions:

Introduction: The telephone line has certain detrimental characteristics. One such problem is echo. Due to unavoid-

SMECC



TYPICAL DELAY CURVE

Fig. 6

(This figure was derived from Fig. 13, p. 17, BELL TELEPHONE SYSTEM Technical Publication Monograph 3580.)

able engineering compromises, there is some echo in any telephone line, particularly on long-distance calls. Usually, for voice use, it is reduced to such proportion so that it does not ordinarily disturb voice talkers. However, for TTY communications, such echoes must be controlled by proper modem design so that they do not affect accuracy of TTY pulses, transmitted and received, at any location. In other words, we want undistorted TTY pulses, so that each TTY machine has a chance to decode them and to deliver exactly what the sender is saying, rather than to print something else, garbling. How accurate these pulses must be involved considerations relating to TTY machine adjustments and their tolerances -- quite another story.

What are echoes? They are just that, reflections of sounds. A well-known example is the echo of a shout across a chasm reflecting against a cliff on the other side. Echoes are particularly disturbing to music lovers listening to orchestras in improperly-designed rooms. Baffles and ceiling/wall conformations must be designed to absorb such reflections. Telephone lines go through switching areas and transformers; such points introduce discontinuities, thus introducing reflections and re-reflections. Suffice to say, there is a whole area of literature pertaining to such things.

In general, echoes can and do occur as much as 50 milliseconds after cessation of tonebursts. Such are typical of circuits between east and west coasts. The basic TTY signaling bit is 22 milliseconds. Thus, it is exceedingly important that such echoes be controlled in some manner, or else they will render TTY communications impossible.

Telephone lines are imperfect in another way. Sometimes a given call encounters a bad connection, with a resulting weak signal. In this case, one must hang up and then re-dial to obtain a better connection. In spite of all such things, telephone lines are remarkably efficient, and they generally do deliver the desired results with a minimum of bother and fuss on the part of their users. We TTY users need only be concerned that our couplers do their job right.

Demonstrations of Typical Echoes on Telephone Lines:

Discussion: A kind of radar system can be set up to detect echoes on telephone lines. The simplest way of doing this is to transmit isolated 22-millisecond, 1800 Hertz tonebursts into a telephone handset, and then record resulting reflections, as picked off from the detector portion of the terminal unit and fed into a suitable oscilloscope. This has been done many times to analyze echoes, not only coming back to the talker, but also other echoes caused by re-reflections, going to the listener.

Shown in Figure 7 are some displays showing TTY pulses on calls to such areas as Los Angeles, St. Louis, and Washington, D. C. Please note that these are echoes resulting from isolated 1800-Hz tonebursts as keyed in LTRS mode using a Model 14 Transmitter Distributor (14-TD). There is a fascinating variety of echoes as received on various calls. Incidentally, all these calls were from the San Francisco area.

Figure 7A: Telephone call to Silver Spring, Maryland. The 22-millisecond toneburst is followed by an echo of about 10 ms. in duration, resulting in a 50-percent SPACE distortion on the resulting keying in the TTY magnet line. The next oscillogram, immediately below, shows the same TTY signal, cleaned up and accurately keying the magnet line, using an echo-suppressing technique.*

Figure 7B: Telephone call to Los Angeles, California. Much the same echo conditions as in the preceding description. This time, the echo was longer, resulting in a SPACE bit falling into the first intelligence bit in the TTY code, causing the letter V to print out on the TTY machine. The oscillogram, below, shows the cleaned-up TTY signal, now accurately reproducing the LTRS signal.

Figure 7C: Telephone call to St. Louis, Missouri. This is a particularly fascinating echo display. Two echoes can be seen following the "main-bang" toneburst. This demonstrates reflections from two separate reflecting points along the line. Such multiple echoes are occasionally seen on long-distance calls. As before, the oscillogram, below, shows a clean TTY signal.

All the previous oscillograms have been on echoes received and displayed at the transmitting point; such echoes are called "talker echoes". Now, here in this Figure 7D, we have a "listener echo" as an add-on to the signaling toneburst at the receiving point. This was a local call, from one telephone to another. This listener echo was a re-reflection of some kind along the telephone line.

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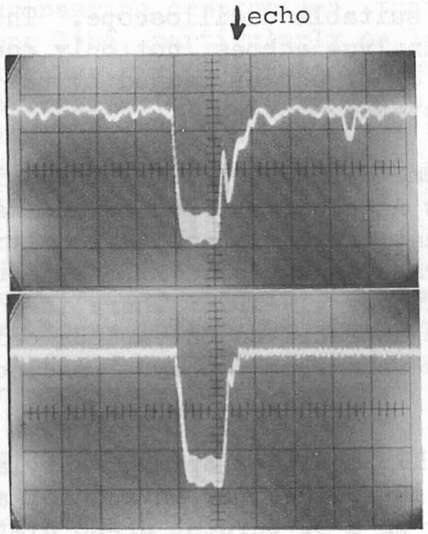
*U.S. Patent Nr. 3,507,997, Canada Patent Nr. 873989

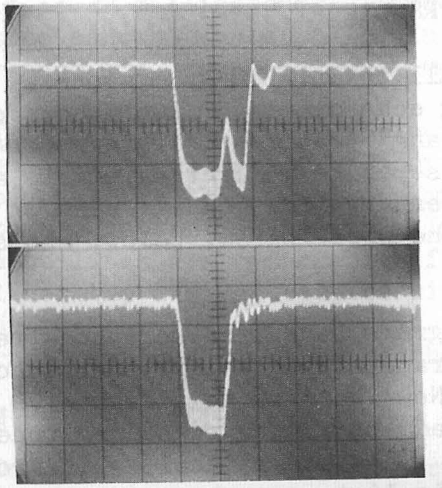


22-millisecond
1800 Hertz tonebursts

Same as above, with
echo suppressing tone
added.

TELEPHONE CALL TO
SILVER SPRING, MARYLAND
FROM SAN FRANCISCO, CALIF.

FIGURE 7A

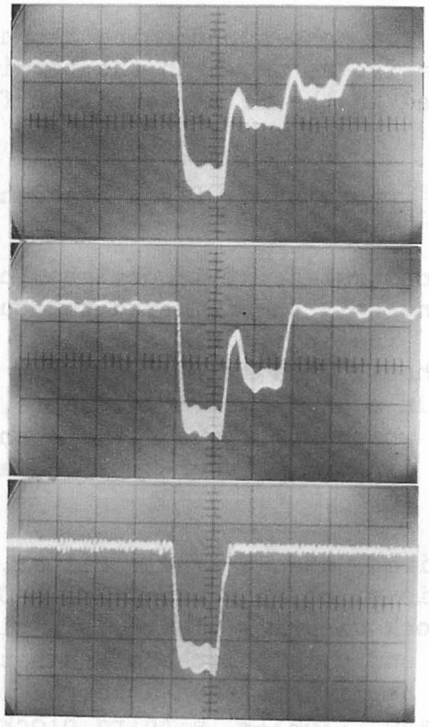


22-millisecond
1800 Hertz tonebursts

Same as above, with
echo suppressing tone
added.

TELEPHONE CALL TO
LOS ANGELES, CALIF.
FROM SAN FRANCISCO, CALIF.

FIGURE 7B



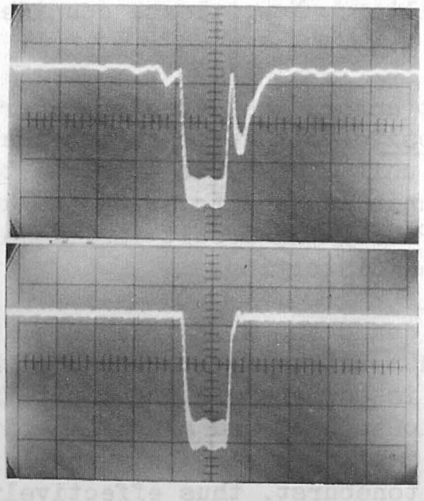
22-millisecond
1800 Hertz tonebursts

Same as above.
Different transmit
level adjustment.

As above, with echo
suppressing tone
added.

TELEPHONE CALL TO ST. LOUIS, MO.
FROM SAN FRANCISCO, CALIF.

FIGURE 7C



22-millisecond
1800 Hertz tonebursts

Same as above, with
echo suppressing tone
added.

LOCAL CALL BETWEEN TWO
TELEPHONES
(SAN FRANCISCO, CALIF. AREA)

FIGURE 7D

Now, we will discuss the echo-suppressing technique, which has been quite effective as shown in the terminal units presently widely used in the Teletypewriters for the Deaf, Inc. network.

Echo Suppression, Using a Transmitted Offset-Frequency Toneburst:

As has just been demonstrated, it is obvious that a TTY communication system, using only on-off keyed tonebursts, cannot very well succeed. The individual signaling tonebursts are followed by echoes. This is particularly aggravating to systems operating in a high-gain mode. Here, we are designing a terminal unit which will be as simple and foolproof as possible, with a minimum of user-operated adjustments.

The system, as conceived, uses a single filter, responsive to SPACE-bit transitions, at a frequency of 1800 Hz. Shown in Figure 8 is a block diagram. There is a pickup device, placed at the ear end of a telephone handset. Follows a block showing a limiter amplifier, then a second block showing a single filter, and, finally, a third block showing a detector-keyer which then feeds pulses into the TTY magnet line. These three blocks, in addition to the pickup device, represent the receiving portion of the terminal unit.

Shown in the third block is a MARK injecting arrangement, designed to inject one unit of constant voltage to keep the detector-keyer output on MARK in the absence of any signaling SPACE toneburst from the filter. Now, please consider Figure 9.

When a SPACE toneburst enters the detector-keyer, it generates two units of opposite voltage to switch the TTY magnet line to SPACE. One unit is used to overcome the MARK injection, and the second unit is used to swing the keyer postion symmetrically to SPACE. The result is TTY magnet-line keying with very little distortion.

Echoes, as mentioned, could and will interfere, if such echoes are from 1800 Hz SPACE-bit keyings. How are they suppressed? A logical way is to generate an offset-frequency toneburst, immediately following any and all SPACE-bit tonebursts. Thus, the limiter amplifier sees only the large-amplitude offset-frequency toneburst, thus effectively covering the weaker SPACE-bit echo. The filter has negligible response to this offset frequency, so this results in MARK signaling to the TTY magnet line, by virtue of the aforementioned single-

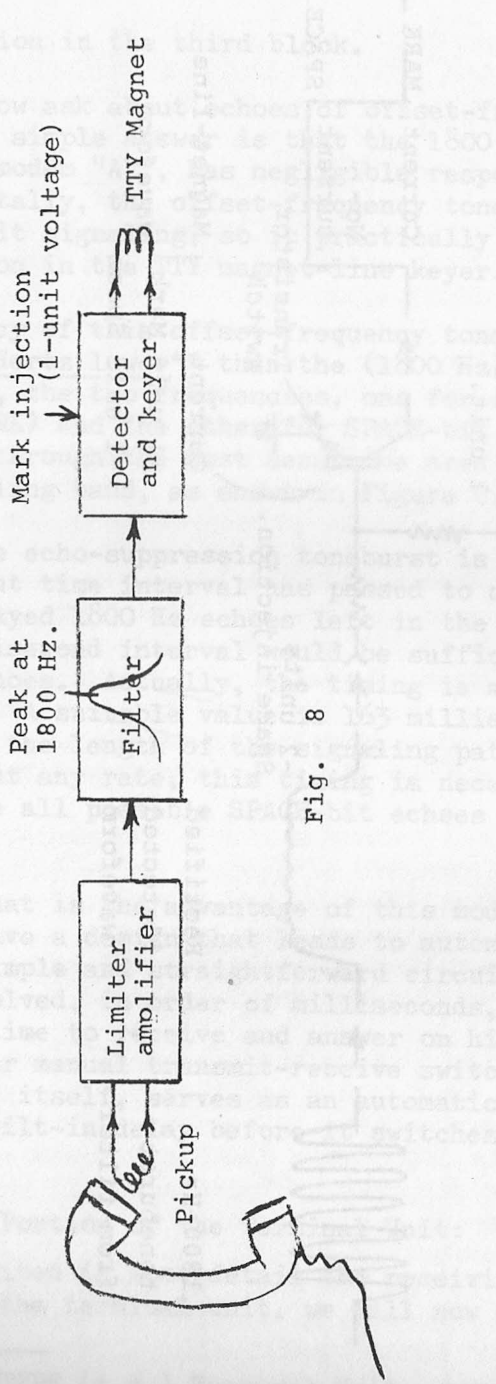


Fig. 8

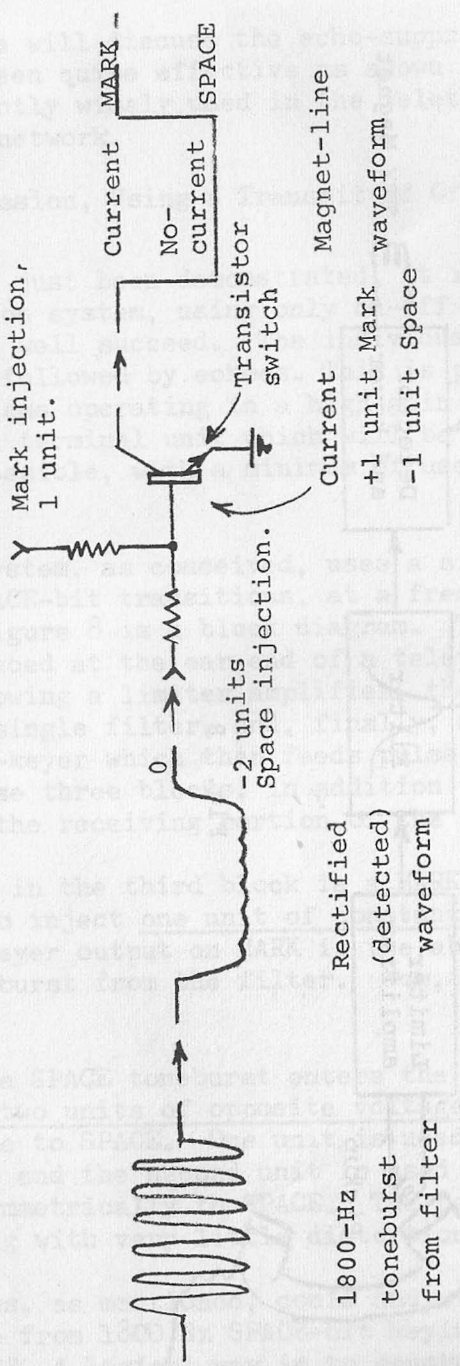


Fig. 9

unit MARK injection in the third block.

One could now ask about echoes of offset-frequency tonebursts. The simple answer is that the 1800 Hz filter, as in a certain modem "A"*, has negligible response to such echoes. Incidentally, the offset-frequency toneburst is nominally MARK-bit signaling, so it practically acknowledges the MARK injection in the TTY magnet-line keyer.

The frequency of this offset-frequency toneburst is several hundred Hertz lower** than the (1800 Hz) SPACE-bit signaling. Thus, the two frequencies, one for echo suppression (nominal MARK) and the other for SPACE-bit signaling, suffice to pass through the most sensitive area in the telephone-line signaling band, as shown in Figure 6.

Further, the echo-suppression toneburst is turned off after a sufficient time interval has passed to assure that there are no delayed 1800 Hz echoes left in the telephone line. A 50-millisecond interval would be sufficient to suppress most echoes. Actually, the timing is made longer than that value. A suitable value is 163 milliseconds, corresponding to the length of the signaling pattern for one TTY character. At any rate, this timing is necessary, in order to overcome all possible SPACE-bit echoes in the telephone line.

Now, just what is the advantage of this modem "A" system? Here, we have a design that leads to automatic transceive, using a simple and straightforward circuit. The short timing involved, in order of milliseconds, gives each user sufficient time to receive and answer on his TTY, and with no particular manual transmit-receive switching. Thus, the TTY keyboard, itself, serves as an automatic transmit switch, with a built-in delay before it switches back to receive.

The Transmitting Portion of the Terminal Unit:

Having described in some detail the receiving portion (demodulator) of the terminal unit, we will now consider the

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*Modem "A": PHONETYPE (t.m.) Terminal Unit, manufactured by Applied Communications Corp.

**Nominally, 1400 Hz, with a tolerance of ± 10 percent.

transmitting portion (modulator). It consists, essentially, of an oscillator, which is not only turned on-and-off, but is also frequency-shift keyed. Two frequencies are generated, alternately, for SPACE-bit signaling and for echo suppression. Now, consider Figure 10.

The keyboard drives a timing circuit which causes the oscillator to turn on and to stay on as long as any TTY character signaling continues. Upon cessation of keying, the timer turns off the oscillator after about 150 milliseconds. Timing, here, is relatively uncritical just so long as it is sufficient to cover all possible echo time intervals during telephone calls. The frequency shift is accomplished by means of a switching circuit which causes the oscillator to vary in frequency, signaling (SPACE) or echo-suppressing (MARK), as signalled by the keyboard.

Shown in Figure 11 are a series of oscillograms showing the signaling as it progresses through the system from keyboard actuation to TTY magnet actuation. The first two oscillograms, A and B, pertain to the signaling in the transmitting portion, while the other two oscillograms, C and D, pertain to the signaling in the receiving portion, as, for instance, at the far end of a telephone line.

Oscillogram A shows a single TTY character for the letter Y. It consists of a start pulse (S), then five intelligence pulses (MSMSM), and a stop pulse (M). As only one character was transmitted, the stop pulse extends itself into a MARK condition on which the TTY machine is at rest, after having printed out one Y letter.

Oscillogram B shows the toneburst pattern, as it enters the telephone line. This is an on-off keyed, frequency-shift-keyed tone package. Comparing with the signaling as shown in A, the 1800-Hertz SPACE-bit tones and the offset-frequency echo-suppressing tones are well represented. In addition, there is a continuation of the echo-suppressing tone for approximately 165-milliseconds after the last SPACE-bit signaling in the TTY-code pattern. This assures that the telephone line will be cleared of all SPACE-bit echoes before the tone turns itself off.

Oscillogram C shows the detected toneburst pattern in the receiving portion. The MARK and SPACE transitions are well shown, and, further, there is negligible effect when the tone turns itself off. A special circuit is used to

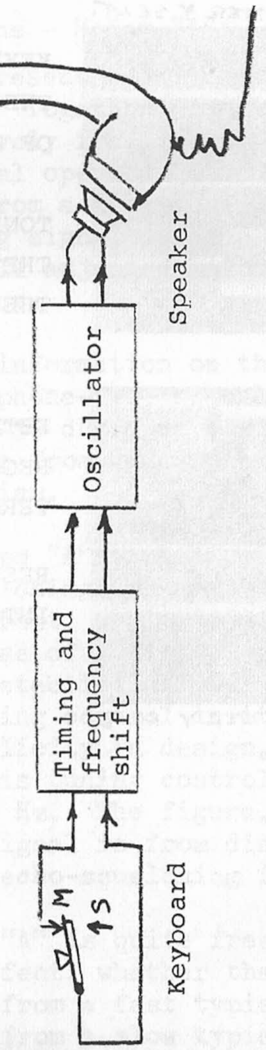
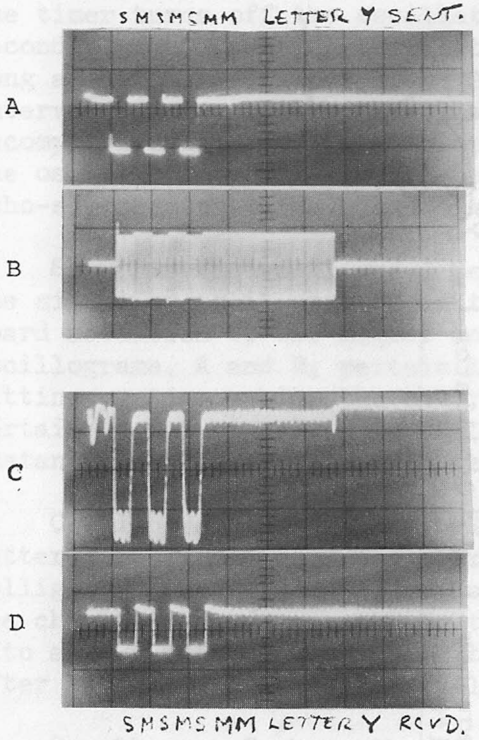


Fig. 10



A — KEYBOARD SIGNAL INTO THE TRANSMITTING PORTION OF THE TERMINAL UNIT.

B — TONEBURST PATTERN INTO THE LOUDSPEAKER, FEEDING THE TELEPHONE HANDSET.

C — DETECTED PATTERN IN THE RECEIVING PORTION OF THE TERMINAL UNIT.

D — RESULTING SIGNAL, AS KEYED INTO THE TTY MAGNET LINE.

FIGURE 11

sample midpoints of the MARK-SPACE transitions in this waveform, as delivered by the detector, driven by the single 1800 Hz filter.

Oscillogram D presents the waveform as delivered to the TTY-magnet-keying line. Thus, it is an identical reproduction of the keyboard signal at the transmitting point of the telephone line.

Performance Specifications - Modem "A":

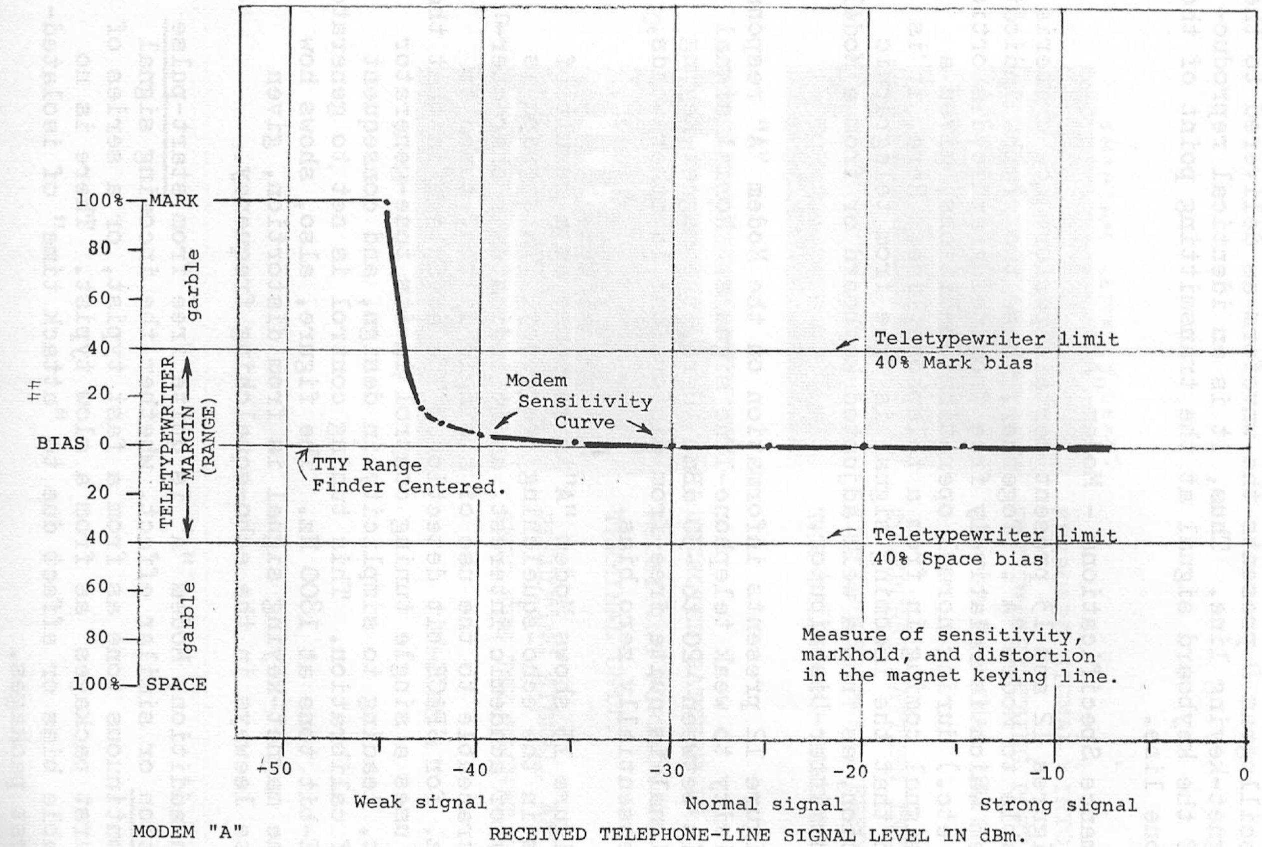
Figures 12 and 13 present certain performance criteria applicable to Modem "A". Together, these two graphs indicate a system which is relatively free from telegraphic distortion (bias, etc.) during normal operating conditions, given a clean signal coming in from a telephone line. Here, it is assumed that the incoming signal is free from telegraphic distortion, as from a well adjusted keyboard or from a Model 14 Transmitter-Distributor.

Figure 12 presents information on the Modem "A" response sensitivity to weak telephone-line signals. Normal signal level is between -20 to -30 dBm. Here, the magnet-keying line signal is quite free from distortion; in other words, it is essentially zero bias.

Figure 13 shows Modem "A"'s response as a result of leeways in the echo-squelching frequency. This graph is chiefly of academic interest, as it indicates a characteristic traceable to the use of a single filter, tuned to 1800 Hz, for SPACE-bit detection. The advantage is that the system uses a single tuning control in its tone-generator circuit, leading to simplicity in design, and consequent ease of calibration. This tuning control is set to generate a SPACE-bit tone at 1800 Hz. The figure, also, shows how free the magnet-keying signal is from distortion, given moderate leeways in the echo-squelching frequency.

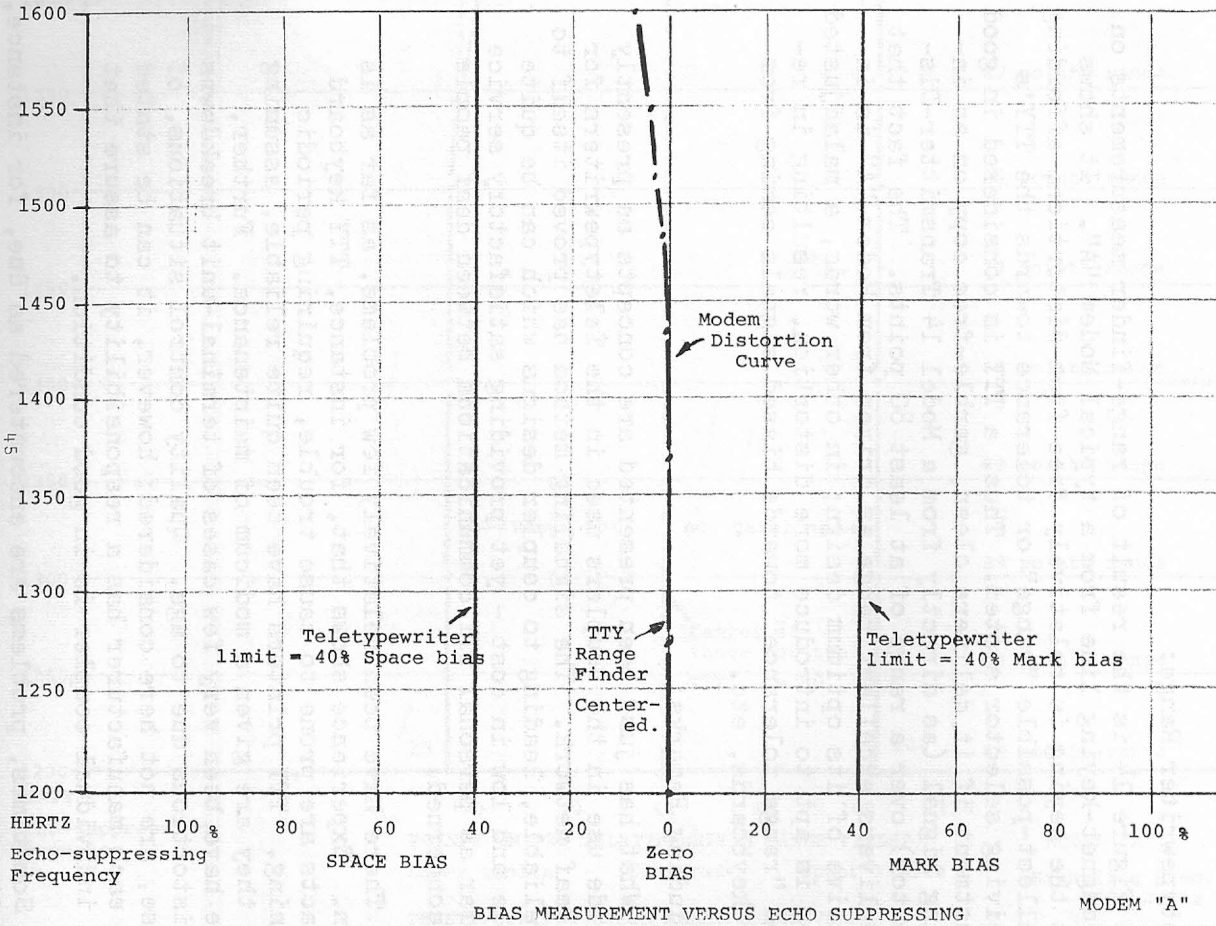
In addition, Modem "A" is quite free from start-pulse distortion or similar effect, whether the incoming signal is a continuous tone as from a fast typist, or a series of "toneburst packages" as from a slow typist. There is no measurable bias or effect due to "attack time" of isolated-toneburst packages.

All in all, Modem "A" is conservatively rated at less than 5 percent overall telegraphic distortion. At least, we can be reasonably sure that distortions found could



BIAS MEASUREMENT VERSUS TELEPHONE-LINE SIGNAL LEVEL

Fig. 12



BIAS MEASUREMENT VERSUS ECHO SUPPRESSING FREQUENCY

Fig. 13

be caused by poor keyboard adjustments, or maladjustments in the teletypewriter's receiving selector system. In other words, what is desired is a reliable modem which one can depend upon. There are too many parts in a TTY communication system, and it is urgently desired that each part be as reliable and foolproof as possible.

Teletypewriter Range:

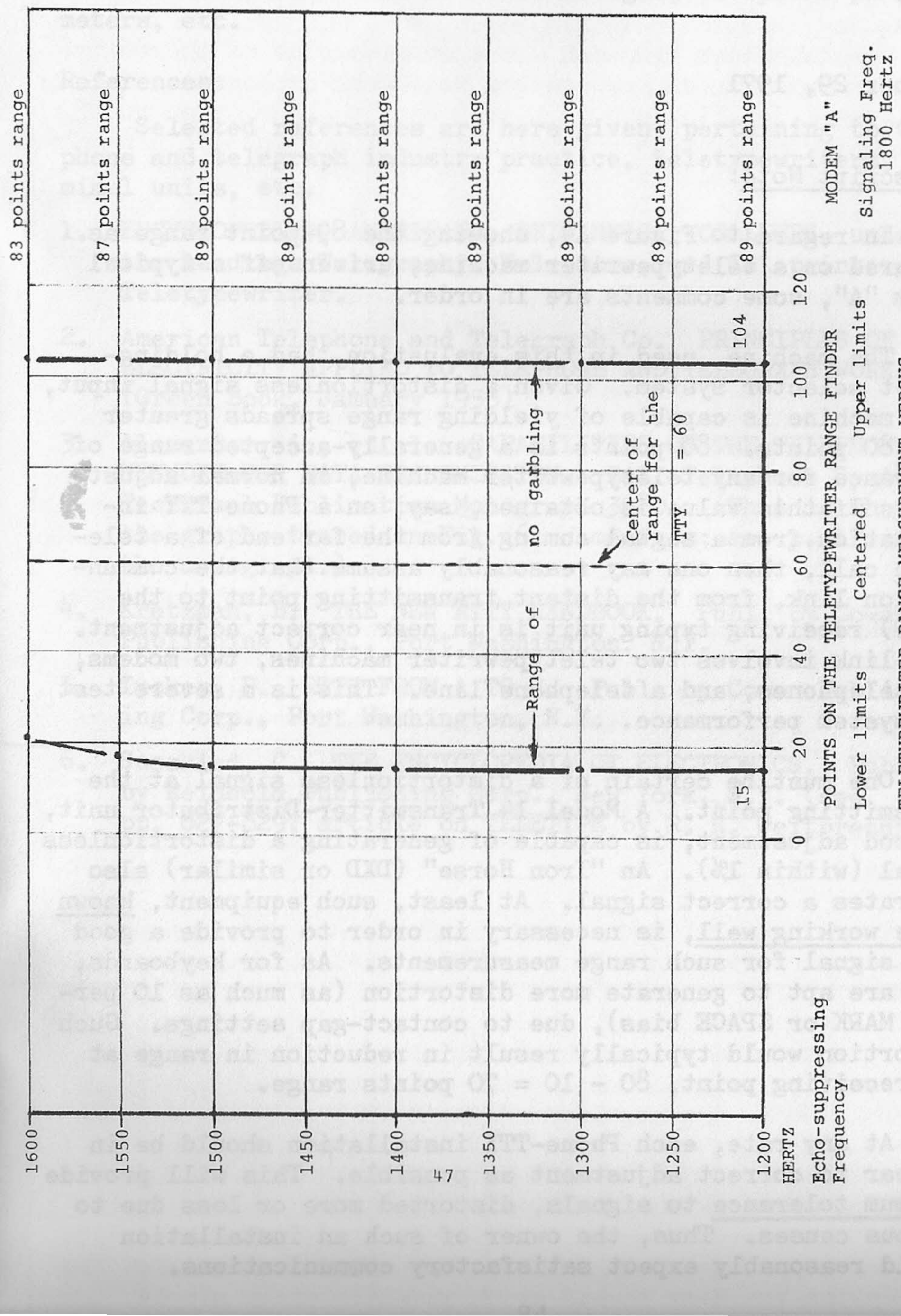
Figure 14 is the result of range-finder measurements on the magnet-keying line from a typical Modem "A". It shows that the keying is relatively free from distortion, affording a fullest-possible "range" or tolerance towards the TTY's receiving selector system. Thus, a TTY is considered in good adjustment if it delivers clean, garble-free copy on an incoming signal (as directly from a Model 14 Transmitter-Distributor) over a range of at least 80 points. The fact that it delivers excellent range as driven from Modem "A" is indicative of its optimum design; in other words, a maladjusted modem is apt to introduce more distortion, resulting in reduced "range tolerance" towards biased signals coming from poor keyboards, etc.

Concluding Remarks:

What has just been presented are concepts as presently in wide use in the couplers used in the Teletypewriters for the Deaf network. The signaling method has proved itself to be reliable, leading to coupler designs which can be quite simple and low in cost - yet providing satisfactory service insofar as personal TTY communications between deaf people are concerned.

There have been relatively few problems, as far as is known. Experience shows that, for instance, TTY keyboard contacts are prone to cause trouble, requiring periodic cleaning. TTY printers have been quite reliable, assuming that they are given a modicum of maintenance. Further, there have been very few cases of terminal-unit breakdowns or distortions due to age. Quality control situations, of course, are not here considered; however, it can be stated that each manufacturer has a responsibility to assure that each individual coupler is in good condition.

Sometimes, problems are encountered as due, for instance, to radio-frequency interference in the telephone line from some nearby broadcasting station. The telephone company installs special filters in such telephones as necessary.



TELETYPEWRITER RANGE MEASUREMENT VERSUS FREQUENCY (ECHO SUPPRESSING)

Fig. 14

Acknowledgement:

Appreciation is here expressed to Teletypewriters for the Deaf, Inc. for inviting the presentation of this paper at the TDI conference in Washington, D.C. on November 13-14, 1971.

October 29, 1971

Postscript Note:

In regard to Figure 14, showing the 89-point range as measured on a teletypewriter machine, driven off a typical Modem "A", some comments are in order.

The machine, used in this evaluation, had a holding-magnet selector system. Given a distortionless signal input, this machine is capable of yielding range spreads greater than 80 points. 80 points is a generally-accepted range of tolerance for any teletypewriter machine, in normal adjustment. If this value is obtained, say, on a Phone-TTY installation from a signal coming from the far end of a telephone call, then one may reasonably assume that the communication link, from the distant transmitting point to the (here) receiving typing unit is in near correct adjustment. This link involves two teletypewriter machines, two modems, two telephones, and a telephone line. This is a severe test for system performance.

One must be certain of a distortionless signal at the transmitting point. A Model 14 Transmitter-Distributor unit, in good adjustment, is capable of generating a distortionless signal (within 1%). An "Iron Horse" (DXD or similar) also generates a correct signal. At least, such equipment, known to be working well, is necessary in order to provide a good test signal for such range measurements. As for keyboards, they are apt to generate more distortion (as much as 10 percent MARK or SPACE bias), due to contact-gap settings. Such distortion would typically result in reduction in range at the receiving point, 80 - 10 = 70 points range.

At any rate, each Phone-TTY installation should be in as near to correct adjustment as possible. This will provide maximum tolerance to signals, distorted more or less due to various causes. Thus, the owner of such an installation should reasonably expect satisfactory communications.

Before closing, it is well to mention teletypewriters using pulling-magnet selectors. Modem "A" is capable of driving one such machine to a range span of 80 points. Thus, when evaluating system performance, there are various factors to be considered - such as modem designs, telephone parameters, etc.

References:

Selected references are here given, pertaining to telephone and telegraph industry practice, teletypewriters, terminal units, etc.

1. ENCYCLOPEDIAS, AMERICANA, BRITANNICA, COLLIERS, under the headings Telegraphy, Telephone, and Teleprinter/Teletypewriter.
2. American Telephone and Telegraph Co. PRINCIPLES OF ELECTRICITY APPLIED TO TELEPHONE AND TELEGRAPH WORK. (Green Book, January 1953)
3. Alexander, A., et al. CAPABILITIES OF THE TELEPHONE NETWORK FOR DATA TRANSMISSION. Bell Telephone System Technical Publication Monograph 3580. (This is where the graph, traced in Fig. 6, came from; see p. 17 in the monograph.)
4. Kretzman, B. THE NEW RTTY HANDBOOK. Publ. by Cowan Publishing Corp., Port Washington, N.Y.
5. Tucker, D. RTTY FROM A TO Z. Publ. by Cowan Publishing Corp., Port Washington, N.Y.
6. Susskind, C. THE ENCYCLOPEDIA OF ELECTRONICS. Publ. by Reinhold Publishing Corp., New York, N.Y. (see pp. 827-829; article on TELETYPE by R. H. Weitbrecht)

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