April 3, 1934. H. RASSOW 1,953,658

MULTIPLEX TELEGRAPH EQUIPMENT

Filed Oct. 17, 1932 2 Sheets-Sheet 1

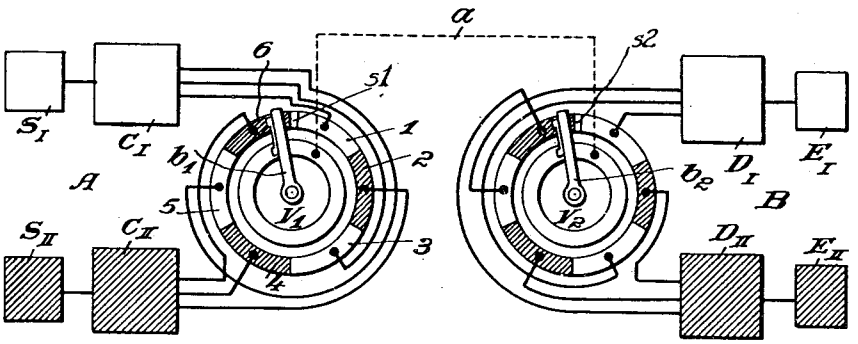


Fig. 1

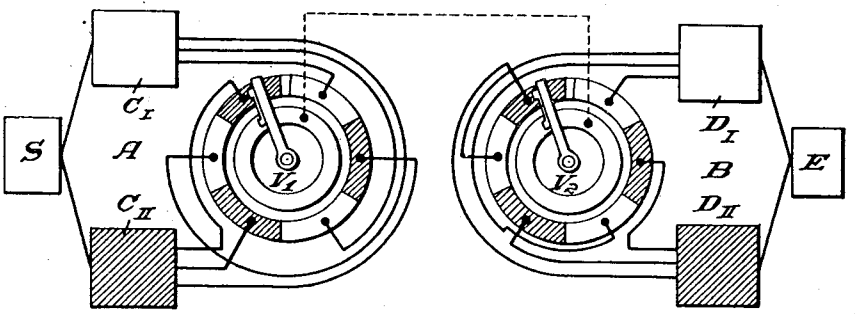


Fig. 2

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MULTIPLEX TELEGRAPH EQUIPMENT

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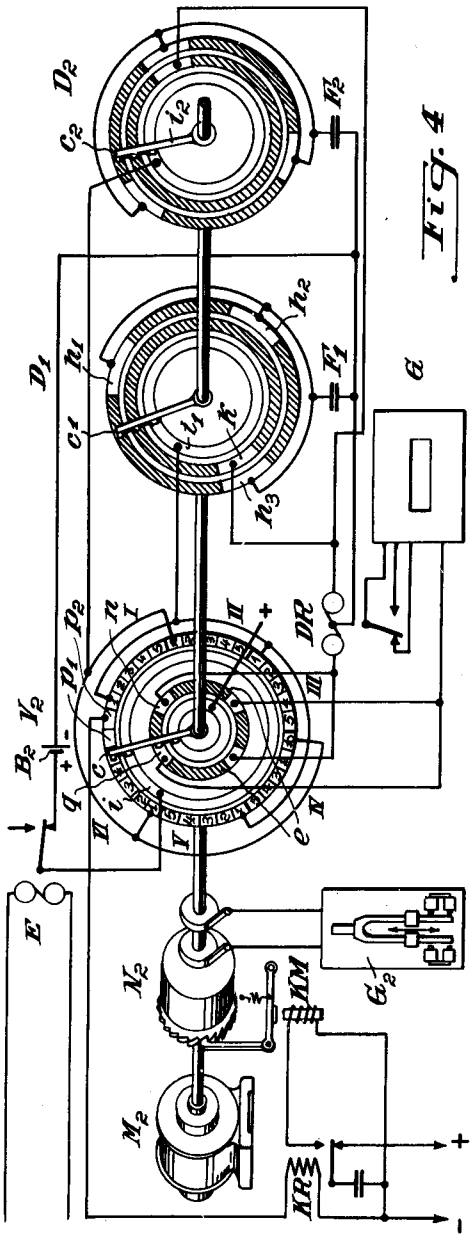


Fig. 4

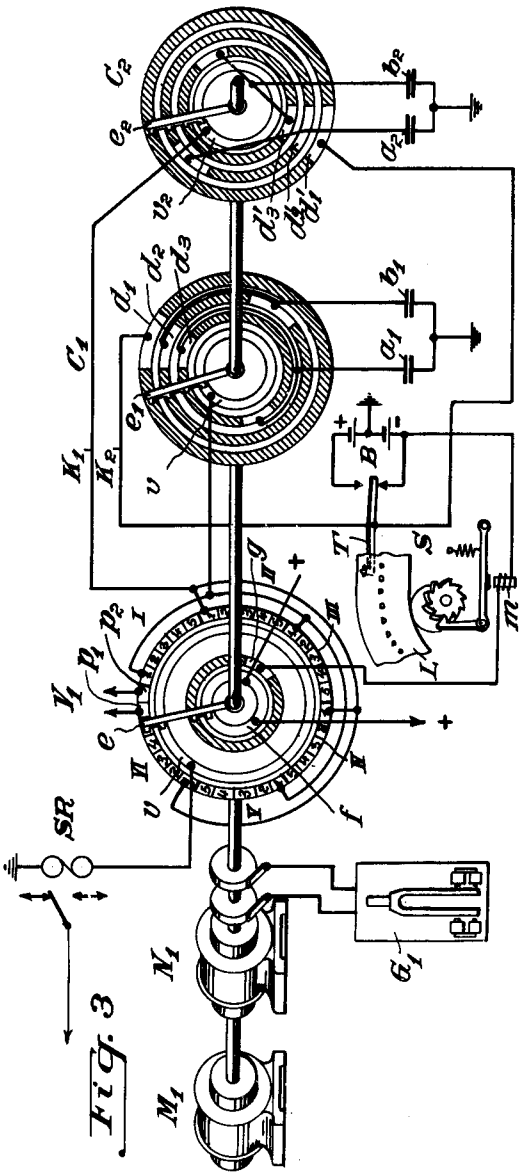


Fig. 3

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MULTIPLEX TELEGRAPH EQUIPMENT

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Application October 17, 1932, Serial No. 638,155
In Germany July 11, 1931

6 Claims. (Cl. 178—52)

My invention relates to improvements in multiplex telegraph systems, and more particularly for wireless operation with interference elimination by repeated transmission of the same signal. The object of the invention is to increase the economy of such systems. According to the state of the interference every signal is transmitted two or three times. The capacity of an apparatus is in consequence of this repetition of the signals correspondingly reduced to one half or one third. The increase of the correctness of the transmission of the messages thus causes a reduction of the speed of operation.

Some embodiments of my invention are illustrated in the drawings affixed hereto and forming part of my specification.

The drawings show:

Fig. 1, the principle of the mode of operation of such a multiplex telegraph system,

Fig. 2, an embodiment of my invention in diagrammatic representation,

Fig. 3, a more detailed representation of the transmission mechanism diagrammatically shown in Fig. 2, and

Fig. 4, a more detailed representation of the receiving mechanism of Fig. 2.

In Fig. 1 of the drawings a half duplex operation over two channels between the two stations A and B is diagrammatically illustrated. At station A is only shown the respective transmission mechanism and at the station B only the receiving portion of the apparatus. In the case of operation over wires the two stations are connected by means of the line a through the brushes b_1, b_2 rotating in perfect synchronism with the two distributors V_1, V_2. In the case of wireless operation the two brushes are connected to corresponding transmitting and receiving amplifiers. The distributors V_1 and V_2 are subdivided into a number of equal sectors which is a common multiple of the provided repeated transmission of the same signal. In the case illustrated, there are provided $2\times3=6$ sectors since the transmission is to be effected by means of two channels and each signal is to be sent three times. Each sector 1 to 6 is again subdivided into five segments, not shown in this figure, in correspondence with the five units. In addition thereto there is provided a seventh sector s_1, s_2 which operates each revolution and transmits a signal for the purpose of synchronizing the revolving brushes. The two perforated tape transmitters S_I, S_{II} provided at the station A transmit the telegraph signals to a transmission impulse storing device C_I and C_{II} where the impulses are stored up in accordance with the triple emission of signals to be effected later on. The storing of the impulses may be effected mechanically, i. e. by means of perforated tapes or strips, or electromagnetically, for example by relay chains, or electrostatically, for instance by condensers, or also by adjusting mechanical storage members by means of electromagnets. This storing device C_I is connected to the sectors 1, 3, 5, the storing device C_{II} to sectors 2, 4, 6 of the distributor V_1. Each signal is thus sent three times over the brush b_1. As the brush b_2 of the receiving distributor V_2 is in synchronism with the brush b_1, the signals received are correspondingly transmitted to the receiving impulse storing devices D_I, D_{II} and by these transmitted to the telegraph receiving apparatus E_I, E_{II} for recording or printing.

In order to render the operation of the telegraph plants more economical maximum telegraph speeds will be employed wherever possible. The speed aimed at in wireless operation is 150 Bauds. In actual operation a telegraph speed of only 6.5 letters per second=32.5 Bauds is obtained in telegraph apparatus operating according to the five-unit code. From this results a subdivision into a plurality of telegraph channels the number of which stands in inverse ratio to the number of the multiple transmissions for the purpose of interference elimination, for example in the case of double transmission three channels and in the case of triple transmission two channels. In actual practice a maximum speed of only 90 Bauds can, however, be relied upon for the present. The individual channels would therefore be utilized to only about half their capacity, i. e. a telegraph speed of only three letters per second obtained.

The object of my invention is to combine the two transmitters operating on a channel each into a single transmitter, for the purpose of rendering the operation more economical. The message to be transmitted is dispatched from one transmitter by means of two channels, in such a manner that the letters or signals at the odd places (1, 3, 5 and so on) in the sequence of the text to be transmitted are transmitted over the one channel, and the letters or signals at the even places (2, 4, 6 and so on) over the second channel and are recorded at the receiver by suitable apparatus in the original order of succession.

By the combination of two transmitters,

which both operate at a maximum telegraph speed of three letters per second each and call for two operators into a transmitter operating on two channels, one operator is saved without the capacity of the plant being reduced, inasmuch as this single transmitter is now able to operate at a speed of six letters per second.

An embodiment of my invention is diagrammatically illustrated in Fig. 2 of the drawings. It shows the combination of the two transmitters S_I, S_{II} of Fig. 1 into a single transmitter by connecting in parallel the connections of this transmitter to the storing devices C_I of the one channel and to the storing device C_{II} of the other channel. In the same manner the two receivers E_I, E_{II} are replaced by a single receiver E. The arrangement of the distributors is identical with that already shown and described in Fig. 1. If it is now desired to transmit from station A to station B the letters *a*, *b*, *c*, *d*, for example, the subdivision of the signals sent takes place in such a way, that the letters *a*, *c* are transmitted to the transmitting distributor V_1 across the storing device C_I of one channel, and the letters *b*, *d* across the storing device C_{II} of the other channel. At station B the signals received are transmitted to the storing devices D_I and D_{II} by the distributor V_2 in such a manner, that the letters *a*, *c* are transmitted to the storing device D_I and the letters *b*, *d* to the storing device D_{II}, while by means of a receiving apparatus E the recording or printing of the letters *a*, *b*, *c*, *d* takes place in the correct order of succession.

In Figs. 3 and 4 of the drawings my invention, which is only shown diagrammatically in Fig. 2, is illustrated in greater detail. Fig. 3 shows the transmitting mechanism, Fig. 4 the receiving mechanism of the plant diagrammatically illustrated in Fig. 2.

The transmitting apparatus shown in Fig. 3 consists substantially of a perforated tape transmitter S, the transmitting distributor V_1, the impulse storing devices C_1, C_2, which are all mounted on a single axle adapted to be driven by the motor M_1. The impulse storing devices C_1, C_2 consist of contact drums or rollers and condensers a_1, b_1, a_2, b_2 by the charging of which the impulses are stored. The distributor V_1, which controls the transmitter relay SR, serves for dispatching the current impulses. The transmitter relay transmits in well known manner the impulses as double current signals to the key relay of the wireless transmitter, from which they are passed into the transmitting aerial. The distributor which is represented as contact disk with revolving contact arms, is on its periphery divided into six sectors I to VI of five segments 1 to 5 each.

Coupled in a certain gear ratio with the distributor revolve the contact transmitters of the storing devices C_1, C_2. The determination of the current combinations to be dispatched for the five-current step-code takes place by the tape key or feeler mechanism T. Into this mechanism is fed a perforated tape L prepared in known manner in a hand punching apparatus. The tape key mechanism T consists of five selector levers, one of which only is shown in Fig. 3. According to whether the point of the feeler lever encounters a perforation or a solid portion of the tape or strip the lever places itself against the contact of the battery B connected with the negative or positive pole and closes for this circuit a contact d_1, d'_1 of the storing devices C_1, C_2. At a certain moment the brush of the distributor brush arm *e* comes in contact with the segment I_1, i. e. the segment 1 of the sector I, and connects it to the transmitting relay SR through the undivided ring *v*. Simultaneously the brushes of the storing device brush arms e_1, e_2 bridge the contacts d_1, d_2, d_3, d'_1, d'_2, d'_3, with the undivided rings v_1, v_2 of the storing devices C_1 C_2. This now completes a circuit from the negative pole B across the selector lever T, contact d_1, brush arm e_1 and ring v_1 of the storing device C_1, hence across segment I_1, and ring *v* of the distributor V_1 to the transmitter relay SR, and causes this relay to emit the impulse which corresponds with the perforation in the perforated tape L. The repeated transmission required for the elimination of interferences is attained by the storage condensers a_1, b_1 being at the same time connected to the selector lever T across the contacts d_2, d_3, so that both condensers are negatively charged. The transmission ratio between distributor and storage device is fixed in such a way that after $2\frac{1}{3}$ revolutions of the distributor brush *e* the storage device brush arm e_1 has moved to such an extent only that it touches the contact d_2. At the same moment the distributor brush is on the segment III_1 (segment 1 of the sector III). In this way a circuit is completed across the condenser b_1, contact d_2, ring v_1, segment III_1, ring *v* and the transmitter relay across which the condenser b_1 discharges itself. This discharge current impulse has the same direction as the current impulse sent out before over the segment III_1. It thus causes in the transmitter relay the second dispatch of the previously selected impulse. When the distributor brush arm *e* has again advanced by $2\frac{1}{3}$ revolutions and the storing device brush arm e_1 by the corresponding distance, the condenser a_1 discharges itself across the contact d_3, ring v_1, segment V_1, ring *v* and the transmitter relay SR. This brings about the third dispatch of the same impulse. For the remaining selector levers of the tape key selector mechanism T corresponding contact mechanisms and storing devices are provided, not shown in the drawings. This has the consequence that the impulse combinations selected by the lever T are emitted over the segments 1 to 5 of the sector I, and then of the sectors III and V. As soon as the distributor brush arm has left the segment I_5, the selection of the combination of perforations is finished and the repetition of the signals takes place independent of the perforated tape on other sectors. After completion of a revolution of the distributor brushes a fresh signal can thus be selected over sector I. This does not take place over sector I, however, but over sector II. Previous to this in the course of the rotation of the distributor a circuit is completed which passes from the positive pole across the ring *f*, the contact *g* and the feed magnet *m* to the negative pole of the battery B, for the feed magnet *m*, whose armature *n* feeds the perforated strip or tape L forward by one hole division. For storing the freshly adjusted signal a further storing device C_2 is provided, which like the storing device C_1 cooperates with the segments I, III, V and the segments II, IV and VI. The circuit for the storing device C_2 is completed by the brush e_2. The contact segments d'_1, d'_2, d'_3 of the storing device C_2 show in their arrangement a phase displacement in comparison with

the arrangement of the corresponding contact segments of the storing device C_1.

As described before the circuit is then as follows: negative pole of the battery B across the selector or lever, contact d'_1, brush arm e_2, ring v_2 of the storing device C_2, hence across segment II_1 and ring v of the distributor V_1 to the transmitter relay SR. In this way it is rendered possible, as already explained in the introduction to the specification with reference to Fig. 2, that a message is transmitted from a transmitter S across the two storing devices C_1, C_2 by means of two channels K_1, K_2, in such a manner that the letters or signs standing in the sequence of the text to be transmitted at the odd places are transmitted over the channel K_1, the letters or signs at the even places over the second channel K_2.

Fig. 4 of the drawings illustrates the receiving arrangement. This arrangement consists of a receiving relay E, the receiving distributor V_2 with the storing devices D_1, D_2, which are all mounted on a common shaft and are operated by the motor M_2. The arriving signals are first received in the wireless receiver, amplified and in the rectified state fed to the receiving relay. This relay cooperates with the receiving distributor V_2 and the receiving storing devices D_1, D_2, the construction of which is similar to the corresponding parts of the transmitter. The receiving distributor V_2 is exactly as the sending distributor V_1 subdivided by six sectors with five segments each and the transmission ratio as well as the mutual position of the brush arms of the receiving distributor and the receiving storing device are identical with those of the transmitter. By the provision of special mechanism to be described later on care is taken, that the brush arm c of the receiving distributor V_2 always revolves synchronously and in phase coincidence with the brush arm e of the transmitting distributor V_1. At the moment when the transmitter dispatches an impulse over the segment I_1 and the receiving relay E is reversed in correspondence with this impulse, the brush arm c of the receiving distributor V_2 bridges the segment I_1, while the storing device brush arm c_1 is located upon the contact h_1, and in this way a circuit is closed from the armature of the receiving relay across the ring i, segment I_1, ring i_1 of the storing device D_1, brush arm c_1, contact h_1 to the condenser F_1, the second coating of which is permanently connected to the negative pole of the battery B_2. From the drawings it will be readily gathered that one contact of the receiving relay E is connected to the positive pole, and that the other is insulated, however. The condenser F_1 is thus charged then only if the segment I_1 of the relay armature is connected to the positive contact when the distributor brush 1 sweeps over it. Since distributor and the storing device brush arm c, c_1 of the receiver always have the same position as those of the transmitter, the segment III_1 is touched after $2\frac{1}{3}$ revolutions of the distributor brush c at the moment in which the transmitter dispatches the impulse considered before, for the second time. The brush arm of the storing device has now moved up to the contact h_2 so that the condenser F_1 is connected to the armature of the receiving relay for the second time. This also happens across contact h_3 if after further $2\frac{1}{3}$ revolutions the distributing brush arm c_1 passes on to the segment V_1 and the transmitter dispatches the same impulse for the third time. It is now obvious that the condenser is charged if during the three switching operations the relay armature was connected to the positive contact at least once; it is however not charged if the armature of the receiving relay made contact with the insulated contact every time. In this way results an evaluation of the reception, as called for by the interference elimination system according to the Verdan system employed here, in an extraordinary simple manner. In correspondence with the cooperation of the receiving distributor V_1 with the storing device D_1, the receiving distributor V_2 cooperates with the storing device D_2. Exactly in the same manner as the circuit between V_2 and D_1 is completed through the segments I, III, and V, the corresponding circuit with the storing device D_2 is completed through the contact segments II, IV and VI.

The receiving distributor leads the impulses received forward to the printing mechanism G. The adjustment of the printing relay DR for the purpose of converting the impulses received into type printing according to the state of the condensers F_1, F_2 causes no difficulties. Shortly before the moment in which the third transmission from the sector V is taken up, the printing relay DR receives from the ring 1 of the distributor V_2 across contact n a current impulse which reverses it to the negative side. Shortly after the third transmission the storing device brush arm i_1 connects the condenser F_1 across the contact h_3 and the contact R to another winding of the printing relay DR. If the condenser had then not been charged. the relay armature remains on the adjusted side; if the condenser had been charged, however, the armature is reversed to the signal side. The identical equipment is of course also provided for the remaining impulses of each five-unit signs so that the combination of perforations selected in the selector T of the transmitter S is transmitted to the adjustment of the five printing relays under elimination of the interferences. Only one of the type printing relays is illustrated in the drawings. The position of these five printing relays is employed for the selection of the type to be printed as in the standard type printing apparatus. It now only remains necessary to release the printing mechanism for carrying out a printing process, which takes place during the further rotation of the distributor brush arm c across the contact g. The maintenance of the synchronism between the transmitter and the receiver is of great importance. To start with, it is obvious, that for a good coincidence of the phase position between the distributors V_1 and V_2 the maintenance of a constant speed at the transmitter is a necessity. This constant speed is attained by a local synchronization. From the Figures 3 and 4 it will be gathered that a direct current motor M_1, M_2 serves for the drive of the distributors and the storing devices. With the motor is directly coupled a synchronous motor N_1, N_2, which is connected with a tuning fork generator G_1, G_2. The oscillating tuning fork generates an alternating voltage of constant frequency, which is amplified and fed to the synchronous motor. The synchronous motor temporarily operates as synchronous member and prevents variations of the speed, which would otherwise be produced by voltage fluctuations at the direct current motor, temperature rises, variations in the friction and the like.

In order that the receiver may adjust itself in accordance with the transmitter, it is necessary that the transmitter should transmit a sig-

nal for the phase position. For this purpose there are mounted on the periphery of the transmitter distributor V_1 in addition to the thirty segments of the six condensers two special segments p_1, p_2 which are permanently connected to the negative or the positive pole respectively of the source of current. Across these segments issues, independent of the signs which are dispatched over the other segments, during each revolution a phase sign (—, +). The reversal from — to + is then for the receiver the time signal which indicates that at that moment the transmitter distributor starts a fresh revolution.

At the receiver a definite speed is attained exactly as in the case of the sender by the tuning fork generator G_2 and the synchronous motor M_1 with the direct current motor M_2. The frequency of this tuning fork is, however, set a little higher than that of the transmitter, so that the shaft of the receiving distributor leads in relation to the shaft of the transmitter. To maintain the correct phase position, it is therefore necessary to turn the receiving distributor back at certain intervals. This is effected in the following manner: In correspondence with the segments for the phase signal of the transmitter the receiver is likewise fitted with two segments p_1, p_2. The segment p_1 is insulated, while the segment p_2 is connected to the winding of a sensitive relay KR (correction relay), the other end of which is permanently connected to the negative pole. When the phase position of the transmitter and receiver brush arms is identical, the passage from the contact p_1 to contact p_2 takes place at the transmitter, i. e. the reversal from the signal current to the disconnecting current at the transmission relay and at the receiving relay at the moment in which the receiving brush also passes from segment p_1 to segment p_2. During the sweeping of the brush over the insulated segment p_1 the armature of the receiving relay is thus connected to the voltage. During the sweeping of the brush over segment p_2 the armature touches the insulated contact, so that in both cases no circuit is completed for the correction relay KR. During the course of the further revolutions the receiving distributor leads, however, so that then the brush is already on segment p_1 while the armature of the receiving relay is still on the signal side, and is thus connected to the voltage. The correction relay KR thus receives a short current impulse whose duration is determined by the amount of the lead of the receiver. At a definite amount of lead the correction relay responds. From the armature of the correction relay is operated the coupling magnet KM, which releases the coupling connected to the distributor drive for one revolution. Together with the coupling revolves a gearwheel Z which meshes with a toothed rim on the periphery of the stator of the synchronous motor. The response of the correction relay KR thus causes a partial rotation of the stator of the synchronous motor by an amount determined by the gear ratio. The rotation takes place in such a direction, that the displacement of the phase position of the rotor connected therewith causes a setting back off the distributor brush arm. After the setting back has been effected the distributor performs a number of revolutions until the lead of the receiver has again attained such an amount that the correction relay KR responds.

In operation the frequency of the receiver tuning fork is so adjusted that one setting back falls to each 8 to 9 distributor revolutions. If atmospherics exist these cause a change-over of the receiving relay to the insulated contact. This is quite immaterial as long as the lead of the receiver has not yet attained the amount necessary for setting it back. If this amount of lead exists, however, the setting back is rendered impossible by an interference falling on the phase signal. It may in some cases happen that the phase signal is interfered with during two or even three successive revolutions. It is, however, obvious that the further lead of the receiver then developing is not objectionable, as it is unequivocally fixed by the adjustment of the tuning fork. The receiver is in undisturbed operation set back after about each 9 revolutions without the reception of the messages being interfered with. It is thus obvious that the synchronous run is fully ensured even in the case of strongest interferences with the reception.

What I claim as my invention is:

1. In a multiplex telegraph system of the type wherein each signal character impulse is transmitted a plurality of times for overcoming static and/or interference, the method of communication from a single transmitter located at a transmitting station which comprises sending from said transmitter signal character impulses to different circuits at the transmitting station, storing said impulses in each of said circuits, transmitting said impulses from each of said circuits alternately over a single channel, and repeating the transmission of said last impulses a plurality of times.

2. In a multiplex telegraph system, the method of communication between a single transmitter and a single receiver which comprises transmitting from said single transmitter odd numbered signal character impulses according to their chronological order of occurrence over one circuit and even numbered signal character impulses over another circuit, utilizing a single channel which is common to both of said circuits for said odd and even numbered impulses and repeating the transmission of the character impulses over said single channel.

3. In a multiplex telegraph system, a first distributor, a second distributor and a third distributor, a transmission line coupled to said first distributor, a perforated tape transmitter in circuit with said second and third distributors and arranged to apply signal character impulses alternately to said second and third distributors, said first distributor having alternate portions thereof respectively connected to said second and third distributors whereby said transmission line is coupled alternately to said second and third distributors successively.

4. In a synchronous multiplex telegraph system, a first distributor, a second distributor and a third distributor, a transmission line coupled to said first distributor, a perforated tape transmitter in circuit with said second and third distributors and arranged to apply signal character impulses alternately to said second and third distributors, said first distributor having alternate portions thereof respectively connected to said second and third distributors whereby said transmission line is coupled alternately to said second and third distributors successively, a receiver having three other distributors which are similarly related to said receiver as the distributors at said transmitter are related to said transmitter, the distributors at said receiver being in synchronous relationship with the corre-

sponding distributors of said transmitter and in circuit with same.

5. In a multiplex telegraph system of the type wherein each signal character impulse is transmitted a plurality of times for overcoming atmospheric disturbances, a first distributor, a second distributor and a third distributor, a transmission line coupled to said first distributor, a perforated tape transmitter in circuit with said second and third distributors and arranged to apply signal character impulses alternately to said second and third distributors, said first distributor having alternate portions thereof respectively connected to said second and third distributors whereby said transmission line is coupled alternately to said second and third distributors successively, and impulse storing means at each of said second and third distributors for repeating the same signal character impulses to said first distributor as said first distributor functions to repeatedly connect said transmission line to said second and third distributors.

6. A system as defined in claim 4, characterized in this, that said impulse storing means consist of condensers.

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6. A system as defined in claim 4, characterized in this, that said impulse storing means consist of condensers.

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CERTIFICATE OF CORRECTION.

Patent No. 1,953,658. April 3, 1934.

HORST RASSOW.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 5, line 85, claim 6, for the claim reference numeral "4" read 1; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of December, A. D. 1936.

Henry Van Arsdale

(Seal) Acting Commissioner of Patents.