Jan. 15, 1929. 1,699,444

W. C. PETERMAN

SYNCHRONIZED QUADRUPLEX TELEGRAPHY

Filed Sept. 18, 1924 4 Sheets-Sheet 1

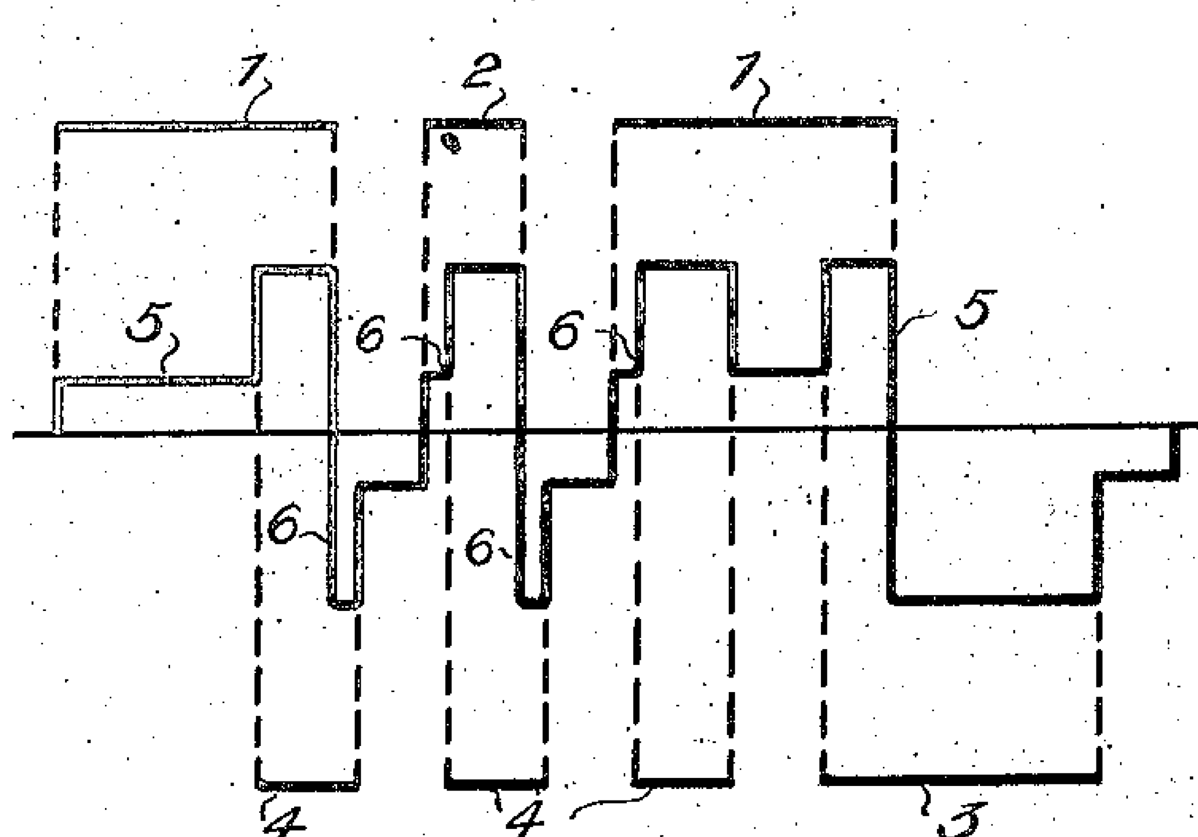

Fig. 1

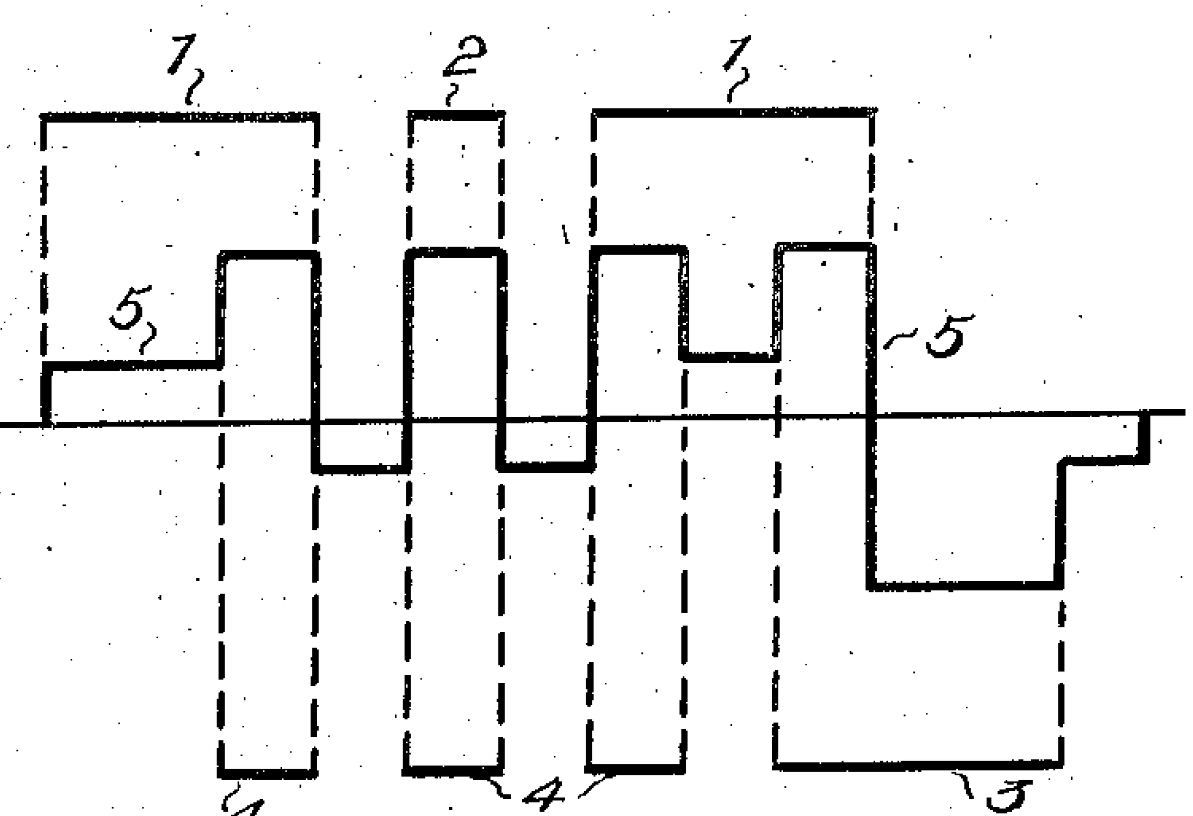

Fig. 2

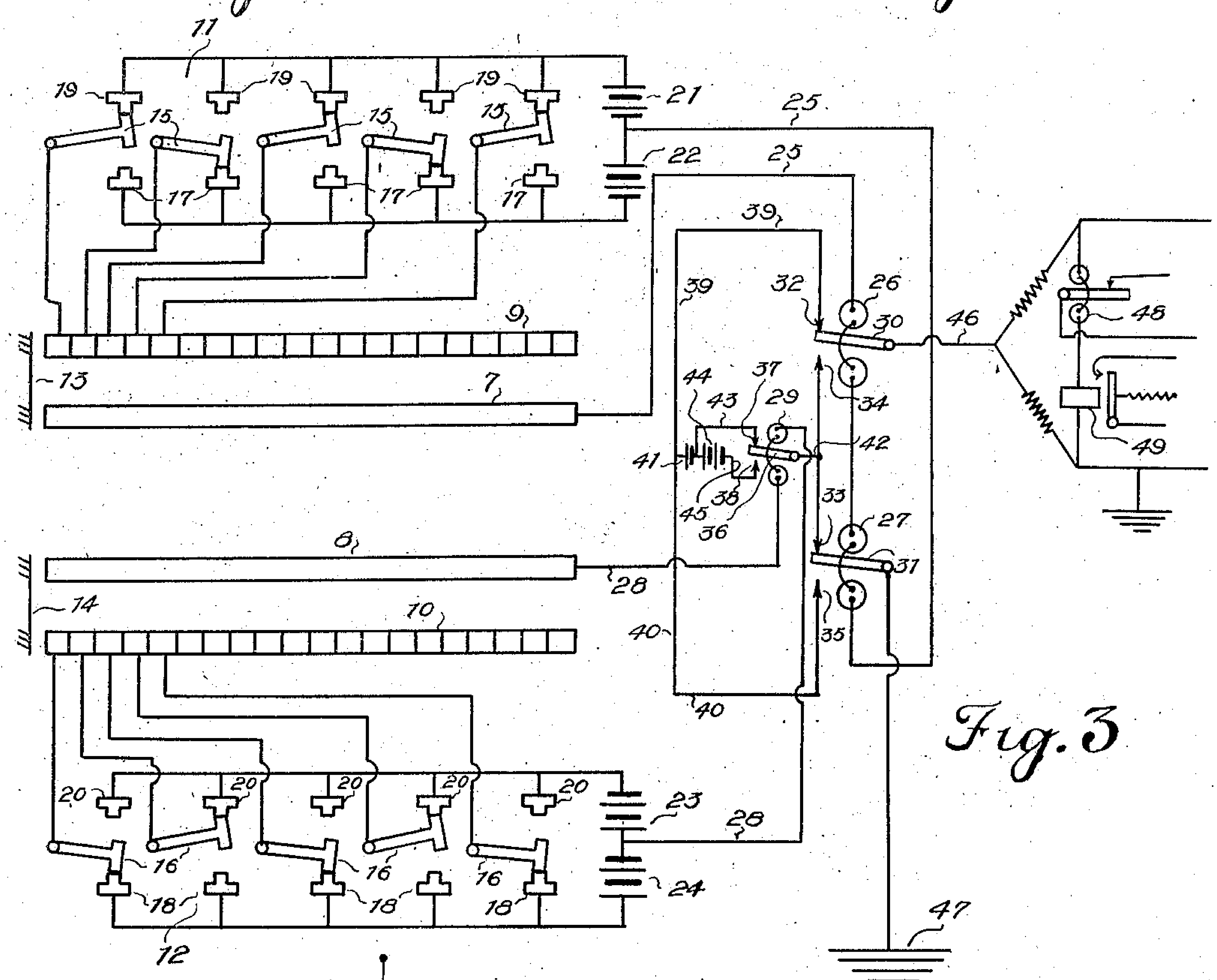

Fig. 3

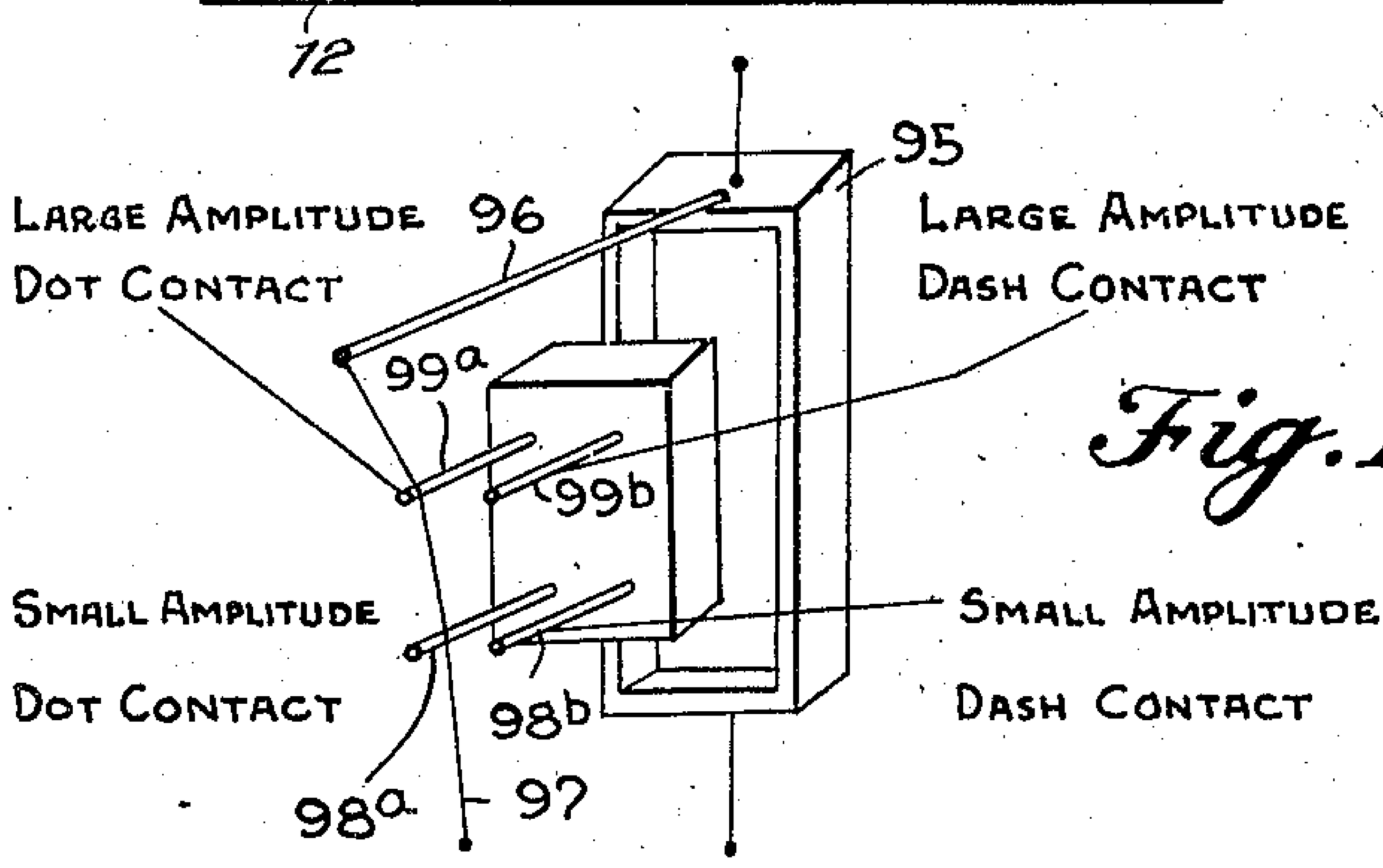

Fig. 10.

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SYNCHRONIZED QUADRUPLEX TELEGRAPHY

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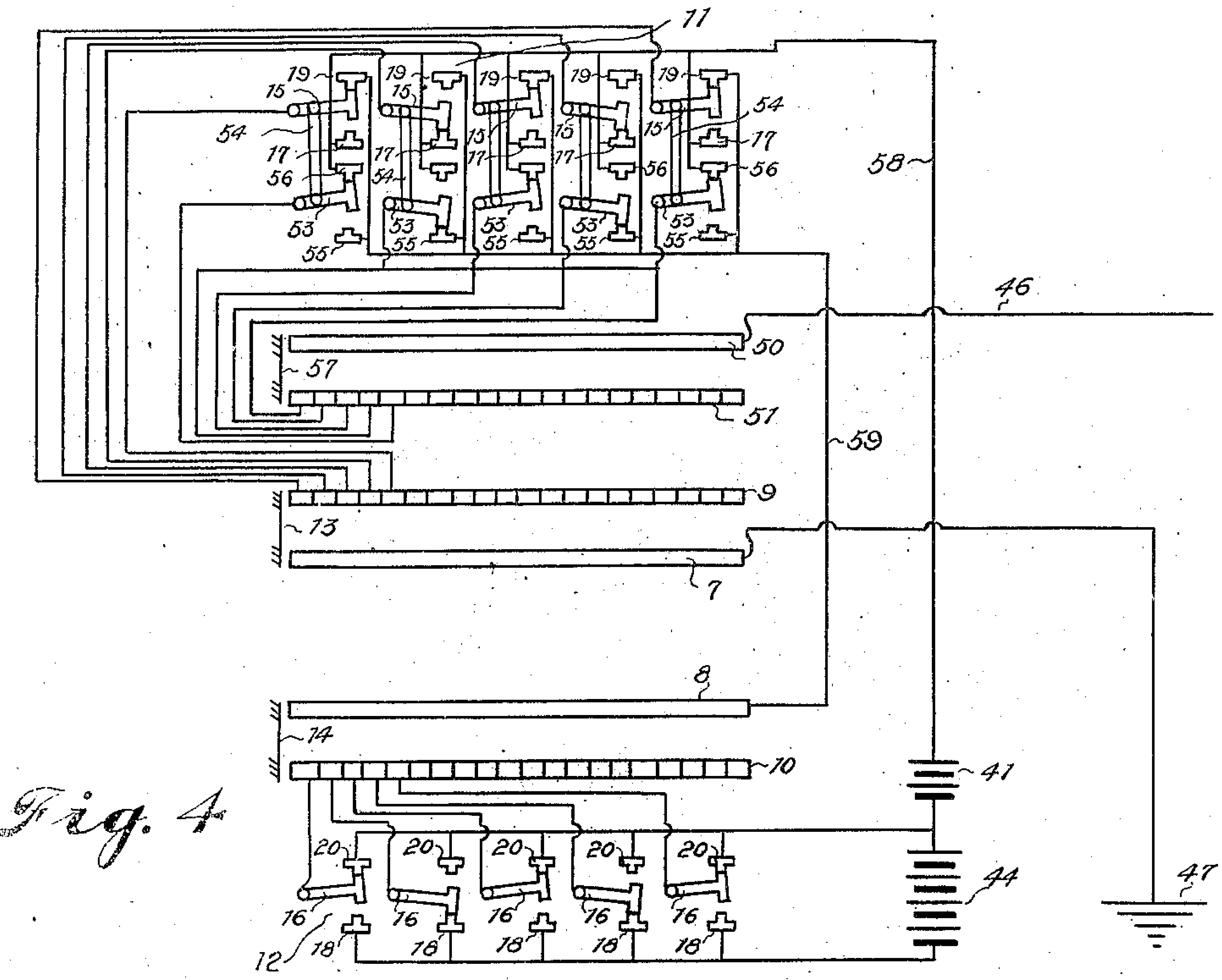

Fig. 4

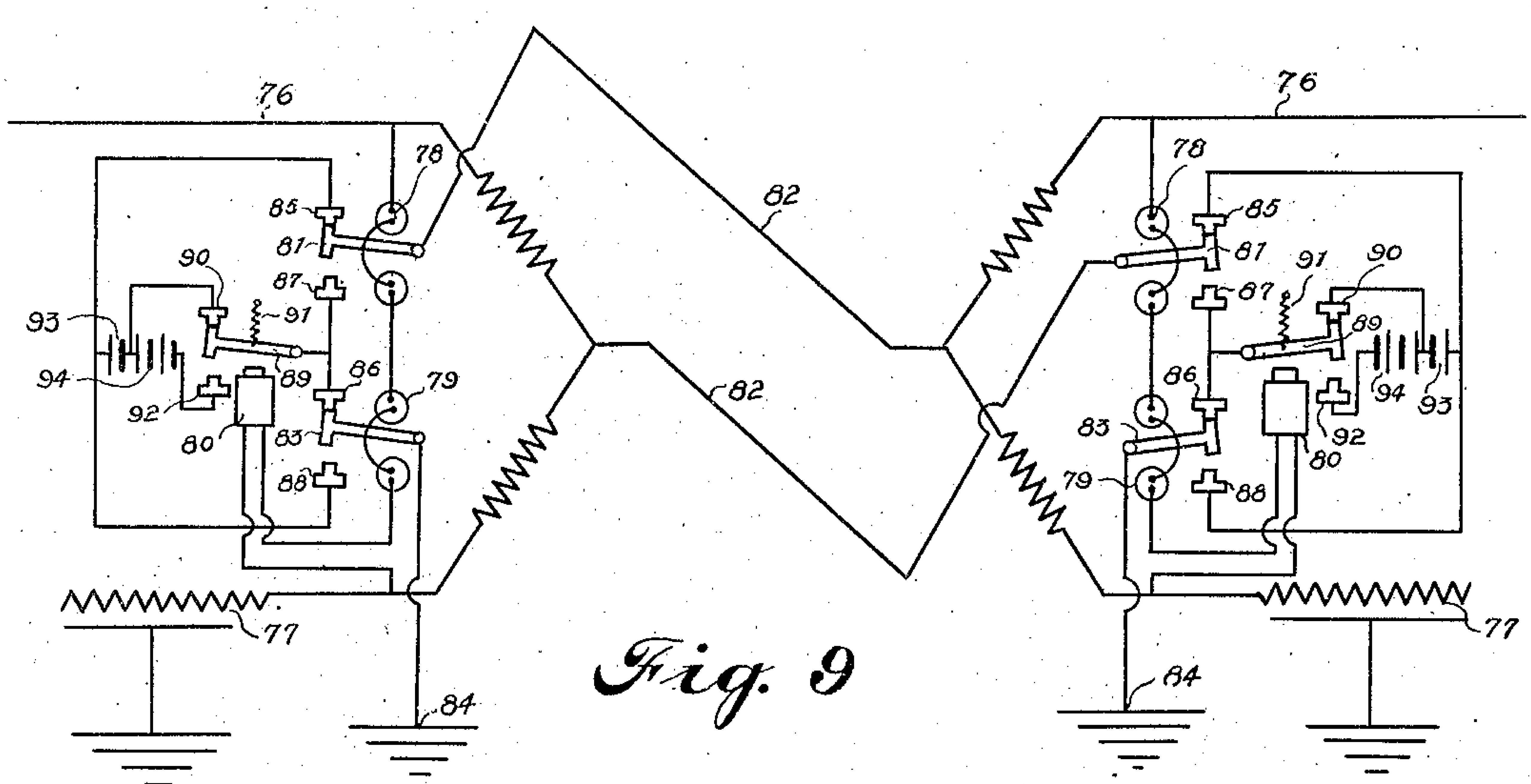

Fig. 9

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SYNCHRONIZED QUADRUPLEX TELEGRAPHY

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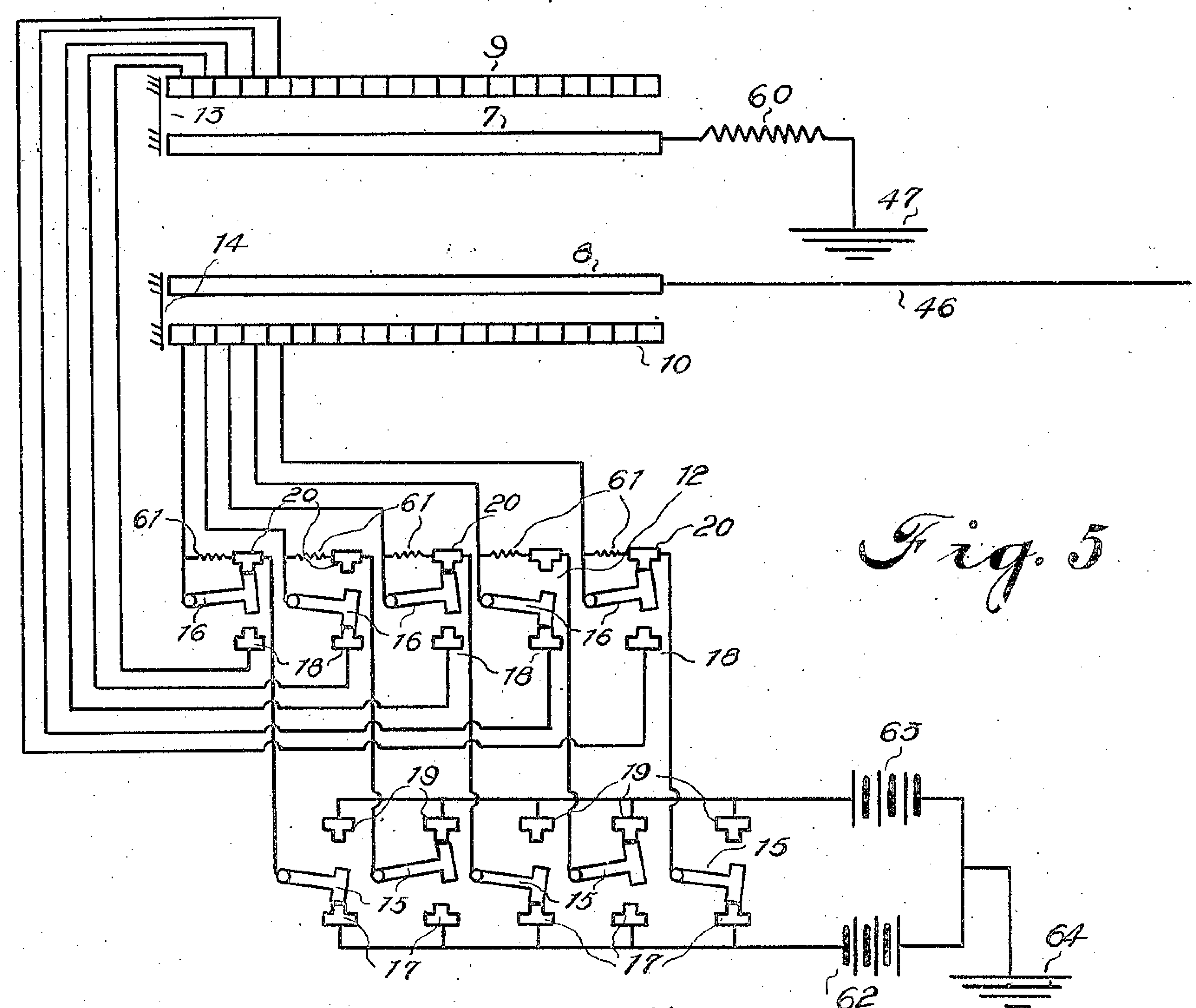

Fig. 5

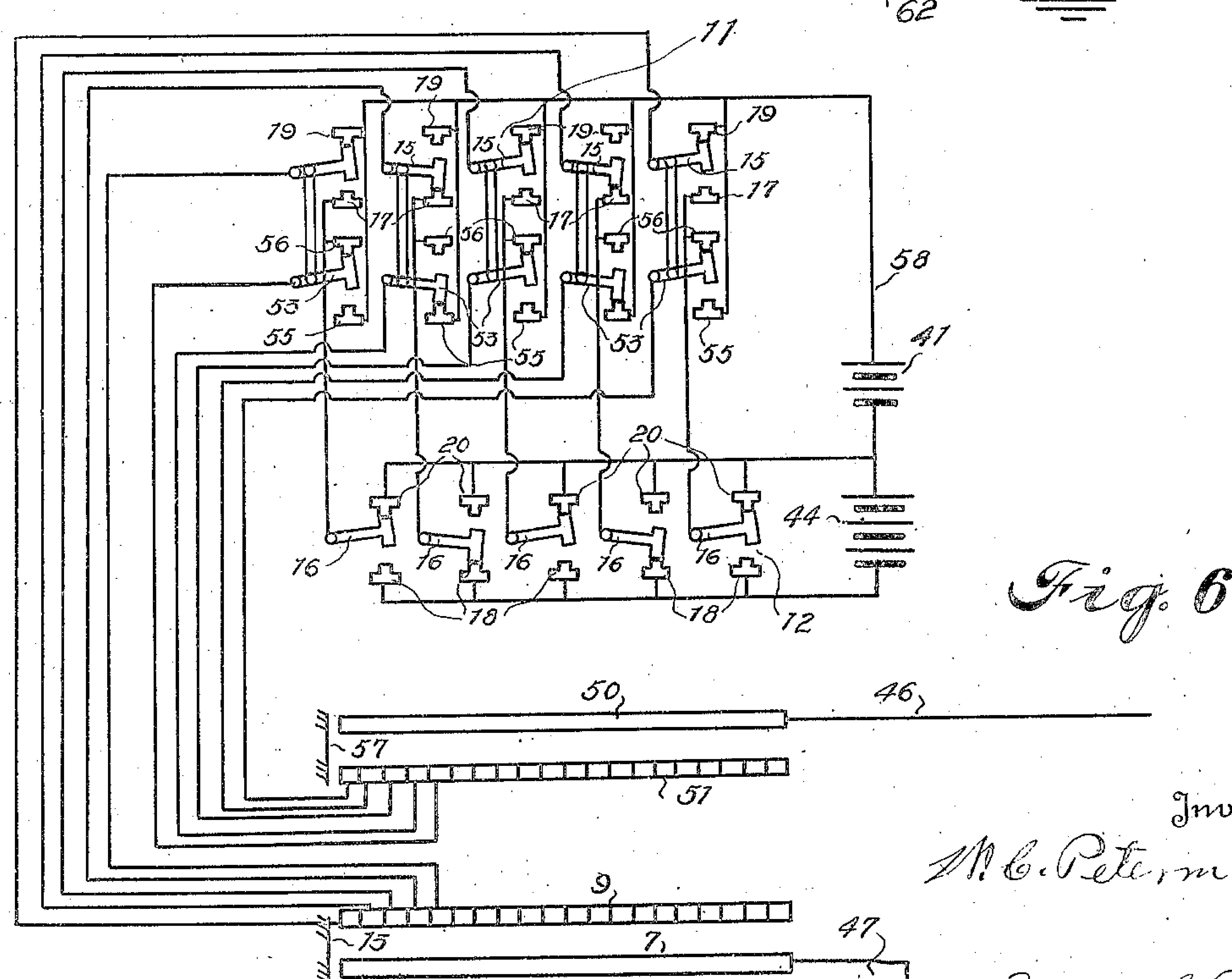

Fig. 6

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SYNCHRONIZED QUADRUPLEX TELEGRAPHY

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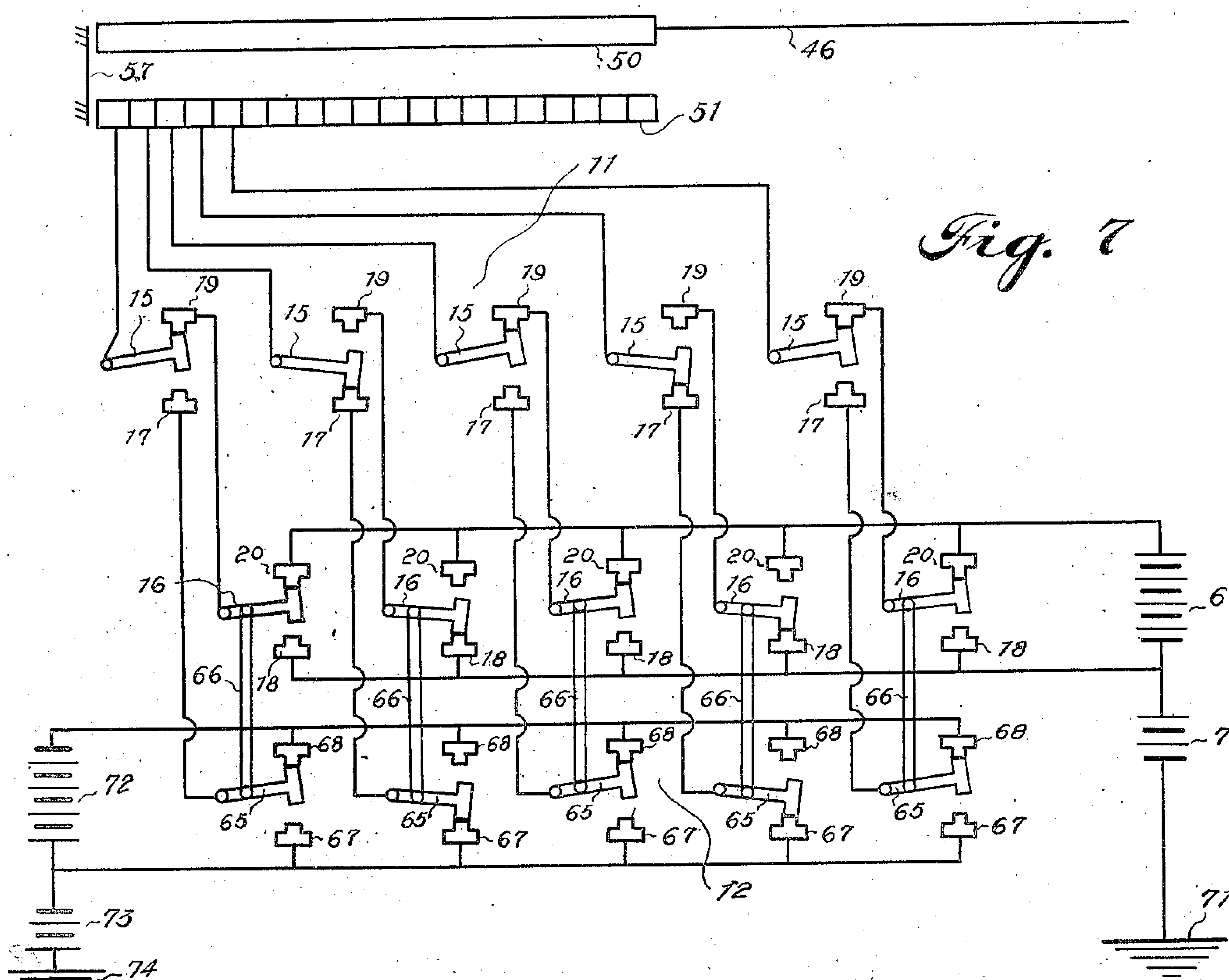

Fig. 7

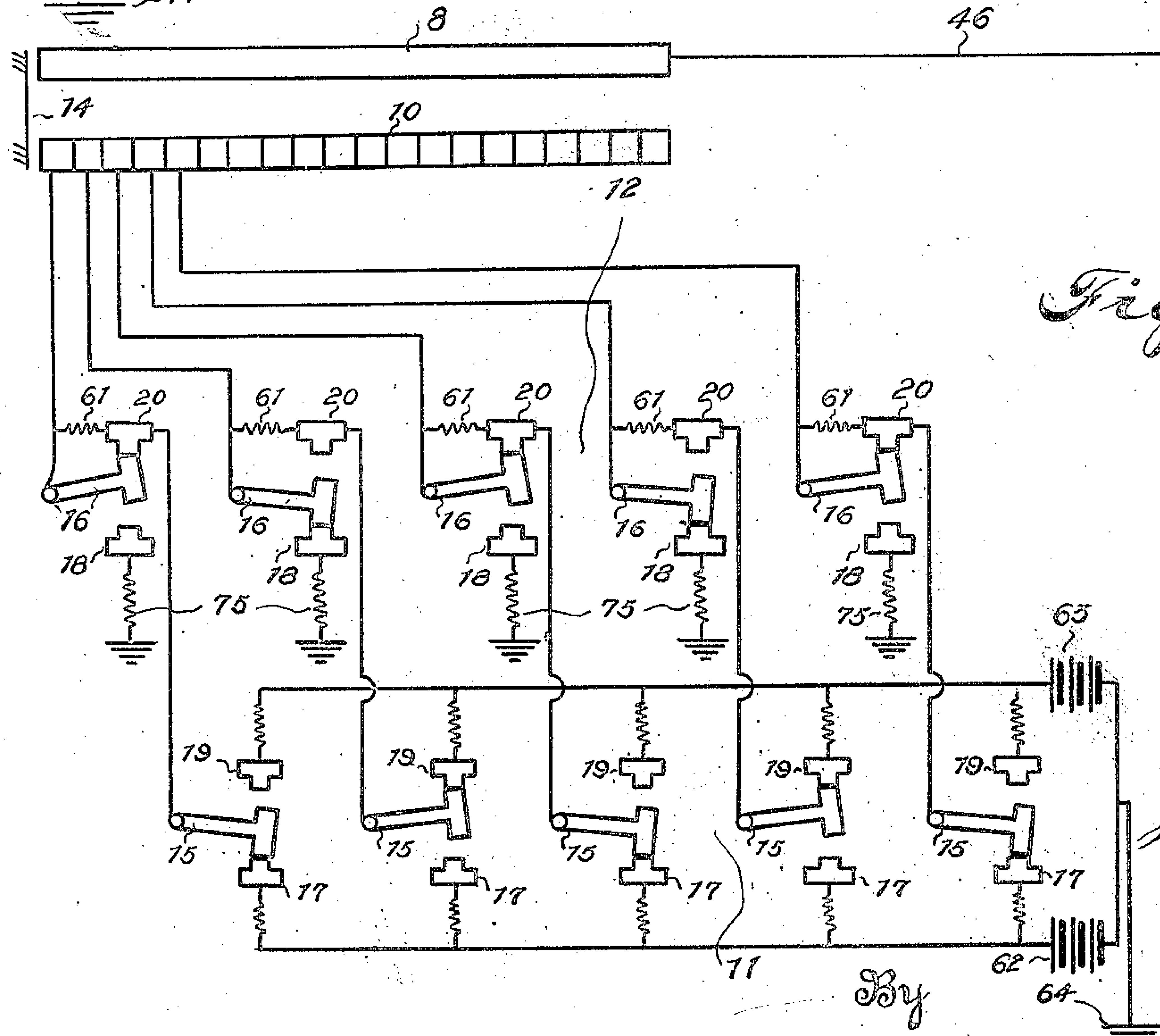

Fig. 8

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Patented Jan. 15, 1929. **1,699,444**

UNITED STATES PATENT OFFICE.

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SYNCHRONIZED QUADRUPLEX TELEGRAPHY.

Application filed September 18, 1924. Serial No. 738,471.

The present invention relates to systems of telegraphy.

More particularly the invention relates to improvements in methods of operating systems of telegraphy in which a plurality of messages may be simultaneously transmitted in the same direction over a single line wire, and to improvements in apparatus for such systems.

In the well known diplex, quadruplex, sextuplex, octoplex, and like telegraph systems, a plurality of messages are simultaneously sent in the same direction over a single line wire. A common method of distinguishing between the different messages is to rely upon the polarity of impulses to produce one set of signals, and to rely upon variations in current strength to produce another set of signals. A well known system in which the polarity of signals, and current strengths are relied upon to send different messages simultaneously is the quadruplex system utilizing a receiving polarized relay responsive to reversals in current whether strong or weak, and a neutral receiving relay responsive only to impulses of more than a predetermined minimum strength at each station. In such systems, it is at present the practice to send signals on each side out of step and without any definite established relation with regard to each other. The result is that a great number of abrupt changes in applied potential occur on the line, which in well known manner, set up various high frequency vibrations. The setting up of these frequencies results in increased attenuation and distortion of the signals, which on the usual lines, becomes so serious as to produce false effects on the neutral side. The false effects so produced, impair seriously the practical value of such systems and greatly increase the operating difficulties. I have found that by establishing a definite relation in the transmission of impulses on the polar and the neutral sides so that the changes in strength of current for signals on the neutral side are caused to occur when the current is reversed for signals on the polar side, the number of abrupt changes in transmitted current strength and applied potential are materially reduced. The result is a decided improvement in the signals due to decreased attenuation and distortion, making possible multiple simultaneous transmission over lines which have been heretofore practically unavailable for this type of transmission.

Because of the relatively great number of impulses used in the transmission of multiplex equal unit printing telegraph codes, such as the well known Baudot, the number of sudden current changes, when attempts have been made to operate such systems, quadruplex in the usual manner, have been so great as to cause prohibitive distortion and attenuation. A further feature of the improvement effected by application of the present invention is the fact that it makes possible the practical quadruplex operation of multiplex rotary distributor printing telegraph systems, in this manner materially increasing the carrying capacity of the lines to which the invention is applied.

The objects of the invention are to provide improved methods of operaiton and improved apparatus for telegraph systems of the character mentioned; to provide improved transmitting and repeating arrangements for quadruplex systems; to provide novel methods of operation and novel apparatus for rotary distributor multiplex systems, and such other objects as may be attained by utilization of the various combinations, subcombinations and principles hereinafter set forth in the detailed disclosure of preferred embodiments of the invention and in the appended claims.

Referring to the drawings

Fig. 1 represents the variations in applied potential of transmitted signals on an ordinary quadruplex line.

Fig. 2 represents the applied potential variation for the signals indicated in Fig. 1, when sent in accordance with the present invention.

Figs. 3 to 8 inclusive show diagrams of various transmitting arrangements for applying the invention to rotary distributor multiplex systems.

Fig. 9 illustrates a receiving and retransmitting or repeating arrangement; and Fig. 10 illustrates another modification of the quadruplex repeating arrangement.

In Figs. 1 and 2, the reference characters 1 indicate dashes sent on the polar side of an ordinary quadruplex system and 2 represents the dots sent on the polar side. The dots and dashes are made up of impulses of proper length and of one polarity, and the spaces between dots and dashes are indicated by impulses of opposite polarity. On the neutral side, 3 and 4 indicate dots and dashes respectively, which are indicated by impulses of increased strength of either polarity, the spaces between dots and dashes being indicated by impulses of decreased strength. As is well understood, the polar receiving relay in such systems is operated by impulses regardless of strength while the neutral receiving relay is operated only by the strong impulses of either polarity.

The polar and neutral signals are out of step as ordinarily sent, with the result that, as shown by the curve 5 in Fig. 1, a number of abrupt changes in applied potential occur at 6. These abrupt changes may be eliminated as shown in Fig. 2, by proportioning the lengths of the signals, and spaces between signals in such manner, and so timing transmission of each side that reversals of polarity on the polar side, and variations in strength of impulses on the neutral side must occur simultaneously. By making the dots equal in length to the spaces, the dashes equal in length to three dots, and using automatic transmitters such as any well known form of keyboard, storage, or tape transmitting mechanisms, connected together or operated in definitely timed relation in any manner, excellent results may be obtained. The various forms of automatic transmitters adaptable for this method of operation are well known in the art, and the connection thereof in a manner to establish the definite relation are mere matters of detail requiring no specific disclosures to those skilled in the art. It will also be understood that equal length permutation codes may also be transmitted to operate printers by the start-stop method from tape or keyboard transmitters.

In Fig. 3, transmitting apparatus for a quadruplex multiplex permutation code rotary distributor arrangement is shown. A rotary distributor is provided with a pair of continuous rings 7 and 8 and a pair of rings 9 and 10 made up of insulated conducting segments. The distributor is divided off in well known manner into a plurality of channels comprising five transmitting segments in each channel. Connected to the segments forming each channel of rings 9 and 10 are a plurality of Baudot tape transmitters 11 and 12, one only being indicated connected to each ring for the sake of clarity in disclosure. Transmitters 11 are individual to the polar side and transmitters 12 are individual to the neutral side of the system. A pair of brushes 13 and 14 which may be carried by the same distributor arm, or driven otherwise in fixed relation, establish connection consecutively between the contacts of rings 9 and 10 with rings 7 and 8 respectively. Only the actual transmitting segments have been indicated, but it will be understood that the usual synchronization and local control means, such for example as the transmitter stepping controls are provided. The usual local controls and synchronization methods may be applied in well known manner by those skilled in the art and since they form no novel part of the present invention, they have been omitted in the disclosure to more clearly show the invention.

The tongues 15 and 16 of the transmitters 11 and 12 are controlled in well known manner by suitable means to be positioned against the contacts 17 and 18, or the contacts 19 and 20 of the respective transmitters in a manner to place marking and spacing potentials from batteries 21, 22, 23 and 24 on the corresponding segments of rings 9 and 10. A circuit from conducting ring 7 to the mid-point between batteries 21 and 22 is completed by conductor 25 through polarized relays 26 and 27, which comprise the transmitting relays for the polar side. A circuit from ring 8 to the mid-point of batteries 23 and 24 is completed by conductor 28 through polarized relay 29, which constitutes the transmitting relay for the neutral side. When impulses of one polarity are to be transmitted to the line, the current through relays 26 and 27 is such as to cause tongues 30 and 31 thereof to engage contacts 32 and 33 respectively and when the polarity of the impulses is to be reversed, tongue 30 is caused to engage contact 34 and tongue 31 is thrown into engagement with contact 35. To transmit neutral side spacing and marking conditions respectively, tongue 36 of relay 29 engages contacts 37 and 38. Contacts 32 and 35 are connected by conductors 39 and 40 to one terminal of transmitting battery 41; contacts 33 and 34 are connected to tongue 36 of relay 29 by conductor 42; contact 37 is connected by conductor 43 between the terminals of batteries 41 and 44; and contact 38 is connected to a terminal of battery 44 by conductor 45. Tongue 30 of relay 26 is connected to the line lead 46, and tongue 31 of relay 27 is grounded at 47.

In operation, brushes 13 and 14 will move over the contacts of rings 9 and 10 in definitely fixed relation and in a manner to simultaneously apply the polar and neutral side impulses to the line. The nature of the impulses will be determined by the positions of the transmitting tongues 15 and 16 in well known manner. Tongues 30 and 31 of relays 26 and 27 will move simultaneously in a manner to apply the reversals of polarity to the line in accordance with the code combinations to be transmitted on the polar side and tongue 36 will be shifted between contacts 37 and 38 in accordance with the signals to be transmitted on the neutral side. With tongue 36 against contact 37 a weak impulse will be transmitted from battery 41, and with tongue 36 against contact 38 a strong impulse will be transmitted from the combined batteries 41 and 44.

The polarity of the impulses will be governed by tongues 30 and 31. At the receiving end, polarized relay 48 will be responsive to all impulses to control synchronous multiplex receiving apparatus in accordance with the reversals due to transmitted signals on the polar side, while neutral relay 49 will respond to the strong impulses independently of polarity to control synchronous multiplex apparatus on the neutral side. Any appropriate and well known form of line-relay-controlled receiving apparatus may be operated by relays 48 and 49. It will be noted that the relative position of brushes 13 and 14 is such as to cause any movement of tongue 36 to occur simultaneously with tongues 30 and 31, and the variations in strength of line impulses will accordingly occur simultaneously with the reversals in polarity.

In Fig. 4 a form of synchronous quadruplex multiplex transmitting apparatus embodying the invention is shown in which the transmitting relays are eliminated and the impulses are imparted from the distributor directly to the line. The distributor shown in Fig. 3 is modified by the addition of conducting ring 50 and segmented ring 51, the segments of which are the same in number and occupy the same angular sectors as corresponding segments of ring 9. The transmitters 12 on the neutral side are the same as for Figure 1. The transmitters 11 on the polar side, have added thereto an extra set of transmitting tongues 53 which are permanently connected to and movable with tongues 15 by means of connecting links 54. Tongues 53 are adapted to engage with fixed contacts 55 and 56 when tongues 15 linked thereto engage contacts 17 and 19 respectively. Tongues 53 are connected in order to consecutive segments of ring 51 and in such relation that brushes 13 and 57 establish connections simultaneously between rings 7 and 50 and each pair of linked tongues 15 and 53. Ring 50 is connected to line lead 46; ring 7 is connected directly to ground 47; contacts 20 of the neutral side transmitters are connected to the mid-point between batteries 41 and 44; contacts 18 of the neutral side transmitters are connected to the end terminal battery 44; contacts 17 and 56 of the polar side transmitters are multipled together and connected by lead 58 to the free terminal of battery 41; and contacts 19 and 55 of the polar side transmitters are multipled together by lead 59 to ring 8.

In operation brushes 13, 14 and 57 simultaneously establish connections between the segments of rings 9, 10 and 51 and the corresponding rings 7, 8, and 50. The position of tongues 15 and 53 of the transmitters 11 determine the polarity of the impulses, and the positions of tongues 16 of transmitters 12 determine whether a weak impulse from battery 41 alone, or a strong impulse from batteries 41 and 44 combined will be transmitted. With a tongue 16 against its contact 18 in transmitters 12 and the corresponding tongues 15 and 53 against contacts 19 and 56 in transmitters 11, a circuit will be completed from ground 47, through ring 7, brush 13, the corresponding segment of ring 9, tongue 15, contact 19, lead 59, ring 8, brush 14, the corresponding segment of ring 10, tongue 16, contact 18, batteries 44 and 41, lead 58 to contact 56, tongue 53, the corresponding segment of ring 51, brush 57, ring 50 to line lead 46. A strong impulse of definite polarity will pass to the line. Assuming that on the next impulse the tongue 16 engages contact 18, but the tongues 15 and 53 engage contacts 17 and 56, the circuit will pass from tongue 15 to contact 17, lead 58, batteries 41 and 44, contact 18, tongue 16, over brush 14 to ring 8, contact 55, tongue 53, and over brush 57 to ring 50 and line lead 46, transmitting a strong impulse of reversed polarity. When a tongue 16 is thrown into engagement with its contact 20, battery 44 is removed from the transmitting circuit, and weak impulses of a polarity determined by the positions of tongues 15 and 53 will be transmitted. The receiver control may be the same as set forth in connection with Fig. 3.

In Fig. 5 an arrangement is shown whereby resistances are introduced by the neutral side transmitter in a manner to vary the strength of the impulses. In this form, ring 7 is connected through a resistance 60 to ground 47, contacts 18 of the neutral side transmitters 12 are connected in order to the segments of ring 9; tongues 15 of the polar side transmitters 11 are connected to the corresponding contacts 20 of transmitters 12; tongues 16 of transmitters 12 are connected to the segments of ring 10; contacts 20 of transmitters 12 are connected through resistances 61 to the leads from tongues 16 to ring 10, and ring 8 is connected directly to line lead 46. Contacts 17 of transmitters 11 are connected to the negative terminal of battery 62 and contacts 19 are connected to the positive terminal of battery 63. The opposite terminals of batteries 62 and 63 are grounded at 64. In operation, the positions of tongues 15 determine the polarity of the impulses transmitted. With the corresponding tongues 16 against contacts 20, resistances 61 will be shunted by the tongues 16 and the strong impulses will be transmitted. With tongues 16 engaging contacts 18, resistances 61 will be in series with the line circuit, and brush 13 will complete shunt paths through tongues 16, contacts 15, segments of ring 9, ring 7, through resistance 60 to ground 64, causing weak impulses to be transmitted. The inclusion of resistances 61 and establishing the shunt through resistance 60 will effect a material reduction in strength of the line impulses.

In Fig. 6 a simplification of the arrangement shown in Fig. 4 is disclosed. The rings 8 and 10 are eliminated, tongues 16 of transmitters 12 are connected directly to the corresponding contacts 17 and 56 of transmitters 11, and lead 59 is connected to the contacts 19 and 55 of transmitters 11. The remaining connections are the same as set forth in the description of Fig. 4. In operation, the positions of tongues 16 determine whether battery 44 will be connected in the circuit or cut out. With tongues 16 engaging contacts 18, battery 44 will be added to battery 41 and strong impulses will be transmitted, and engaging contacts 18, weak impulses will be transmitted. The positions of tongues 15 and 53 will determine the polarity of the transmitted impulses. The line circuit comprises ground 47, ring 7, brush 13, ring 9, tongues 15, contacts 19, conductor 58, batteries 41 and 44 or 41 alone, contacts 18 or 20, tongues 16, contacts 56, tongues 53, ring 51, brush 57 and ring 50 to line 46; or from tongues 15, through contacts 17, tongues 16, contacts 18 or 20, through batteries 44 and 41 or 41 alone, conductor 58, contacts 55, tongues 53, rings 51 and 50 to line 46.

In Fig. 7 an arrangement is shown in which only one segmental distributor ring is utilized. In this form line 46 is connected to ring 50, and the polar side transmitters 11 have the tongues 15 thereof connected in order to the segments of ring 51. Tongues 65 are connected to tongues 16 of neutral side transmitters 12 by means of links 66. Contacts 67 and 68 are adapted to be engaged by tongues 65. Contacts 17 and 19 of transmitters 11 are connected to corresponding pairs of tongues 16 and 65 respectively of transmitters 12; contacts 20 are connected to the positive terminal of battery 69; contacts 18 are connected to the negative terminal of battery 69 and to the positive terminal of battery 70, and the negative terminal of battery 70 is grounded at 71. Contacts 68 are connected to the negative terminal of battery 72; contacts 67 are connected to the positive terminal battery 72 and to the negative terminal of battery 73, and the positive terminal of 73 is grounded at 74. In operation, as brush 57 rotates over the segments of ring 51 impulses of varying strengths and polarity are imparted to line 46. The polarity of the impulses is determined by the position of tongues 15 of transmitters 11, and the strength of the impulses is determined by the positions of tongues 16 and 65. The positive impulses are transmitted from batteries 69 and 70 and the negative impulses are transmitted from batteries 72 and 73.

In Fig. 8 a modification of the form shown in Fig. 5 is disclosed in which only one segmented distributor ring is utilized. The rings 7 and 9 and resistance 60 of Fig. 5 are eliminated and the contacts 18 of transmitters 12 are grounded through resistances 75, one of which is individual to each contact. With tongues 16 engaging contacts 20, resistances 61 are shunted and strong impulses are transmitted. When contacts 18 are engaged, resistances 61 will be in series in the line circuit and a high resistance shunt or leak path will be closed through contacts 18 causing weak line impulses to be sent.

It will be understood that in each of the forms disclosed, the usual local and synchronization controls are provided. The neutral and polar transmitting tapes are stepped ahead simultaneously and since the transmission occurs from a common distributor, the changes in strength and polarity will occur simultaneously in each form. Accordingly the impulses on the line will be the same for each form of transmitting apparatus.

An arrangement of transmitting relays and batteries similar to that shown in Figure 3 may be effectively utilized in a repeater for quadruplex systems. Such a repeating arrangemeent is illustated in Fig. 9. Connected in a bridge between line conductors 76 and the usual artificial balancing lines 77, are polarized receiving relays 78 and 79 and neutral receiving relay 80. Relays 78 and 79 are responsive to all impulses of either polarity, and relay 80 responds only to strong impulses of either polarity. The tongues 81 of relays 78 are connected to the transmitting leads 82 of the lines to which the received signals are to be repeated, and tongues 83 of relays 79 are grounded at 84. Tongues 81 and 83, engage contacts 85 and 86 when an impulse of one polarity is received, and engage contacts 87 and 88 when an impulse of opposite polarity is received. Tongues 89 of relays 80 are held against contacts 90 by springs 91 when weak impulses of either polarity are received and are attracted to engage contacts 92 when strong impulses of either polarity are received. Contacts 85 and 88 are connected to one terminal of batteries 93; contacts 86 and 87 are connected to tongues 89 of relays 80; contacts 90 are connected to the midpoint between batteries 93 and 94; and contacts 92 are connected to the end terminals of batteries 94.

In operation, tongues 81 and 83 of relays 78 and 79 will be positioned against contacts 85 and 86 or 87 and 88 in accordance with the polarity of the received impulses, and tongues 89 will engage contacts 90 or 92 in accordance with the strength of the received impulse. The connections to batteries 93 and 94 are such that the received impulses will be repeated in amplified form over leads 82. The retransmitting circuit is completed on each side from ground 84 over tongue 83 and contact 86, tongue 89 contact 90 through battery 93 for a weak impulse, or contact 92 through batteries 94 and 93 for a strong impulse, thence over contact 85, tongue 81 to lead 82 and outgoing line 76. For an impulse of opposite polarity the circuit passes from tongue 83 through contact 88 battery 93 and contact 90 for a weak impulse, or batteries 93 and 94 to contact 92 for a strong impulse, thence over tongue 89, contact 87, and tongue 81 to lead 82.

Instead of receiving the polar and neutral sides of a quadruplex system upon separate relays, I may provide for the reception of both polar and neutral sides on a single relay. Such relay may be of the well known stretched wire type disclosed in Muirhead's British Patent No. 10120 of 1901, but modified by providing two sets of contacts on each side of "no-man's-land", one set spaced farther apart than the other and located at a different position along the stretched wire. If the signal is of small amplitude, the stretched wire will make contact with one of the first pair of contacts only, but if it is of large amplitude it will lap or bend over the first contact and make contact with one of the contacts of the more widely separated pair. I have illustrated such an arrangement in Fig. 10, in which 95 represents the usual suspended coil of a stretched wire relay to which the swinging pointer 96 is attached. The contacting wire 97 is fixed at its lower end and attached to the end of the pointer at its upper end. As will be evident to those familiar with the art, the local circuits are so arranged that the local apparatus ordinarily operated by the polar relay of a quadruplex is operated from the closely set contacts 98^a, 98^b and the local apparatus ordinarily operated by the neutral relay of a quadruplex is operated from the more widely separated contacts 99^a, 99^b.

I claim:—

1. A signaling system, comprising a polarized receiving apparatus responsive to impulses of reversed polarity for the reception of a message, said receiving apparatus being also responsive to a greater degree when said impulses are of certain predetermined strength to thereby receive a second message, a transmitter for sending impulses of reversed polarities, a transmitter for causing said impulses to be of said increased predetermined strength, and means for operating said transmitters in a manner to cause changes in polarity and in strength to occur simultaneously.

2. In a signalling system, polar and neutral receiving apparatus for the simultaneous reception of two messages, a pair of relays actuated in accordance with signals to be transmitted over said line to said polar apparatus for transmitting impulses of reverse polarities, and a single relay actuated in accordance with signals to be transmitted over said line to said neutral receiving apparatus for transmitting impulses of different current values.

3. The combination as set forth in claim 2 in which said single relay and said pair of relays are polarized.

4. In a signaling system as set forth in claim 2, a current source co-acting with said single relay having terminals for supplying different voltages, said relay operating to connect the line with said different terminals controlled by the signal impulses to be transmitted to said neutral receiving apparatus.

In testimony whereof I affix my signature.

WILLIAM C. PETERMAN.