Nov. 3, 1942. A. H. REIBER 2,300,434

MULTIPLEX TELEGRAPH SYSTEM

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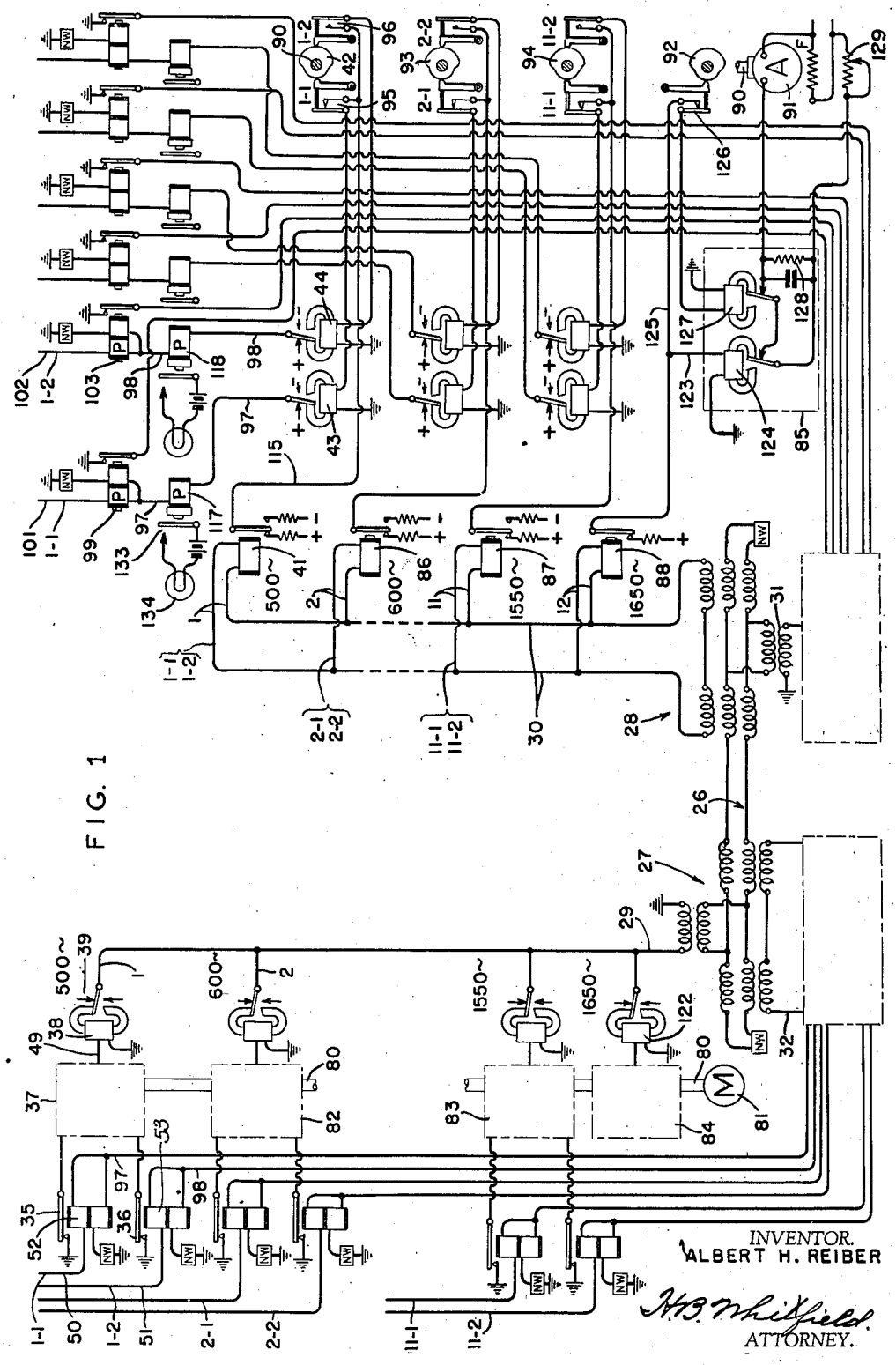
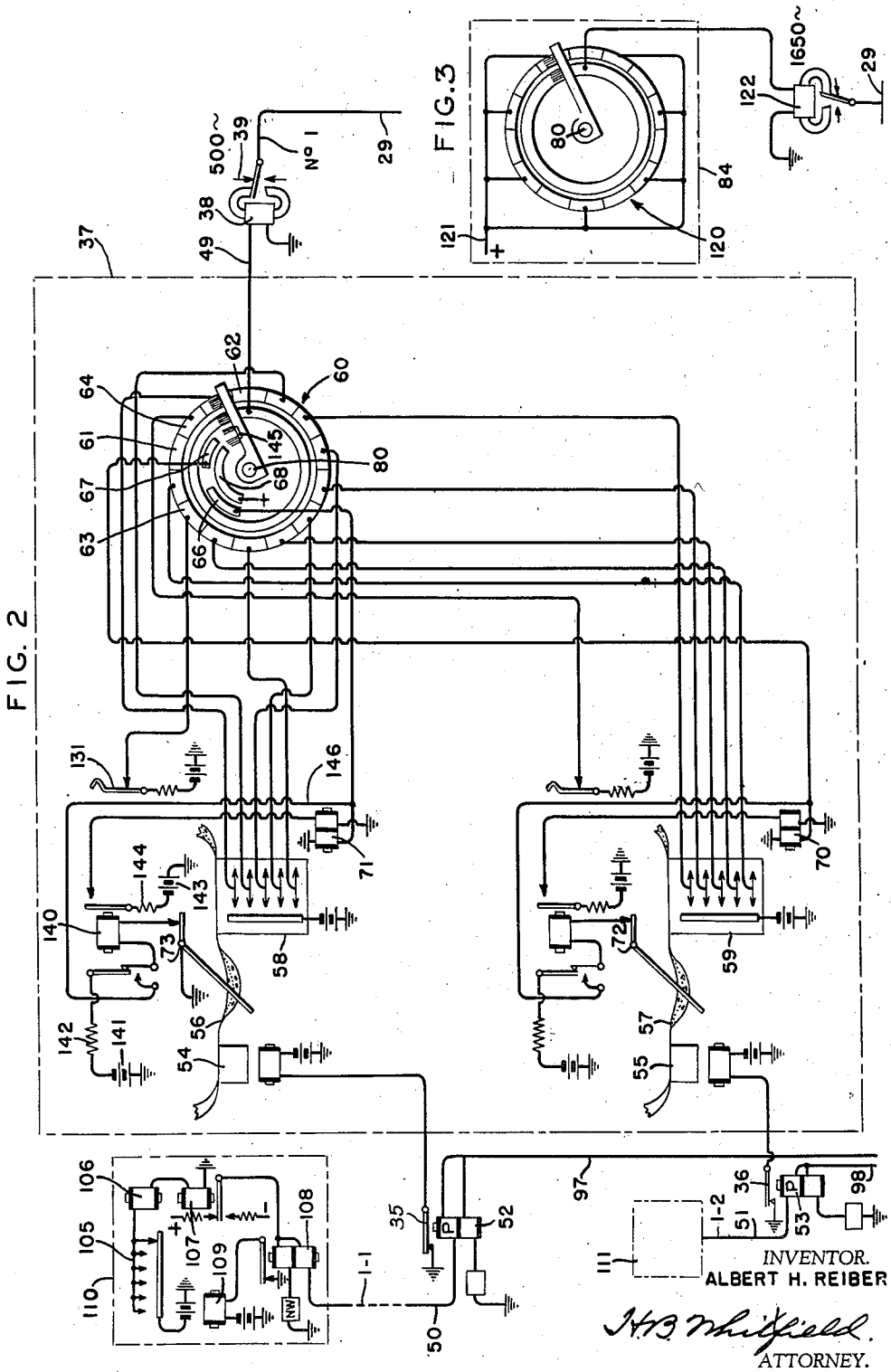


FIG. 1

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Filed July 17, 1939 2 Sheets-Sheet 2



Patented Nov. 3, 1942

2,300,434

UNITED STATES PATENT OFFICE

2,300,434

MULTIPLEX TELEGRAPH SYSTEM

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Application July 17, 1939, Serial No. 284,823

10 Claims. (Cl. 178—51)

This invention pertains to multiplex telegraph systems, and more particularly to multiplex systems of carrier current or resonant type.

It is well known to transmit simultaneously over a single circuit a plurality of alternating currents of variant frequencies, to control these currents independently in code manner, to indicate independent messages, and to separate the variant frequencies upon reception by use of means of resonant nature. Such a structure does not attain the maximum load efficiency of line circuits of lengths and of other constants as usually practiced.

Accordingly, the general object of this invention is to increase the traffic load capacity of a resonant multiplex system by increasing the baud index of currents in the line, and by distributing the resultant greater number of code signals to a larger number of telegraph recorders.

These objects are attained by utilizing the principles of the commutated and timed signals of synchronous multiplex systems with the principles of resonant multiplex systems, taking advantage of the independence of the several variant frequencies of the resonant system. Each resonant frequency channel of a resonant multiplex system may be operated under any preferred means of control; namely, as a manual Morse code channel, as a mechanical Wheatstone channel, as a start-stop signal channel, as a synchronous multiplex channeled system or as a start-stop diplex system.

Apparatus effective to transmit start-stop code signals in a resonant multiplex system is combined with synchronous commutators of diplexing nature to permit addition of further start-stop terminal equipment to increase the total number of concurrent communications, two such communications being attained in each of the resonant channels.

In the specific apparatus described herein, diplexing of a resonant channel is effected at the transmitting central office by utilizing a commutator driven at a regulated speed in which short time intervals are assigned to the diplex channels alternately. The commutator is arranged further to supply automatically to the diplex subchannels cyclic impulses of start and stop nature with time intervals between successive start impulses which are controlled by message tape to embody signal impulses representing intelligence being transmitted. Distribution of the signal impulses into the respective channels at the receiving central office is effected by a simpler distributor since start and stop impulses do not complicate the problem at the receiving apparatus.

Common driving mechanism is provided for all of the commutators of all of the resonant channels of a line conductor and likewise common synchronizing or phasing mechanism.

A better understanding of the invention may be had from the following description taken in conjunction with the accompanying drawings, in which

Fig. 1 illustrates a complete system; and

Fig. 2 illustrates a detail to complete the disclosure of Fig. 1.

The invention is embodied according to Fig. 1 in a structure basically conforming to the disclosures of U. S. Patents Nos. 1,227,113 and 1,227,114 issued to Campbell, means being included to provide a multiplex system having both resonant and synchronous commutational features.

Referring to Fig. 1, there is disclosed a line circuit 26 terminating in two induction coil systems 27 and 28. Connections shown are of well known hybrid coil nature and effect transmission of resonant signals from transmitting conductor 29 to receiving loop 30 and concurrently from transmitting conductor 31 to receiving loop 32.

Transmission into systems 27 and 28 is by control of contacts as 35 and 36 taken in groups of two, through mixer commutator sets as 37, detailed in Fig. 2, which control operation of biased polar relays as 38 to impress resonant currents from sources as 39 upon the conductor 29. The assigned frequencies are taken arbitrarily for illustrative purposes only. Reception from receiving loop 30 is into resonant relays as 41 which through synchronized commutators as 90, 93, 94 control retransmitting polar relays, as 43 and 44 taken in groups of two.

Circuit details are shown in Fig. 2 for the mixer 37 which combines all signals received over two duplexed extension lines 50 and 51, received by the duplexing relays 52 and 53 and contacts 35 and 36, into signal impulses on conductor 49 and relay 38 which controls transmission over channel No. 1 of the conductor 29. Lines 50 and 51, accordingly, may be designated as subchannels 1—1 and 1—2 respectively. Code signals received through contacts 35 and 36 are operative on reperforators 54 and 55 to effect a stored record in tapes 56 and 57 respectively. Tape sensers 58 and 59 have contacts connected to alternate segments in multiplex transmitter distributor 60. Brushes of distributor 60 transmit from tapes 56 and 57 alter-

nately, impulse by impulse, and transmit start and stop impulses when in engagement with segments 61, 62 for start impulses or 63, 64 for stop impulses. For stepping the tapes 56, 57, when slack, segments 66 and 67 and circuits are provided in the distributor 60.

Tape switch relay 140 to render magnet 71 operative is maintained normally energized by current in a holding circuit including battery 141, resistor 142, contacts of energized relay 140, winding of relay 140, contacts of tape switch 73, and ground. In operation, relay 140 is continuously energized by its described holding circuit and tape stepping magnet 71 is cyclically energized and operated in well-known manner during each engagement of brush 145 with segment 66. Operation of a tape senser as 56 may be stopped by utilization of a mechanical latch with which such sensers are provided, or by control of tape switch 73 operating through relay 140.

Should stepping of the tape 56 on operation of senser magnet 71 render the tape taut and result in an open condition of the contacts of tape switch 73, de-energization of relay 140 will follow, closing a second energizing circuit or holding circuit for magnet 71 including battery 143, resistor 144, contacts of de-energized relay 140, a winding of magnet 71, and ground. Thereafter, magnet 71 will remain continuously energized by its holding circuit. Brush 145 in commutator 60 at each engagement with segment 66 will supply an ineffective impulse of current through a winding of magnet 71 and also will supply a potential impulse over conductor 146 and through contacts and winding of de-energized relay 140 to the now open contacts of tape switch 73. Upon renewal of the tape supply, switch 73 will close its contact with brush 145 in random position without result until brush 145 engages segment 66 when relay 140 will be energized by current in the path traced and will be locked by its described holding circuit through the now closed tape switch. The magnet 71 remains under control of brush 145 until that brush has disengaged from segment 66, when normal transmission will be resumed.

Assembly of a plurality of extension arm receiving apparatus units, according to Fig. 2, in relation to associated resonant multiplex transmitting circuits is shown in Fig. 1. A shaft 80, Fig. 1, is driven by motor 81 at regulated speed of one revolution for each consecutive code signal in a subchannel, and carries a plurality of commutators including commutator 60, Fig. 2, in rectangle 37 and similar commutators connected in similar circuits in rectangles 82 and 83, Fig. 1, for message transmission. Eleven such commutators are indicated by numerals 1—1, 2—2, to 11—1, 11—2, and as many as desired may be provided. A further rectangle 84 indicates a further commutator, Fig. 3, for generating signals suitable for controlling the synchronizing and phasing operations in a remote phasing device and speed regulator 85, Fig. 1, of any desired type.

Each rectangle 37, 82, 83, Fig. 1, represents apparatus for operating a resonant channel as 1, 2, 11, and for subdividing each such resonant channel into two commutational subchannels, as 1—1, 1—2, 2—1, 2—2, 11—1, 11—2.

Apparatus for subdividing each resonant channel comprises one commutator 60 and two tape sensing devices 58 and 59, Fig. 2, connected as described above, the tape sensing devices being supplied with tape either from keyboard perforators or from reperforators remotely controlled over extension arm lines as 50 and 51. Duplexing relays as 52 and 53 are shown but are not essential to the invention which may be operated over two conductors if desired.

Frequencies of the resonant circuits are indicated as 500 cycles to 1,550 cycles and the synchronizing circuit is indicated at 1650 cycles. Obviously these frequencies are not limitations of the invention, but are indicated for illustrative purposes only.

In the receiving equipment, of which induction coils 28 form part, received signals of all frequencies are impressed upon the loop 30. By virtue of tuning implied in the resonant relays 41, 86, 87, and 88, the received resonant impulses are separated and each frequency causes response of that relay which is identified with the channel of the impulses of that frequency.

A shaft 90 is driven by motor 91 controlled in speed of one revolution per signaling impulse in a subchannel by regulator 85 and controlled in phase by regulator 85 jointly with cam commutator 92 of phasing channel 12. Shaft 90 carries a plurality of commutator cams 42, 93, and 94 which correspond respectively with the brush commutators in rectangles 37, 82, and 83. It will be understood that the type of commutator shown does not limit the invention.

Referring specifically to channel 1, Fig. 1, there is shown a resonant relay 41, and cam 42 with its controlled contacts 95 and 96, which jointly operate the polar relays 43 and 44 to generate polar retransmission signal impulses in the extension arm conductors 97 and 98 representing subchannels 1—1 and 1—2. Plus and minus symbols indicate grounded batteries. Subchannel 1—1 extends from conductor 97 through duplexing relay 99 and extension arm conductor 101 to substation equipment similar to that shown in rectangle 37, Fig. 2. Subchannel 1—2 extends similarly from conductor 98 through duplexing relay 103 and extension arm conductor 102 to a similar substation. At each substation, presuming duplexing of conductors 50 and 51 as shown, there are provided a keyboard transmitter 105, a home recorder 106, a transmitting relay 107, a duplexing relay 108 and a receiving recorder 109, all interconnected as shown in a rectangle 110, Fig. 2. A similar substation on line 51 is indicated by rectangle 111.

In operation of resonant channel No. 1, keyboard transmitters as 105 at substations 110, 111, Fig. 2, generate signal impulses which are propagated through contacts of transmitting relays as 107 and through contacts 35, 36 of duplexing relays 52, 53 to controlling magnets of reperforators 54, 55 where records are effected code signal by code signal in the two tapes 56 and 57. Commutator 60 transmits continuously to relay 38 under control of tapes 56 and 57 alternately, and intersperses start and stop signals generated by segments 61, 62, 63, and 64. The instant transmitted impulse, as shown, is No. 1 character impulse of spacing nature from subchannel 1—1.

No. 1 channel relay 38 receives impulses of direct current from commutator 60 and in response delivers from its contacts into conductor 29 impulse periods of resonant current from a source 39 having an indicated frequency of 500 cycles. The resonant periods are controlled in part from tape senser 58, in part from tape senser 59 and in part from segments 61, 62, 63, 64 of distributor 60 and are interspersed with intervals of no cur-

rent. All of these periods of current are effective on resonant receiving relay 41 and by contacts of relay 41 equivalent polar impulses are impressed on conductor 115 whence by operation of synchronous cam commutator 42 and cam controlled contacts 95, 96 the impulses are distributed to polar relays 43, 44, those impulses which are generated by tape senser 58 and which pertain to subchannel 1—1 being distributed to relay 43 also pertaining to subchannel 1—1 and those impulses generated by tape senser 59 of subchannel 1—2 being distributed to relay 44 of subchannel 1—2. From relays 43 and 44, received impulses are transmited over conductors 97, 98, through slow-to-release relays 117, 118 and duplexing relays 99, 103 to extension arm line conductors 101 and 102 respectively which extend to substation apparatus which may be similar to that illustrated in rectangle 110, Fig. 2.

Synchronism and phasing may be maintained by any known means. In Fig. 3 is illustrated a commutator 120 the segments of which correspond to segments in distributor 60, Fig. 2. Alternate segments of commutator 120 are connected to a source 121 of direct current. Synchronizing impulses synchronous with character impulses from distributor 60 are delivered to biased polar relay 122 which converts them to resonant impulses in the conductor 29, Fig. 1. The cynchronizing impulses are received by relay 68, Fig. 1, and corresponding polar impulses are delivered over conductor 123 to biased polar relay 124 and over conductor 125 through cam controlled contact 126 to biased polar relay 127. Contacts of relays 124 and 127 in series form a shunt upon a resistor 128 to increase the speed of motor 91. Contact 126 is adjustable in manner of orientation about shaft 90 and cam 92.

In operation, a received synchronizing impulse operates relay 124 to close its contacts and thereby causes operation of relays 124 and 127 to close the shunt path around resistor 128, which then is broken by relay 127 when contact 126 is opened by cam 92. Resistor 129 is adjustable to determine initial speed of motor 91 with resistor 128 unshunted, the initial speed being lower than desired synchronous speed. When resistor 128 is shunted momentarily in response to each synchronizing impulse, speed of motor 91 will increase to synchronism. Lagging of cam 92 from synchronism will delay opening of contacts 126 and increase length of shunted period of resistor 128 to increase speed of motor 91 which will correct the lag. Phasing is attained by attainment of synchronism and orientation is controlled by the adjusted position of contacts 126.

For signaling between operators at transmitting and receiving central offices, each subchannel is provided with a manual key 131, Fig. 2. Tape senser 58 is stopped by operation of its mechanical latch and key 131 then operated to interrupt all stop impulses through segment 66.

At the receiving central office, stop impulses in conductor 97 maintain the armature of relay 117 in operated position and thus hold the relay contacts open independently of cessation of character code impulses. Should the remote controlling time-period key 131 be operated, the stop impulses will cease, the armature of relay 117 will be released and contacts 133 will close an obvious circuit to operate a signal device 134.

The invention has been described in connection with a specific embodiment thereof which is capable of modification without departing from the spirit or scope of the invention, the invention being defined only by the scope of the appended claims.

What is claimed is:

1. In a multiplex telegraph system, a plurality of resonant channels, a plurality of sources of currents, one source for each of said channels, a plurality of sets of extension circuit equipment, two associated with each of said channels, transmitting distributors, one associated with each of said channels and with the associated two extension circuit equipment in alternatively operable conductive connections, and transmitting relays one for each said channel and responsive to impulses received through said distributor and effective responsively through armature contacts to impress upon its associated channel impulses of like resonant nature corresponding to impulses received through said distributor from said two sets of extension circuit equipment respectively and in alternation.

2. In a multiplex telegraph system, a plurality of resonant channels, a plurality of sources of currents, one source for each of said channels, a plurality of sets of extension circuit equipment, two associated with each of said channels, transmitting distributors, one associated with each of said channels and with the associated two sets of extension circuit equipment in alternatively operable conductive connections, and containing start and stop segments for generating signals supplemental to signals received from each of said sets of extension circuit equipment, and transmitting relays one for each said channel and responsive to signals received through said distributor and effective responsively through armature contacts to impress upon its associated channel signals of like resonant nature corresponding to signals received through said distributor from said two sets of extension circuit equipment respectively and in alternation and to further signals generated by said start and stop segments.

3. In a multiplex telegraph system, a plurality of resonant channels, means to transmit over each of said resonant channels two messages by signaling impulses of like nature with the impulses of said two messages being transmitted in alternation, means to transmit concurrently and synchronously with said impulses of one of said messages further impulses, and phasing means responsive to said further impulses.

4. In a multiplex telegraph system, a resonant channel, means to transmit over said resonant channel two messages by signaling impulses of like nature with the impulses of said two messages in alternation, a further resonant channel, means to transmit over said further resonant channel concurrently and synchronously with said impulses of only one of said messages further impulses, and phasing means responsive to said further impulses.

5. In a telegraph system, a telegraph circuit, a multiplex transmitting distributor at one end of the circuit having an element corresponding to each impulse to be transmitted in a character cycle, a distributor at the other end of the line having a segment corresponding to each channel of the multiplex, multiplex phasing means operative to transmit from the transmitting station to the receiving station a continuous series of uniformly spaced impulses, and means responsive at the receiving station to the continuous series of uniformly spaced impulses for phasing the distributor at the receiving station.

6. In a telegraph system, a circuit, means to

transmit over the circuit alternately the individual impulses from two independent message sources, a signal distributor at the receiving end of the circuit to receive the impulses and distribute the individual impulses alternately to two receiving channels, a motor driving said receiving distributor, a second circuit, means to transmit over said second circuit synchronizing impulses which invariably synchronize the motor so that the individual impulses are invariably distributed to their assigned channels.

7. In a multiplex telegraph system, a plurality of resonant channels, two extension circuits assigned to each resonant channel, a distributor intermediate each channel and each two extension circuits and provided with a plurality of contact members, means for connecting said extension circuits successively to alternate contact members of said distributor whereby a signal impulse will be impressed on said channel alternately from said extension circuits, a channel common to said resonant channels, a plurality of receivers at said receiving station, one identified with each of said extension circuits, and means connected to the opposite end of said common channel for distributing to the receivers identified with said extension circuits the individual impulses as distributed originally to said resonant channels as determined by said distributor.

8. In a multiplex telegraph system, a plurality of resonant channels, two extension circuits assigned to each resonant channel, a distributor intermediate each channel and each two extension circuits and provided with a plurality of contact members equal in number to the number of code signal impulses in each group of code signal impulses to be transmitted from each of said extension circuits, a channel common to said resonant channels, a distributor at the other end of said common channel including a contact corresponding to each resonant channel, means for closing said contact in timed relation to the operation of said transmitting distributor, and means to maintain the phase relation of said latter distributor with said transmitting distributor whereby said contact of the distributor at the other end of the common channel will be closed in proper phase relation with respect to the contact members of said transmitting distributor.

9. In a telegraph system, a communication channel, a first pair of extension circuits, a transmitting distributor connecting said extension circuits to said channel for transmitting signal combinations impulse by impulse over said channel from said circuits in alternation, a second pair of extension circuits, a receiving distributor including a pair of regularly operated contacts to connect said second pair of extension circuits to said channel in alternation, and means for synchronizing the operation of said contacts with signal transmission from said transmitting distributor.

10. In a communication system, a communication channel, a first pair of extension circuits each of which includes signal generating means, a transmitting distributor connecting said circuits to said channel for transmission of generated signal combinations impulse by impulse from said circuits in alternation, a source of synchronizing power, a distributor for applying synchronizing impulses to said channel concurrently with signal transmission thereover, a second pair of extension circuits each including signal receiving apparatus, a receiving distributor including a pair of regularly operated contacts for distributing signals from said channel to said receiving apparatus in alternation, means for driving said receiving distributor, and a set of synchronizing contacts operated by said receiving distributor for supplying said synchronizing impulses to said driving means to synchronize the actuation of said pair of regularly operated contacts with signal transmission from said first pair of extension circuits.

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