No. 777,312. PATENTED DEC. 13, 1904.

H. SHOEMAKER.

MULTIPLEX TELEGRAPH SYSTEM.

APPLICATION FILED JAN. 18, 1904.

NO MODEL. 2 SHEETS—SHEET 1.

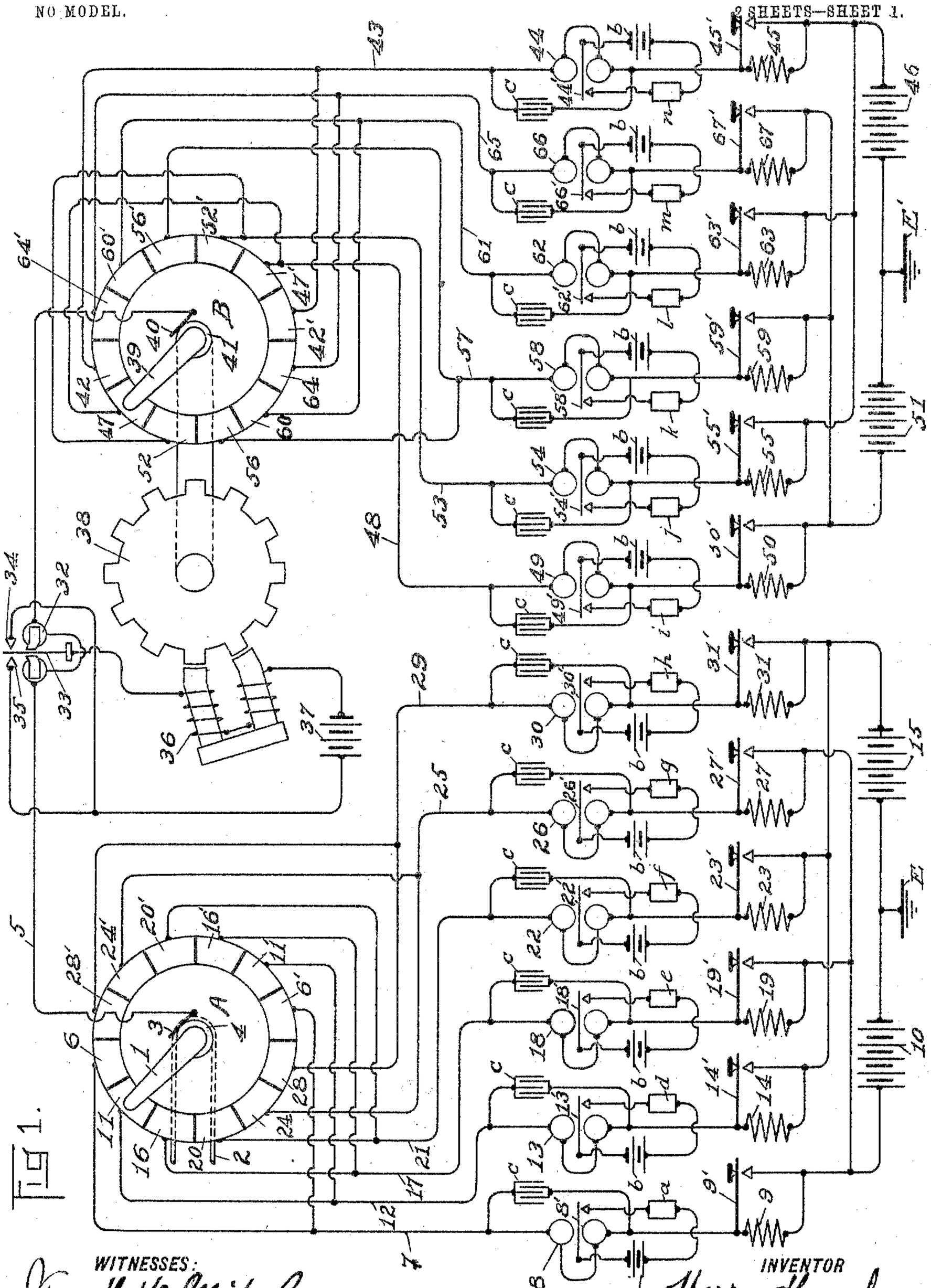

FIG 1.

WITNESSES:

Fredk W. Midgley.

Lilian M. Lercamer.

INVENTOR

Harry Shoemaker

BY

Cornelius D. Ehret

his ATTORNEY.

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NO MODEL. 2 SHEETS—SHEET 2.

Fig 2

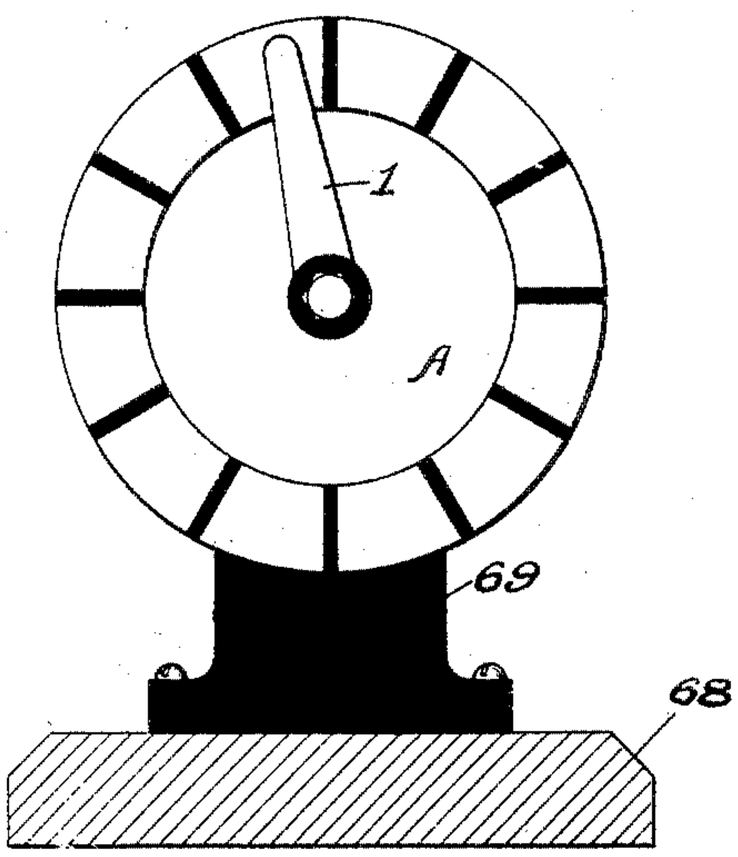


Fig 4

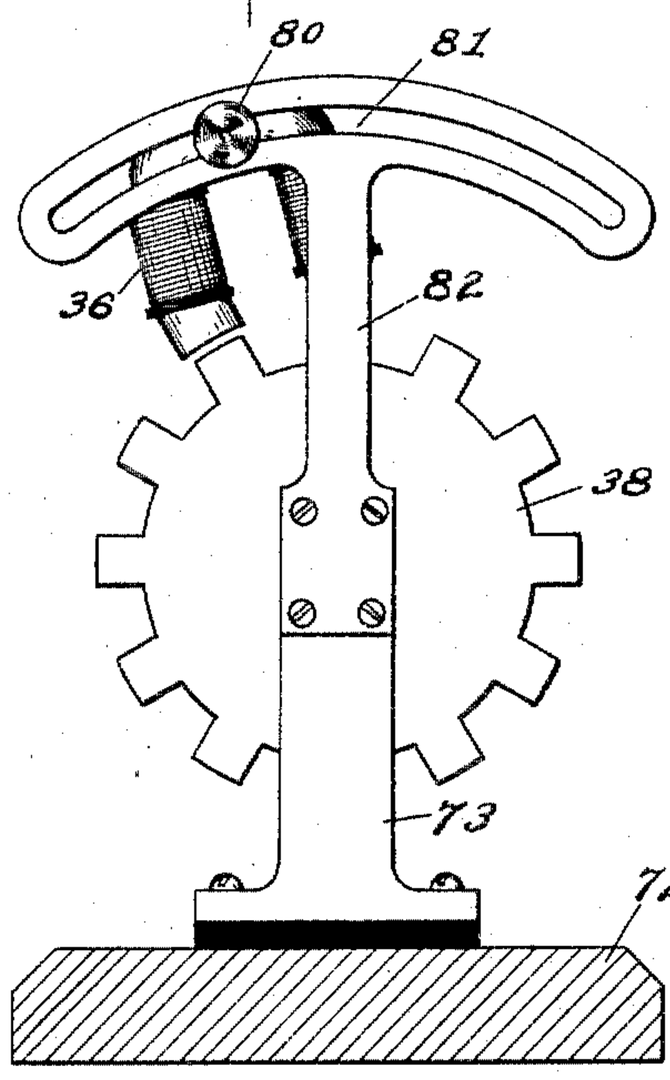


Fig 3.

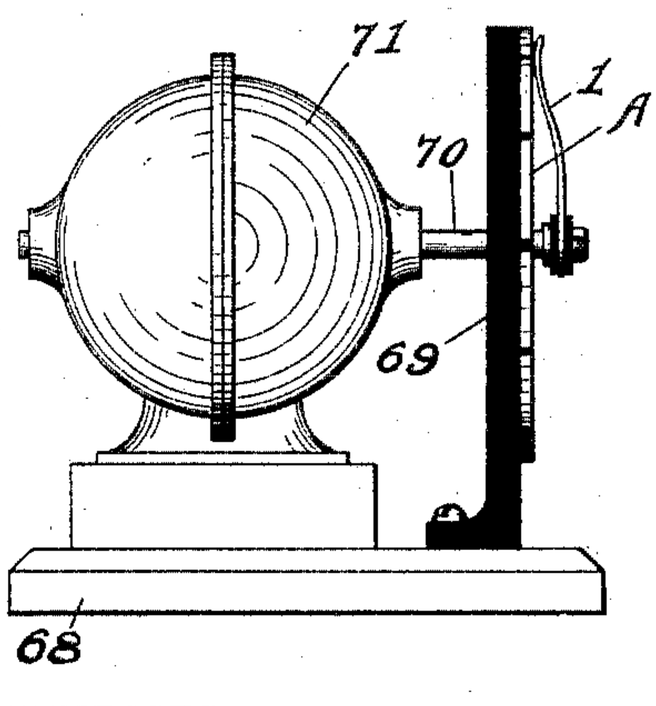
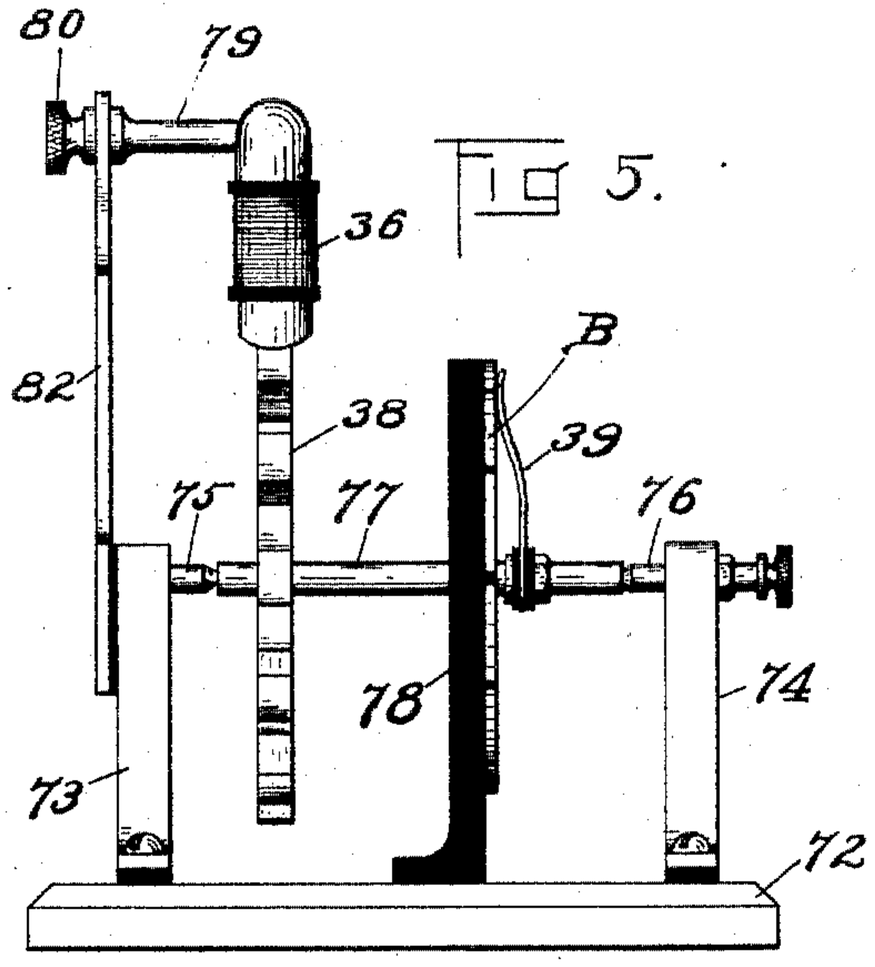


Fig 5.



WITNESSES:

James M. Sawyer

Lilian M. Creamer

INVENTOR.

Harry Shoemaker

BY Cornelius D. Chet

his ATTORNEY.

No. 777,312. Patented December 13, 1904.

UNITED STATES PATENT OFFICE.

HARRY SHOEMAKER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO MARIE V. GEHRING, OF PHILADELPHIA, PENNSYLVANIA.

MULTIPLEX TELEGRAPH SYSTEM.

SPECIFICATION forming part of Letters Patent No. 777,312, dated December 13, 1904.

Application filed January 18, 1904. Serial No. 189,416. (No model.)

To all whom it may concern:

Be it known that I, HARRY SHOEMAKER, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a new and useful Multiplex Telegraph System, of which the following is a specification.

My invention relates to a multiplex telegraph system, in which a plurality of messages may be transmitted simultaneously but independently of each other over the same circuit and in either direction over such circuit.

My invention consists of a telegraph system wherein at one station a sunflower is rotated at practically uniform speed and wherein at any other station a similar sunflower is kept in step with the first-mentioned sunflower by means of a phonic wheel controlled by a line-relay.

My invention consists, further, of a telegraph system wherein alternate positive and negative impulses are transmitted over the circuit, such impulses being strengthened when a signal impulse is transmitted.

My invention consists of a telegraph system wherein at one station a sunflower is rotated at approximately uniform speed and wherein such sunflower operates as the master-sunflower for the entire system and in which the sunflower at each of the other stations is kept in step with the master-sunflower, not by a usual scynchronizing impulse, but by each of the impulses transmitted over the circuit, whether representing a signal or not.

Reference is to be had to the accompanying drawings, in which—

Figure 1 is a diagrammatic view illustrating my invention as applied to a sending and receiving station and in which six messages may be simultaneously and independently transmitted in either direction. Fig. 2 is a front elevation of the master-sunflower. Fig. 3 is a side elevation of the master-sunflower. Fig. 4 is an end elevational view of the phonic wheel and sunflower at a station. Fig. 5 is a side elevational view of the same.

Referring to Fig. 1, A is the master-sunflower of the system whose trailer 1 is driven at practically uniform speed by any suitable means, such as a belt 2. By means of the brush 3 bearing upon the metallic hub 4 electrical communication between the trailer 1 and the line conductor 5 is constantly maintained. As shown, the sunflower A consists of twelve segments, of which diametrically opposite ones are cross-connected. For example, segments 6 and 6′ are connected together and to the conductor 7, from which a connection is made to and through the winding of the relay 8, thence through resistance 9, battery 10, to the earth connection E. Similarly sunflower-segments 11 and 11′ are connected together and to the conductor 12, which has a connection with the earth-plate E through the windings of the relay 13, resistance 14, and battery 15. Similarly segments 16 and 16′ are connected with each other and the conductor 17, between which and the earth-plate E are connected the windings of the relay 18, resistance 19, and battery 10. Similarly segments 20 and 20′ are connected with each other and with the conductor 21, between which and the earth-plate E are connected the windings of the relay 22, resistance 23, and battery 15. Similarly segments 24 and 24′ are connected together and with the conductor 25, between which and the earth-plate E are connected the windings of the relay 26, resistance 27, and battery 10. Similarly segments 28 and 28′ are connected together and with the conductor 29, between which and the earth-plate E are connected the windings of the relay 30, resistance 31, and battery 15.

Batteries 10 and 15 form together a split battery, the two halves 10 and 15 offering, preferably, equal electromotive forces.

Supposing the trailer 1 to be rotating in a counter-clockwise direction as viewed in Fig. 1, it will be seen that when in contact with segment 11 an impulse from battery 15 is sent to line, when in contact with segment 16 an impulse from battery 10 is sent to line, when in contact with segment 20 an impulse from battery 15 is sent to line. In other words, alternate, positive, and negative impulses are

impressed upon the line due to the revolution of the trailer 1, the strength of such impulses depending upon the entire impedance of each circuit controlled by a segment. At the other station of the system is provided a polarized relay 32, whose armature 33 is practically a reed-armature whose natural rate of vibration is equal to the rate of succession of the positive and negative impulses impressed upon the line. In consequence the armature 33 engages alternately the contact-points 34 and 35 and at a rate equal to the rate of succession of the impulses on the line. The contact-points 34 and 35 are connected together, and therefore the local circuit including these contacts, the armature 33, magnet-winding 36, and battery 37 is opened and closed at a rate equal to the rate of succession of the impulses upon the line. In consequence the magnet 36 is energized at a like rate, thus revolving the phonic wheel 38 through as many complete revolutions per second as the number of positive and negative impulses on the line divided by the number of poles on the phonic wheel. This phonic wheel 38 has twelve poles, thus corresponding in number with the number of segments of the master-sunflower A and also of the controlled sunflower B, whose trailer 39 is driven by the phonic wheel 38. In consequence the trailer 39 is revolved at the same rate as trailer 1, and in consequence corresponding segments of master-sunflower A and of the controlled sunflower B are in circuit at the same time. By this arrangement separate synchronizing impulses need not be sent over the line; but each impulse traversing the circuit controls the phonic wheel and brings it in step with the trailer 1 of the master-sunflower.

The trailer 39 is constantly in communication, through the windings of the relay 32, with the line 5 in virtue of the brush 40 pressing upon the hub 41.

In the sunflower B diametrically opposite segments are connected together, as in the case of the sunflower A. Segments 42 and 42′ are connected together and with the conductor 43, between which and the earth-plate E′ are connected the windings of the relay 44, resistance 45, and battery 46. Similarly segments 47 and 47′ are connected together and with the conductor 48, between which and the earth-plate E′ are connected the windings of the relay 49, resistance 50, and battery 51. Similarly segments 52 and 52′ are connected together and with the conductor 53, between which and the earth-plate E′ are connected the windings of the relay 54, resistance 55, and battery 46. Similarly segments 56 and 56′ are connected together and with the conductor 57, between which and the earth-plate E′ are connected the windings of the relay 58, resistance 59, and battery 51. Similarly segments 60 and 60′ are connected together and with the conductor 61, between which and the earth-plate E′ are connected the windings of the relay 62, resistance 63, and battery 46. Similarly segments 64 and 64′ are connected together and with the conductor 65, between which and the earth-plate E′ are connected the windings of the relay 66, resistance 67, and battery 51. Battery 15 at the one station and battery 51 at the other station assist each other, while battery 10 at the one station and battery 46 at the other station assist each other. For example, tracing the circuit with the trailers 1 and 39 in the position shown in Fig. 1, current is flowing from battery 15 through resistance 14, relay 13, conductor 12, segment 11, trailer 1, brush 3, line-wire 5, relay 32, brush 40, trailer 39, segment 47, conductor 48, relay 49, resistance 50, battery 51, earth-plate E′, earth-plate E to the other pole of battery 15. It is thus seen that these batteries 15 and 51 are, in fact, in series with each other and aid each other. Similar circuits might be traced for every other segment of the sunflowers, and it would be found that batteries 10 and 46 assist each other in like manner and that said batteries 10 and 46 are connected with the line-circuit alternately with batteries 15 and 51.

The trailer 1, and in consequence the trailer 39, revolves at a relatively rapid rate, so that each pair of segments is cut into line several times during the time corresponding with the shortest telegraphic code character to be transmitted.

In shunt to the resistance 9 is connected an ordinary operator's key 9′, in shunt to the resistance 14 a similar key 14′, in shunt to the resistance 19 the key 19′, in shunt to the resistance 23 the key 23′, in shunt to the resistance 27 the key 27′, in shunt to the resistance 31 the key 31′; at the other station in shunt to the resistance 50 the key 50′, in shunt to the resistance 55 the key 55′, in shunt to the resistance 59 the key 59′, in shunt to the resistance 63 the key 63′, in shunt to the resistance 67 the key 67′, and in shunt to the resistance 45 the key 45′. With each of these keys in open-circuit position, as shown in Fig. 1, weak, positive, and negative impulses are transmitted over the line 5 through the circuits, one of which was completely traced for the position of the trailers 1 and 39, as shown in Fig. 1. Suppose, however, that the key 14′ is depressed so as to short-circuit the resistance 14 and for an interval of time corresponding with a telegraphic dot. At each contact of the trailer 1 with the segments 11 and 11′ and at each contact of the trailer 39 with the segments 47 and 47′ a relatively stronger impulse will be impressed upon the line by batteries 15 and 51, due to the cutting out of the resistance 14, such stronger impulses being sufficient to actuate the relay-armatures 13′ and 49′, thus closing the local circuits controlled thereby. Since, however, for the telegraphic dot so transmitted several

of these strong impulses traverse relays 13 and 49, the armatures 13′ and 49′ might tend to oscillate and not hold the local circuits closed. To prevent any such fluttering of the armatures of these relays, the condensers *c c* are connected in shunt to the relay-windings, thus constituting a holdover means. These condensers are charged at each impulse and discharged between impulses through the relay-windings, thus keeping the relay practically constantly energized. Thus it is seen that the key 14′ may transmit signals or messages which are reproduced at the other station in the local circuit controlled by the relay 49. Similarly key 50′ may transmit signals or messages which are recorded in the local circuit controlled by the relay 13. Similarly the armature 8′ of relay 8 controls a local circuit. Similarly armature 18′ of relay 18 controls a local circuit. Similarly armature 54′ of relay 54 controls a local circuit, &c., as is apparent from Fig. 1. Likewise in shunt to the windings of each relay is a condenser *c* for the purpose heretofore described. Each of the local circuits includes a local battery *b* and a telegraphic sounder or recorder, such as *a*, *d*, *e*, *f*, *g*, *h*, *i*, *j*, *k*, *l*, *m*, and *n*.

With all of the operator's keys in open-circuit position weak impulses are caused to traverse the twelve relays, six at each station, and they are so adjusted as not to respond to these weak impulses, but to respond only to the stronger impulses, as occasioned by short-circuiting the resistances, such as 9 14 50 55, &c. The relay 32, however, which is simply for the control of the phonic wheel, responds to all impulses sent over the line, both weak and strong.

From the foregoing description it is readily seen that pairs of telegraphic instruments, one instrument of each pair at each station, are alternately in communication with each other and may interchange messages without interference with or from messages being interchanged by the five other pairs of instruments. Keys 9′ and 45′ control sounders or recorders *a* and *n*. Keys 14′ and 50′ control sounders *d* and *i*. Similarly keys 19′ and 55′ control sounders *e* and *j*. Similarly keys 23′ and 59′ control sounders *f* and *k*. Similarly keys 27′ and 63′ control sounders *g* and *l*. Similarly keys 31′ and 67′ control sounders *h* and *m*. It is thus seen that the respective pairs of instruments may communicate with each other as if connected in a simple Morse circuit.

In Figs. 2 and 3, 68 is a base on which is erected the member 69 of insulating material, on which is mounted the sunflower A, over which travels the trailer 1. The trailer 1 is secured to the shaft 70 of the electric motor 71, which rotates said trailer 1 at the desired rate of speed. As previously stated, this sunflower A is the master-sunflower, all other sunflowers in the system being controlled by the phonic-wheel arrangement previously described.

In Figs. 4 and 5, 72 is a base upon which are mounted the standards 73 and 74. These standards carry cone-bearings 75 and 76, on which bears the shaft 77, carrying the trailer 39 of the sunflower B, which is supported by the insulating member 78. Secured to the shaft 77 is the phonic wheel 38, which revolves in front of the poles of magnet 36. This magnet 36 is supported on the arm 79, which by means of thumb-screw 80 may be adjusted to different positions in the slot 81 of the member 82, which is secured to the standard 73. By means of this adjustment of the magnet 36 backward or forward in the slot 81 the sunflowers A and B may be brought accurately into step, even though there may be effects producing lagging or leading of the line-currents. In other words, due to inductance or capacity effects or resistance effects or any combination of them, there may be a lagging or leading effect, which it is desirable to compensate for so as to secure true synchronism of the sunflowers. These effects may vary from day to day with changes of weather, &c., and the simple adjustment of the magnet 36 backward or forward in the slot 81 will compensate for such effects and will insure all the sunflowers of the system running in unison.

Though I have shown but two stations with six instruments each, it is to be understood that my system is applicable to systems involving more stations having fewer or more instruments at each station. With the greater number of instruments at each station the number of segments of the sunflowers are increased, and also, therefore, the number of poles on the phonic wheel. It is to be understood also that though I have shown sources of direct-current energy for impressing impulses upon the circuit sources of alternating currents may be employed, and in place of resistances—such as 9 50, &c.—inductances or capacities may be used or any combination of them or any combination of resistance, inductance, and capacity.

What I claim is—

1. In a multiplex telegraph system, a master-sunflower, a controlled sunflower, means for impressing upon the circuit impulses representing a plurality of independent messages, and means reponsive to said impulses for maintaining said controlled sunflower in synchronism with said master-sunflower.

2. In a multiplex telegraph system, a master-sunflower, a controlled sunflower, and means responsive to the signal impulses for maintaining said controlled sunflower in synchronism with said master-sunflower.

3. In a multiplex telegraph system, a master-sunflower, a controlled sunflower, means for continuously impressing impulses upon the line-circuit, means for modifying said im-

pulses to represent a plurality of independent messages, and means responsive to each transmitted impulse for synchronizing said sunflowers.

4. In a multiplex telegraph system, a line-circuit, a plurality of sunflowers associated with said line-circuit, and a plurality of operators' circuits controlled by each of said sunflowers, each operator's circuit including an impedance, means for controlling said impedance, a relay, and a condenser in shunt with the winding of said relay.

5. In a multiplex telegraph system, a line-circuit, a plurality of sunflowers associated with said line-circuit, a plurality of operators' circuits associated with each sunflower for continuously impressing impulses upon said line-circuit, a relay in each operator's circuit adjusted to respond to signal impulses only, and means responsive to each impulse for synchronizing said sunflowers.

6. In a multiplex telegraph system, a line-circuit, a plurality of sunflowers associated therewith, means for continuously impressing impulses upon said line-circuit, a plurality of operators' circuits associated with each sunflower for modifying said impulses to represent signals, and means responsive to the signal impulses for synchronizing said sunflowers.

7. In a multiplex telegraph system, a master-sunflower, means controlled thereby for impressing alternate, positive and negative impulses upon the line-circuit, a controlled sunflower, a phonic wheel for actuating the same, and means responsive to each transmitted impulse for controlling said phonic wheel.

8. In a multiplex telegraph system, a master-sunflower at a station, means controlled thereby for impressing upon the line-circuit alternate positive and negative impulses, a controlled sunflower at another station, a phonic wheel for controlling the same, a line-relay at said station responsive to each transmitted impulse, and a local circuit controlled by said relay for controlling said phonic wheel.

9. In a multiplex telegraph system, a master-sunflower at a station, a controlled sunflower at another station, and means responsive to and synchronous with the transmitted impulses for controlling said last-mentioned sunflower.

10. In a multiplex telegraph system, a master-sunflower at a station, a controlled sunflower at another station, and means energized in synchronism with the transmitted impulses for controlling said last-mentioned sunflower.

11. In a multiplex telegraph system, a master-sunflower, at a station, means for impressing upon the line-circuit a current of predetermined strength, a controlled sunflower at another station, means responsive to said impressed current for controlling said last-mentioned sunflower, means for changing the strength of said current, whereby a signal impulse is transmitted, said signal impulse serving also to control said last-mentioned sunflower.

12. In a multiplex telegraph system, a master-sunflower at a station, means for impressing upon the line-circuit alternate positive and negative impulses of predetermined strength, a second sunflower at another station, means responsive to said impressed impulses for controlling said second sunflower, and means for changing the strength of said current impulses whereby a signal is transmitted, said impulses of changed strength serving also to control said second sunflower.

13. In a multiplex telegraph system, a master-sunflower at a station, means for impressing upon the line-circuit alternate positive and negative impulses of predetermined strength, a second sunflower at another station, a relay responsive to said impressed impulses for controlling said second sunflower, and means for changing the strength of the impressed current impulses whereby signals are transmitted, said impulses of changed strength also traversing said relay and serving also to control said second sunflower.

14. In a multiplex telegraph system, a master-sunflower at a station, means for impressing upon the line-circuit alternate positive and negative impulses of predetermined strength, a second sunflower at another station, a plurality of operators' circuits controlled by each sunflower, means in each operator's circuit for changing the strength of the impulses traversing such operator's circuit, a relay in each operator's circuit responsive only to the impulses of changed strength, and means responsive to all transmitted impulses for controlling said second sunflower.

15. In a multiplex telegraph system, a master-sunflower at a station, a second sunflower at another station, means for impressing upon the line-circuit alternate positive and negative impulses of predetermined strength, a plurality of operators' circuits controlled by each sunflower, an impeding device in each operator's circuit for determining the strength of the impulses normally transmitted, an operator's key for short-circuiting said impeding device whereby impulses of greater strength represent signals, a relay in each operator's circuit responsive only to the impulses of greater strength, and a relay responsive to impulses of all strengths for controlling said second sunflower.

16. In a multiplex telegraph system, a master-sunflower at a station, means for impressing upon the line-circuit alternate positive and negative impulses of predetermined strength, means for changing the strength of said impulses for transmitting signals, a second sunflower at another station, a phonic wheel for controlling said second sunflower, and a relay in the line-circuit responsive to impulses of all strengths for controlling said phonic wheel.

17. In a multiplex telegraph system, a master-sunflower at a station, means for impressing upon the line-circuit alternate positive and negative impulses of predetermined strength, means for changing the strength of said impulses to transmit signals, a second sunflower at another station, and a relay for controlling said sunflower responsive to impulses of all strengths and having an armature whose natural period of vibration corresponds with the frequency of the impressed impulses.

18. In a multiplex telegraph system, a master-sunflower at a station, means for impressing upon the line-circuit alternate positive and negative impulses of predetermined strength, means for changing the strength of said impulses to transmit signals, a second sunflower, at another station, a relay responsive to the impulses of all strengths, and a phonic wheel for controlling said second sunflower, said phonic wheel being controlled by said relay.

19. In a multiplex telegraph system, a master-sunflower at a station, means for impressing upon the line-circuit at predetermined rate alternate positive and negative impulses of predetermined strength, means for changing the strength of said impulses to transmit signals, a relay at another station responsive to the impulses of all strengths and tuned to the rate of said impulses, and a sunflower controlled by said relay.

HARRY SHOEMAKER.

Witnesses:
LILIAN M. CREAMER,
C. D. EHRET.