No. 793,652. PATENTED JULY 4, 1905.

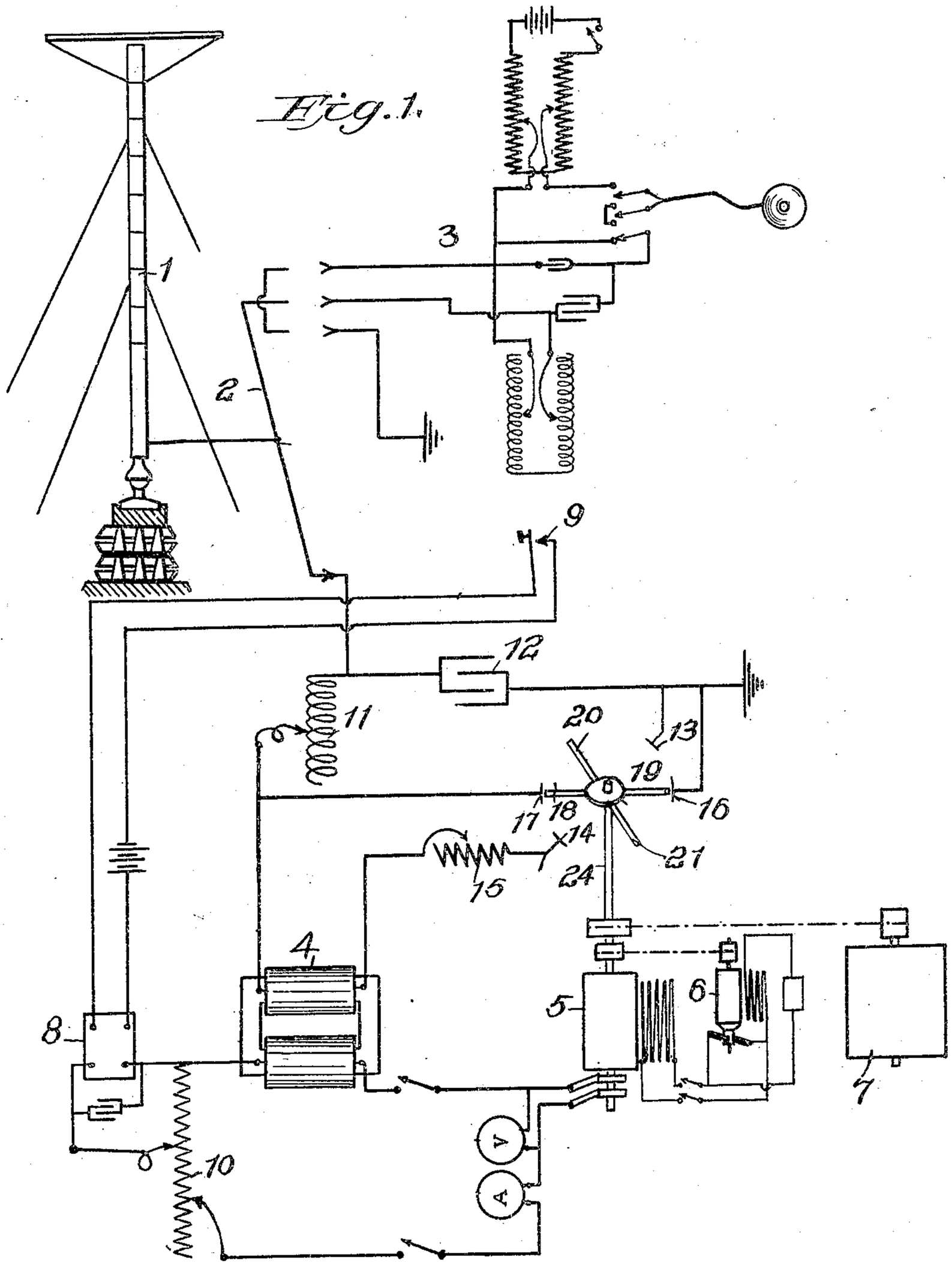
R. A. FESSENDEN.

SIGNALING BY ELECTROMAGNETIC WAVES.

APPLICATION FILED APR. 6, 1905.

4 SHEETS—SHEET 1.

Fig. 1.



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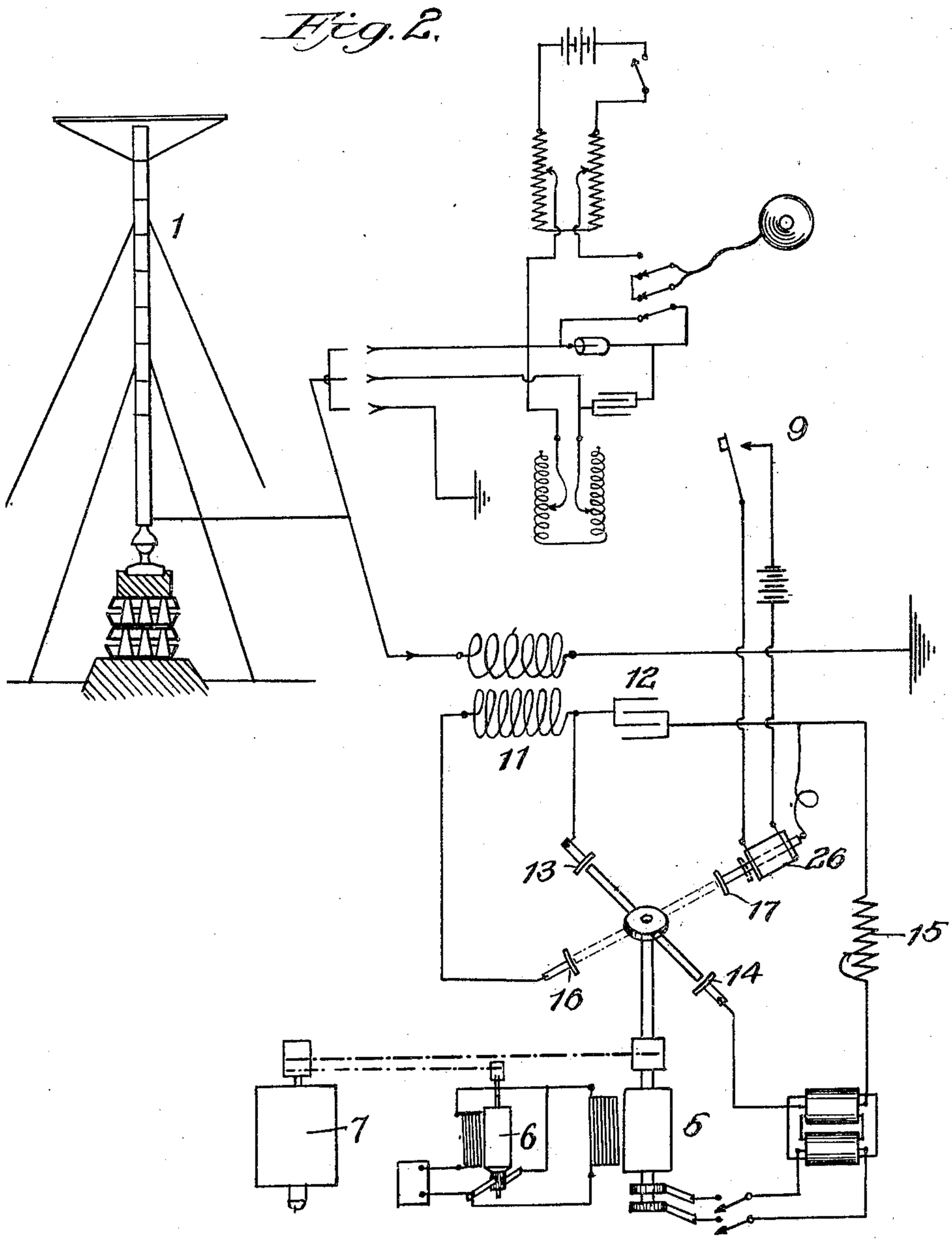
4 SHEETS—SHEET 2.

Fig. 2.



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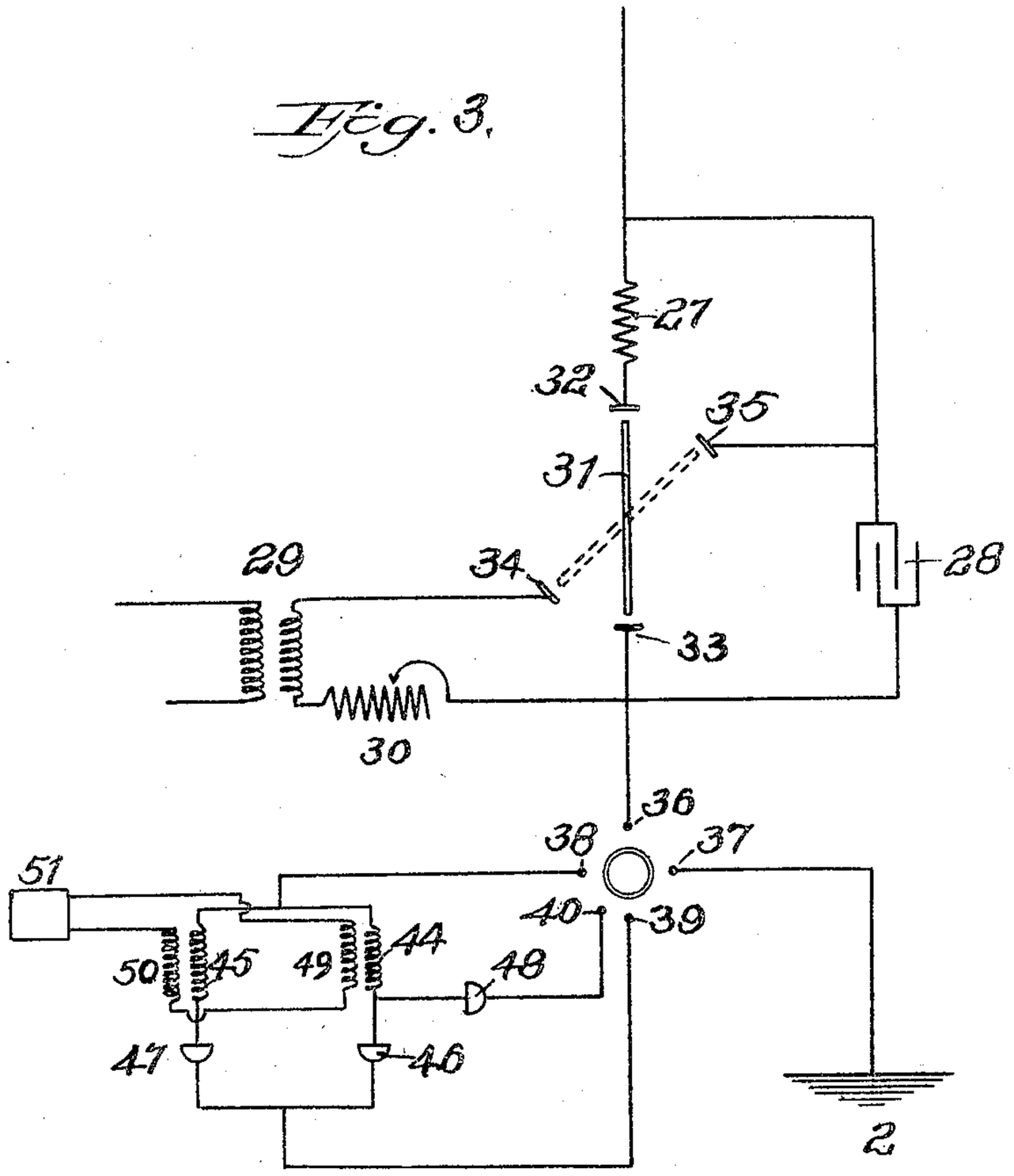
4 SHEETS—SHEET 3.

Fig. 3.



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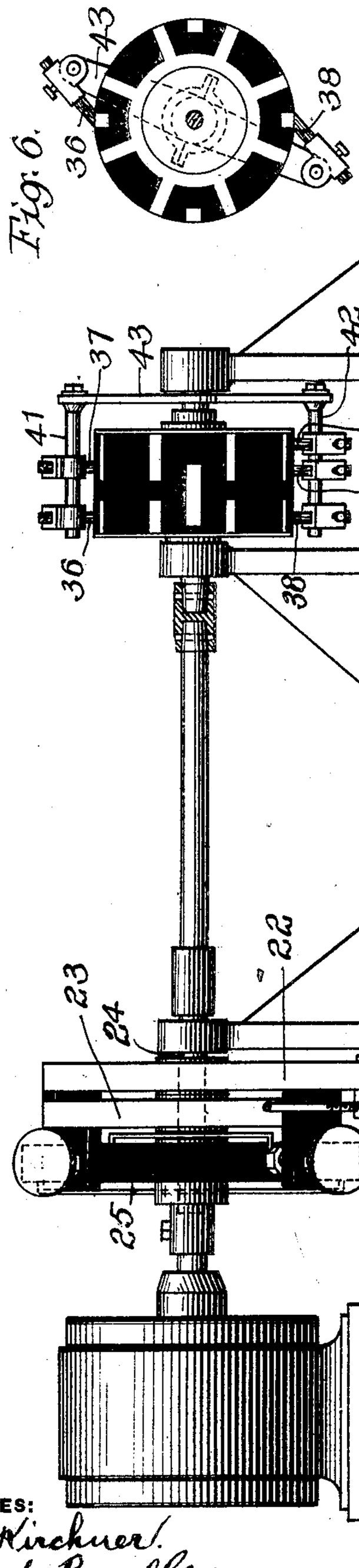

Fig. 4.

Fig. 6.

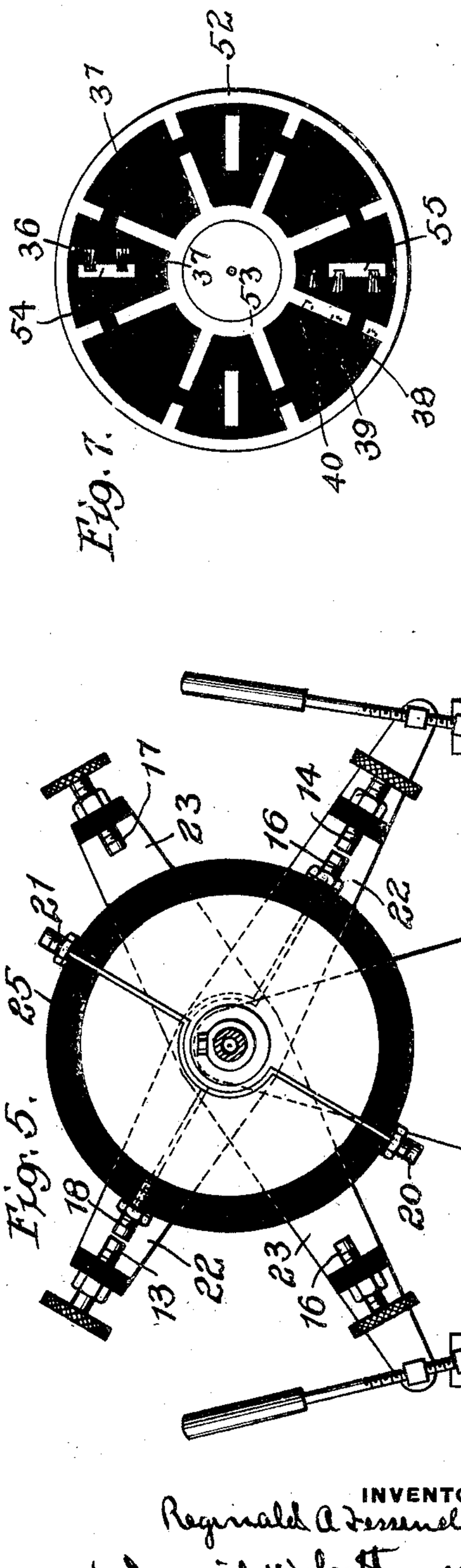

Fig. 7.

Fig. 5.

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No. 793,652. Patented July 4, 1905.

UNITED STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF WASHINGTON, DISTRICT OF COLUMBIA.

SIGNALING BY ELECTROMAGNETIC WAVES.

SPECIFICATION forming part of Letters Patent No. 793,652, dated July 4, 1905.

Application filed April 6, 1905. Serial No. 254,129.

To all whom it may concern:

Be it known that I, REGINALD A. FESSENDEN, a citizen of the United States, residing at Washington, in the District of Columbia, have invented or discovered certain new and useful Improvements in Signaling by Electromagnetic Waves, of which improvements the following is a specification.

The invention described herein relates to certain improvements in signaling by electromagnetic waves, and has for its object the provision of means for the controlled production of radiations from the aerial.

It is a further object of the invention to provide for the reception of signals from one station while sending signals to another station.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings, forming a part of this specification, Figure 1 is a diagrammatic view of sending and receiving circuits at a station in connection with a selector. Fig. 2 is a similar view illustrating a modification. Fig. 3 is a diagrammatic view illustrating the manner of simultaneously receiving and sending signals. Fig. 4 is a side elevation of a desirable form of selector and commutator. Fig. 5 is an end elevation of the selector. Fig. 6 is an end elevation of the commutator, and Fig. 7 is a view illustrating the operation of the commutator.

In the practice of my invention as illustrated in Figs. 1 and 2 the aerial, which is preferably of the construction shown and described in application for Letters Patent, Serial No. 252,942, filed March 30, 1905, is connected by a switch 2 with either the receiving mechanism (indicated at 3) or with the sending mechanism. For sending the primary of the transformer 4 is connected to a suitable source of alternating currents, such as the dynamo 5, which, with its exciter 6, is driven by a suitable motor 7. A transformer of high voltage, preferably from fifty thousand to one hundred thousand volts, is employed unless the method described in Letters Patent No. 706,737 is used, when a lower voltage may be used. As shown, the current through the primary of the transformer 4 is regulated by a suitable means, as a relay, (indicated at 8,) and controlled by the key 9 or other suitable means. The current through the primary of the transformer is adjusted by suitable means, (indicated at 10.) One of the terminals of the secondary of the transformer is connected, through the adjustable inductance or autotransformer 11 and condenser 12, to a contact 13 and the other terminal of the secondary to a contact-plate 14 through an adjustable resistance 15, whereby the amount of surging or oscillating may be regulated while the condenser 12 is being changed. Contact-plates 16 and 17 are arranged intermediate of the contacts 13 and 14 and when electrically connected, as hereinafter described, form portions of a closed circuit including the condenser 12 and inductance 11 in operative relation to the aerial 1. One or more pairs of arms 18, 19, 20, and 21 are so arranged that when rotated they will contact with or be brought into operative relation to the pairs of plates 13, 14, 16, and 17. The arms of each pair and the plates of each pair are so arranged relatively to each other that when one arm, as 18, is in contact with one plate, as 13, the other arm 19 of the pair will be in contact with plate 14 and when the arm 18 moves to the plate 16 the arm 19 will be in contact with plate 17. The arms should be so rotated that the charging and discharging of the condenser will occur at a time of maximum potential of the alternating current and by the employment of a sufficient number of arms may occur at every period of maximum potential. It is preferred, however, that this charging and discharging should occur at every fourth period of maximum potential, so that if the dynamo is a sixty-cycle machine the charging and discharging will occur thirty times a second. While the arms may be driven in any suitable manner, it is preferred that they should be rotated by the shaft of the generator 5.

A convenient construction of selector is shown in Figs. 4 and 5, where the contact-plates 13, 14, 16, and 17 are formed by pins adjustably mounted on arms 22 and 23, loosely mounted on the shaft 24, connected to the shaft of the generator 5. The pins are mounted in

blocks of insulating material secured to the arms 22 and 23, which can be adjusted as regards their angular separation by any suitable means—such, for example, as that shown. The arms 18, 19, 20, and 21 are formed by radial pins secured in a disk 25, mounted in the shaft 24. Diametrically opposite pins are electrically connected, but insulated from adjacent pins, as shown.

In the construction shown in Fig. 1 the movable members of the selector are brought into operative relation to the other members at regularly-recurrent intervals, and the radiation from the aerial is dependent upon the flow of current through the transformer 4, such flow being regulated by the key 9. In other words, the charging of the condenser is regulated, and its discharge follows at regular intervals thereafter. In lieu of regulating the charging of the condenser its charging may be continuous at regular intervals and its discharge regulated by a key, as shown in Fig. 2. As shown therein, provision is made for so shifting one contact-plate, as 17, in the discharging-circuit that although the arms 18, 19, 20, and 21 rotate continuously and the condenser is connected at regular recurrent intervals to the source of alternating current the discharge is controlled by the operator. This control can be conveniently had by the employment of magnetic means for shifting the plate 17. In the construction shown the plate 17 is secured to the core of the solenoid 26, the coil thereof being in a circuit controlled by the key 9. When this method is employed for multiplex sending, a number of movable contact-plates, each operated by its own key, are employed. It will be observed that when employing the selector for sending there will be certain short intervals between the charging and discharging of the condenser. By the employment of suitable means these intervals may be utilized for receiving.

In Fig. 3 a system for simultaneous sending and receiving is diagrammatically shown. The circuit containing the inductance 27 and condenser 28 is tuned, by preference, to the sending-conductor. When using a transformer, as indicated at 29, to charge the condenser, it is preferably adjusted to have a secondary voltage of twenty-five thousand volts. When desired, an adjustable resistance 30 may be employed for dampening unnecessary oscillations.

As described in connection with the apparatus shown in Figs. 1 and 2, a selector consisting of stationary and movable members is employed, whereby the condenser 28 is alternately placed in charging relation to the transformer 29 and in discharging relation to the sending-conductor. This selector is indicated in Fig. 3 by a movable conductor 31 and contact-plates 32, 33, 34, and 35; but it will be understood by those skilled in the art that the construction of selector shown in Figs. 1, 4, and 5 may be employed and that radiation from the sending-conductor may be controlled, as shown in Fig. 1, by controlling the flow of current in the transformer, or by controlling the discharge of the condenser, as shown in Fig. 2. The aerial 1 is connected to ground and to receiving mechanism through a suitable commutator—such, for example, as that shown in Figs. 4, 6, and 7. The brushes 36, 37, 38, 39, and 40 are carried by arms 41 and 42, secured to a bracket 43, and the spool is provided, with suitably-arranged conducting portions, with which the brushes will contact in proper order, as hereinafter described. The aerial is connected to a brush 36, while the brush 37 is connected to ground. The brushes 38, 39, and 40 are connected to portions of the receiving apparatus. The primaries 44 and 45 of an interference-preventer, as described in application, Serial No. 240,269, filed January 9, 1905, and variable condensers 46 and 47 are connected in parallel to brushes 38 and 40. The variable condensers 46 and 47 are adjusted to have equal capacity, so that when the variable condenser 48 is not in circuit the circuits 44 46 and 45 47 will respond equally well to any frequency, but when condenser 48 is in circuit one of the circuits, as 44 46, will respond to a different frequency from that to which the circuit 45 47 will respond. The secondaries 49 50 are connected in series to a suitable receiver 51. The rotation of the commutator-spool should bear a constant relation to that of the movable portion of the selector, and as the movement of the movable portion of the selector should have a constant relation to the rotation of the movable element of the generator the commutator-spool and the movable element of the selector are operated by the shaft of the generator.

The brushes 36, 37, 38, 39, and 40 and the commutator-segments are so fixed relatively to the angular position of the movable conductor 31 that when the conductor is in the position shown in full lines, at which time the condenser 28 will be discharged, the aerial will be connected to ground. While the movable conductor is moving from charging to discharging position and from the latter to charging position the brushes and segments of the commutator have the relative positions indicated by dotted lines in Fig. 7, so that aerial is connected through the condenser 28 to brush 36, thence through segment 52 to brush 38, thence through the receiver-circuit containing the interference-preventer to brushes 39 40, and thence through commutator-segment 53 and brush 37 to ground. While these connections are established the receiving-circuits and mechanism are in operative relation to the aerial and messages can be received.

By the continued movement of the conductor 31 and the commutator the former will be

brought to condenser charging or discharging position and the segments and brushes of the commutator to positions indicated in full lines in Fig. 7. In this position the aerial is connected to ground through brushes 36 and 37 and segment 54. At the same time the receiver-circuit is short-circuited by the connection of the brushes 38 and 39 by the segment 55, and the condenser 48 is insulated, as the brushes 40 will rest on an insulated portion of the commutator and the circuits 44 46 and 45 47 are balanced, and no effect is produced on the receiver.

It will be understood that in connection with the system shown in Fig. 3 suitable means, such as shown in Figs. 1 and 2, are employed for controlling the charging or discharging of the condenser, and thereby the radiations from the aerial.

I claim herein as my invention—

1. In a system of signaling by electromagnetic waves the combination of an aerial, a charging-circuit, a discharging-circuit and means for connecting the aerial alternately to the charging and discharging circuits.

2. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a source of alternating current and means for connecting the condenser to the aerial and the source of alternating current at periods of maximum potential.

3. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a source of alternating current and means for connecting the condenser alternately to the aerial and the source of alternating current at periods of maximum potential.

4. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a source of alternating current, means for alternately placing the condenser in operative relation to the aerial and the source of current and means for varying the potential in the condenser (*i. e.* charging or discharging the condenser).

5. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a source of alternating current and a rotary conductor for placing the condenser in operative relation alternately to the aerial and the source of current.

6. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a source of alternating current and a movable conductor for alternately placing the condenser in operative relation to the aerial and the source of current at periods of maximum potential.

7. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, an alternating-current generator, and a movable conductor operated by the generator for alternately placing the condenser in operative relation to the aerial and the generator.

8. In a system of signaling by electromagnetic waves the combination of an aerial, receiving mechanism, means for the continuous generation of electromagnetic waves, continuously-operating means for placing the aerial in operative relation alternately to the receiving mechanism and the generating means.

9. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a source of alternating current, means for alternately placing the condenser in operative relation to the aerial and the current source, a receiving-circuit and means for connecting the aerial to the receiving-circuit at times intermediate of the connection of the condenser with the aerial.

10. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, means for alternately charging the condenser and discharging it through the aerial, a receiving-circuit and means for connecting the receiving-circuit to the condenser, intermediate of the charging and discharging periods.

11. In a system of signaling by electromagnetic waves the combination of an aerial, a sending-circuit, a receiving-circuit and continuously-operating means for placing said circuits alternately in operative relation to the aerial.

12. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a source of alternating current, a movable conductor for placing the condenser in operative relation alternately with the aerial and the current source, a receiving-circuit and a commutator for connecting the condenser to the receiving-circuit, intermediate of the charging and discharging of the condenser.

13. In a system of signaling by electromagnetic waves the combination of an aerial, a condenser, a generator of alternating current, a movable conductor operative by the generator for placing the condenser in operative relation alternately with the aerial and the generator, a receiving-circuit and a commutator operative by the generator for connecting the receiving-circuit to the condenser intermediate of the charging and discharging of the latter.

14. In a system of signaling by electromagnetic waves the combination of an aerial, two parallel balanced circuits means operative by received oscillations for changing one of said circuits, a sending-circuit and a continuously-operating commutator for connecting the aerial alternately to the receiving and sending circuits.

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:
THOMAS P. BROWN,
LEONA FEATHERS.