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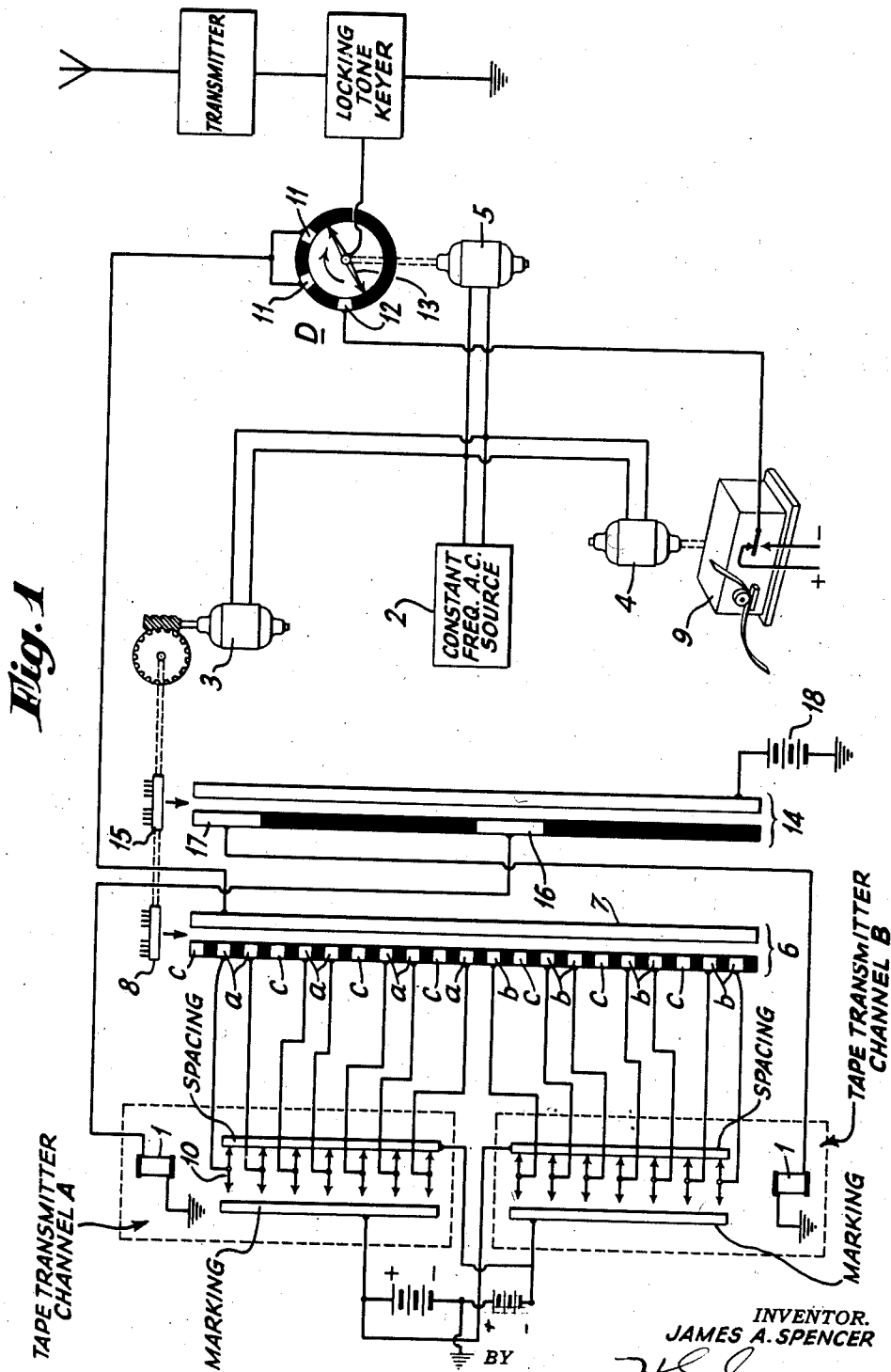
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**2,292,169**

# MULTIPLEX TELEGRAPH SYSTEM

Filed April 29, 1939

2 Sheets-Sheet 1



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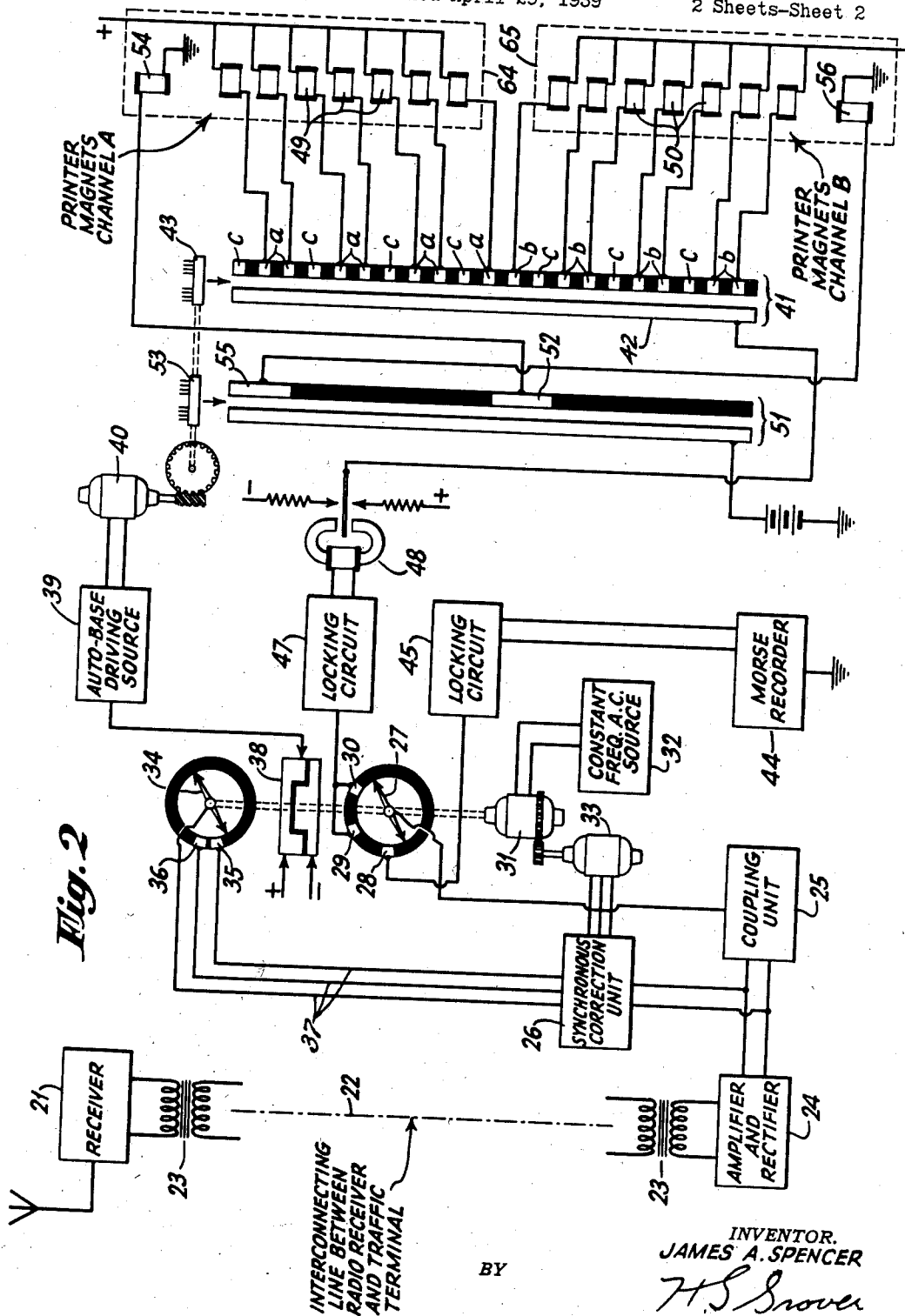
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2 Sheets-Sheet 2



## UNITED STATES PATENT OFFICE

2,292,169

## MULTIPLEX TELEGRAPH SYSTEM

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8 Claims. (Cl. 178—52)

This invention relates to multiplex telegraph systems and more particularly to an arrangement of synchronous telegraph apparatus suitable for multi-channel communications where one at least of the channels is allocated to automatic Morse telegraphy and two or more channels are allocated to equal length printing telegraph code signalling.

It is an object of my invention to provide multiplex telegraph apparatus of the character described in which the signalling time may be suitably divided as between different channels while permitting convenient time intervals to elapse between the transmission of successive complete code signals to one particular channel, which time intervals may be utilized for operating a tape feeding device at the transmitter and for performing the essential printing operations at the receiver.

Various other objects and advantages of my invention will be made manifest from a reading of the following description and from the accompanying drawings in which

Figure 1 shows diagrammatically a preferred circuit arrangement interconnecting the various units to be employed at a transmitting station, and

Fig. 2 shows, also diagrammatically, a preferred embodiment of apparatus units and interconnecting circuits to be employed at a receiving station.

Referring first to Fig. 1, I show conventionally two similar tape transmitters for use on respectively different channels A and B of a multiplex system. These tape transmitters are well known in the art and it is, therefore, unnecessary to show them in detail, other than the contact devices which are controlled by a perforated tape, and the magnet 1 by which the mechanism is actuated, step by step.

The actual allocation of time units to the different channels is preferably made by means of two distributors D and 6. The latter is here shown in developed form and comprises a solid ring 7 and a segmented ring adjacent thereto. The segmented ring includes twenty-one conductive segments a, b and c, which are separated from one another by insulation segments. Seven of these segments, designated c are idle segments, because when the brush 8 passes over them time is allotted to a Morse tape transmitter as shown at 9.

My invention is particularly well adapted to the use of uniform length printer signals having seven units. The perforated tape transmitters A and B have, therefore, been shown each with seven contact devices corresponding with seven rows of

perforations in the tape. The tape-controlled transmitting mechanism, as is well known in the art, is adapted to move the contact elements 10 into engagement with either a marking or a spacing conductor thereby to compose the elements of a code signal. As shown in the drawings, the marking side of the A transmitter is connected to the positive terminal of a direct current source, whereas the spacing side is connected to the negative terminal. In order to reverse the signals on different channels it is preferable to arrange the marking and spacing contacts of the channel B transmitter so that the marking side will be negative and the spacing side will be positive.

The solid ring 7 is connected to two adjacent segments 11 of a multiplex distributor. On this same distributor is a third segment 12 which is fed with marking and spacing impulses derived from a Morse tape transmitter 9. The brush 13 of the multiplex distributor is driven by a motor 5. The motors 3, 4 and 5 are maintained in synchronism with one another due to the fact that they are all driven from the constant frequency source 2. The driving gear supplied to the brushes 8 and 13 respectively is such, however, that successive contacts on distributor 6 will be made segment by segment in synchronism with successive contacts of the brush 13 on the two segments 11 and the one segment 12. In other words, the brush 8 will rotate through one complete cycle over its 21 contact segments, while brush 13 makes three and one-half revolutions. This is because the brush 13 is double ended and one-half revolution is sufficient to cover three segments.

The brush 13 is connected to a keyer of conventional type as used, for example, in radio telegraph circuits. The keyer, in turn, controls a radio transmitter as shown. The apparatus which I prefer to employ in the unit labeled "Locking tone keyer" (Fig. 1) is electronic in action. One such unit is shown in United States Patent 2,086,351 to J. L. Callahan, where in Fig. 1 a keying circuit is indicated by reference numeral 26. It comprises two discharge tubes which are mutually interacting. One of these tubes is rendered conductive by a positive impulse, and it automatically blocks the other tube. In response to a negative impulse, however, the latter tube is rendered conductive, and the first tube is automatically blocked. The cathodes of these tubes are grounded, and this provides a reason for grounding a mid-point in the direct current source shown at the extreme left of Fig. 1 in the instant application.

When the distributors 6 and D have been cor-

rectly phased with respect to one another, it will be seen that while the brush 8 passes over each of the segments *c* a signal may be sent, not through these segments *c*, but directly into segment 12 of the multiplex distributor D from the Morse transmitter 9. Intervening between certain of the segments *c* of distributor 6 are segments *a* which are allocated respectively to each of the seven units of the channel A transmitter. These segments are traversed successively by the brush 8 and simultaneously the brush 13 of the multiplex distributor passes over one or the other of the segments 11. After all of the elements of the code signal for channel A have been transmitted, the elements of a signal for channel B may be transmitted through segments of distributor 6 marked *b* and thence to segments 11 of the multiplex distributor. The time intervening between successive transmission of different code signals by one channel is utilized for feeding the perforated tape forward so as to sense the perforations of the next character signal.

The operating magnet 1 for each tape transmitter is energized at regular intervals so as to carry out the tape sensing function and to feed the tape forward step-by-step. The timing of the operation of each magnet 1 is accomplished by means of a distributor ring 14 in cooperation with a brush 15 which rotates synchronously with brush 8 and is preferably mounted on the same shaft therewith. Segment 16, when contacted by brush 15 (after the passage of brush 8 over the code unit segments *a*) feeds current from the source 13 to the magnet 1 which controls the operation of channel A transmitter. Likewise, when segment 17 is contacted by brush 15 (after the passage of brush 8 over the code unit segments *b*) feeds current to the other magnet 1 which controls the operation of channel B transmitter.

Referring now to Fig. 2, which comprehends the various apparatus units and circuit connections preferably employed at a receiving station, I show therein a radio receiver 21 which may be located at any convenient point preferably in an outlying section where a multiplicity of radio antennas may be set up at points spaced apart for the sake of diversity reception. Only one such antenna and its associated receiver are here shown, as it is well understood how the signals from a plurality of receivers may be combined and transmitted through one interconnecting line to a traffic terminal station. The interconnecting line is shown in the drawings as a dot and dash line 22, at the two terminals of which coupling transformers 23 are located. At the traffic terminal station I preferably locate an amplifier and rectifier 24, the output from which is fed directly to a coupling unit 25 and by a branch circuit to a synchronous correction unit 26. The details of the units 24, 25 and 26 are shown and described in United States Patent #2,062,009, granted November 24, 1936, to R. E. Mathes, and in United States Patent #2,086,351, granted July 6, 1937, to J. L. Callahan.

The output from the coupling unit 25 is fed to a multiplex distributor brush 27 which is double-ended and which engages with three segments 28, 29 and 30 successively. The brush 27 is driven by a motor 31 which is powered from a constant frequency alternating current source 32. Synchronism and correct phasing of the brush 27 is, however, maintained by means of a correction motor 33 which is geared to the stator of the motor 31 and is reversibly rotated in

response to occasional currents from the synchronous correction unit 26 delivered at such times as it is necessary to correct the phasing of the brush 27. These times for applying correction are determined by the action of a brush 34 which cooperates with two segments 35 and 36 of a correction distributor ring. The circuits closed alternatively by the wiping of brush 34 over contacts 35 and 36 in cooperation with the timing of the received signals, as fed into the synchronous correction unit through the conductors 37, determine the action of the synchronous correction unit in controlling the correcting motor 33. The details of this synchronizing function are explained in the foresaid Patent #2,062,009.

Still another set of distributor rings and brushes is mounted on the shaft which is driven by the motor 31. This set is indicated generally at 38 and is more fully explained in United States Patent No. 2,194,509, granted March 26, 1940, to R. E. Mathes. By means of the square wave output from the distributor 38 an alternating current is generated within the apparatus unit 39, termed an auto base driving source. This source supplies alternating current to one or more auxiliary synchronous motors such as that shown at 40. This particular motor 40 drives a printer code distributor represented generally at 41 and constituting two distributor rings one of which, 42, is solid and the other of which is preferably composed of twenty-one conductive segments spaced apart by insulation or gaps. A constant ratio is maintained as between the revolutions of the brush 43 over the rings of the distributor 41 and the revolutions of the distributor brush 27. This ratio is such that the brush 27 contacts successively with the segments 28, 29 and 30 at the same speed as the brush 43 contacts with adjacent segments *a* and *c* or *b* and *c*. Since the brush 27 is double-ended each of the segments 28, 29 and 30 is contacted twice per revolution of the multiplex channel distributor. It is, therefore, necessary for this brush 27 to rotate three and one-half times per revolution of the brush 43 in order to produce twenty-one different paths through the successive segments of the distributor 41. The distributor segments marked *c* are inactive since they correspond in time with the passage of the brush 27 over its segment 28, this segment being appropriate to a Morse recorder circuit which is independent of the printer channels but which shares time on the multiplex channel between two radio stations.

Interposed between the distributor segment 28 and the Morse recorder 44 is a so-called locking circuit 45 the output from which constitutes marking and spacing signals which are fed to the Morse recorder 44. The details of the locking circuit are shown and described in United States Patent #1,844,950, granted February 16, 1932, to J. L. Finch. The purpose of this locking circuit is to prolong the impulses applied as signals to the Morse recorder and to rebuild these signals into a square wave in response to the effective center portions of the received signals which are selected by the small arc of the distributor segment 28.

A similar locking circuit 47 is fed with printer code signal elements from the distributor segments 29 and 30. The relay 48 thus responds to marking and spacing elements of the printer code signals. Positive and negative impulses are applied to the solid distributor ring 42 and thence successively through the several active segments *a* and *b* of the printer distributor 41. This process of distribution of the printer code signals pro-

vides for individual actuation of different ones of the decoding magnets in the printer. Seven of these magnets designated 49 are shown in one group which is appropriate to and which operates the type selectors in a printer for channel A. These magnets are respectively controlled by impulses applied to the segments *a*. Similarly another group of decoding magnets 50 is associated with an individual printer for channel B. These magnets are fed with impulses as applied thereto by the segments *b* of the distributor 41.

Still another distributor ring 51 has a brush 53 rotating thereover, this brush and the brush 43 being preferably mounted on the same shaft. The purpose of the distributor 51 is to initiate local printer operating impulses following the reception of each full code signal. Thus a segment 52 is contacted by brush 53 immediately following the passage of brush 43 over segments *a*. At this time the printer control magnet 54 for channel A printer is actuated. Likewise, after the brush 43 has passed over segments *b*, then brush 53 reaches segment 55 and impresses an impulse upon the printer magnet 56 for actuating the channel B printer.

The embodiment herein described operates in such a manner that the printer for channel A is caused to effect a printing operation while code signals are being received applicable to channel B, and vice versa. It is evident that, preceding each pair of printer code signal units as assigned to the multiplex distributor segments 28 and 29, time is allotted to the Morse code recorder, the signals for which are received on the multiplex distributor segment 28. There is, therefore, no lost time in transmission of signals for three separate communications on the three respective channels of the multiplex system.

A further advantage to be derived from the circuit arrangement as herein shown and described is that of flexibility of disposition of the various operating units. This advantage is brought about by the employment or synchronous motors, such as the motor 40, whose driving source is maintained in synchronism with the received signals by the square wave former 38 in cooperation with the auto base driving source 39. Hence it is possible to locate the multiplex distributor at one convenient point, then to locate the code unit distributor 41 at another convenient point and each of the recording or printing units such as 44, 64 and 65 where they may be properly attached for the reception of messages.

The particular system herein disclosed is one that is well adapted to the operation of 7-unit printers such as shown and described in the following U. S. patents:

No. 2,183,147, granted December 12, 1939, to Moore and Mathes; Nos. 2,153,737 and 2,231,397, granted April 11, 1939, and February 11, 1941, respectively, both to J. A. Spencer.

To those skilled in the art various modifications of the invention may be made without departing from the spirit and scope of the invention itself. Such scope is defined and limited only in accordance with the claims.

I claim:

1. In a multiplex telegraph system, a transmitting station comprising a multiple channel distributor, an automatic Morse code transmitter in circuit with one of the segments of said distributor, a plurality of other segments on said distributor, a plurality of equal-length code signaling devices, each alternatively connectable

to said other segments, a second transmitting distributor having segments individual to the respective code units of a plurality of signals successively transmittable first by one and then by another said device, a receiving station having a multiplex channel distributor and a code-unit analyzing distributor, means for causing signals to be sent from said transmitting station to said receiving station, means for maintaining all of said distributors in synchronism, and means including circuit connections between the two distributors of said transmitting station, also between the two distributors of said receiving station, whereby the dot units of Morse code signals are interspersed between portions of each equal length code signal, the transmission and reception of successive complete equal length code signals being in accordance with successive allotments of channel time to the respective equal length code signaling devices.

2. A multiplex telegraph system wherein the dot mark of the individual channel is used as the fundamental time unit, said system comprising, a transmitting terminal including a Morse code keyer and two sets of equal length printer code keyers, a distributor having a plurality of segments successively traversed by a brush at dot mark frequency, said segments being connected individually to different code-unit portions of each of said keyer sets, and having idle segments interspersed between the connected segments, means including another distributor for periodically connecting said Morse code keyer to the output side of the transmitting terminal during the passage of said brush over each of said idle segments, a receiving terminal having an arrangement of distributors equivalent to that at the transmitting terminal in combination with a Morse recorder and two printers each operative from signals received and assigned thereto by said arrangement of distributors, and means including a signaling channel whereby said Morse recorder and said printers are rendered responsive to signals sent out from said transmitting terminal.

3. A system in accordance with claim 2 and including means locally controlled at the receiving terminal for timing the actuation of each of said printers subsequent to the assignment thereto of the full quota of code signal elements for selecting and printing a given character.

4. A system in accordance with claim 2 and including means driven synchronously with said distributors for suitably timing the actuation of each of said printer code keyers.

5. A multiplex transmitting and receiving system comprising in combination, a three-channel segmented distributor and a multiple dot unit segmented distributor, each of said distributors having a collector ring and a brush for bridging the collector ring in circuit with its segments successively, a Morse code transmitter connected to an appropriate one of the segments of the first said distributor, a printer code transmitter having a plurality of marking-or-spacing unit selectors each connected to an appropriate segment of the second said distributor, a second printer code transmitter having selectors likewise connected to others of the segments of the second said distributor, an electrical connection between the collector ring of the second said distributor and two otherwise unappropriated segments of the first said distributor, transmitting means under control of impulses derived from the collector ring of the first said distrib-

utor, means for causing the brushes of the two distributors to traverse their segments simultaneously and at the same rate of progression, a plurality of recording and printing units located at a receiving terminal, means including a complementary set of distributors at said receiving terminal having connections to said recording and printing units corresponding with those at the transmitting terminal, means rendering said recording and printing units responsive to signals sent out by said code transmitters, and means for maintaining synchronism between all said distributors.

6. A multiplex transmitting and receiving system comprising in combination, a plurality of code signal keying units located at a transmitting station, a plurality of recording and printing units located at a receiving station, a communications channel interconnecting the two stations, channel time distributors at both stations, means for maintaining synchronism and proper phasing of each distributor with respect to the others, means at the receiving station including one of its distributors for selecting the first of each three successive elementary code units of the code signals for assignment to a given recording unit, means at said receiving station including another of its distributors for allocating the remaining elemental code units of the code signals first to one printer unit until a single character code signal has been fully received, and then to another printer until a sub-

sequent character code signal has been received, and means for causing each printer to be actuated during the time that a code signal is being assigned to the other printer.

7. In a multiplex telegraph system, a sending station and a receiving station, means providing communication from the sending station to the receiving station, means at the sending station for transmitting code signals the elements of which are of uniform length, a plurality of printers at said receiving station, means for operating said printers cyclically first to make a character selection in accordance with an assigned code signal and then to print the character selected, means for so staggering the operating cycles of said printers that the character selecting cycle of one printer is concurrent with the character printing cycle of another printer, means at the sending station for interspersing other signals with the code signals assigned to said printers, and responsive means at said receiving station for detecting said other signals.

8. In a multiplex telegraph system according to claim 7, the combination therein set forth wherein said responsive means includes means for recording the intelligence of said other signals concurrently with the operating cycles of said printers, the last said means being responsive to code signal combinations of unequal length.

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