

May 8, 1928.

W. A. PHELPS

1,668,656

RELAY CIRCUIT

Filed Dec. 10, 1926

Fig. 1.

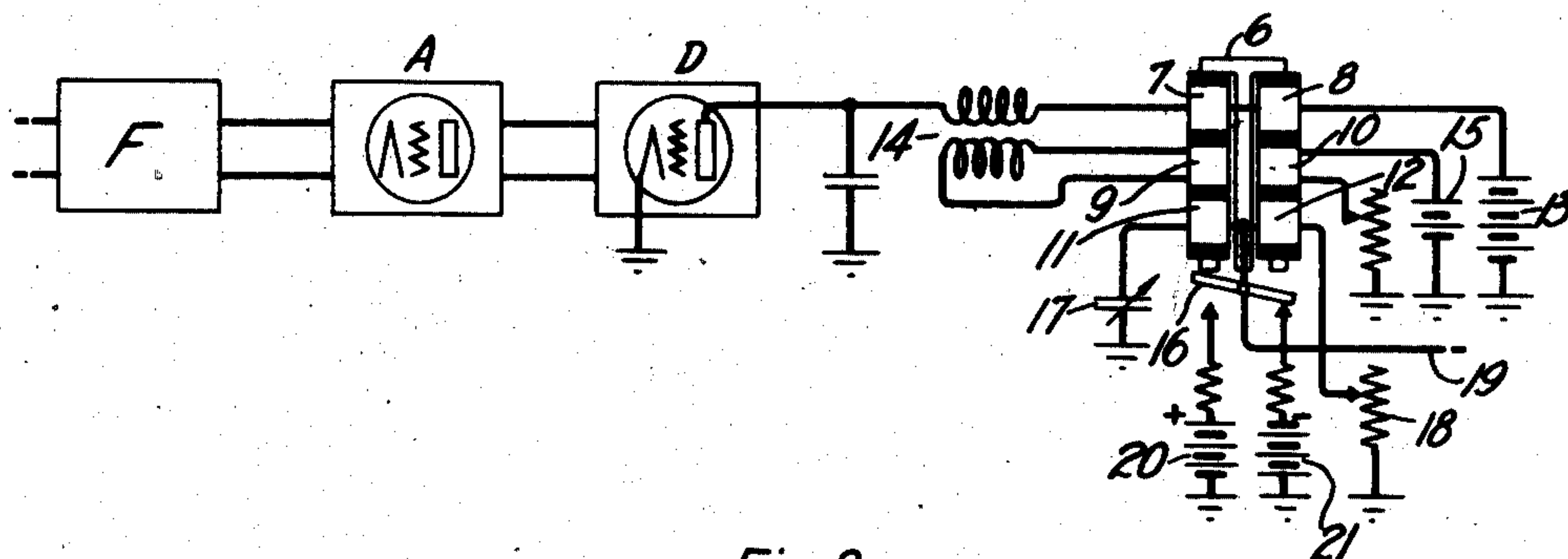


Fig. 2.

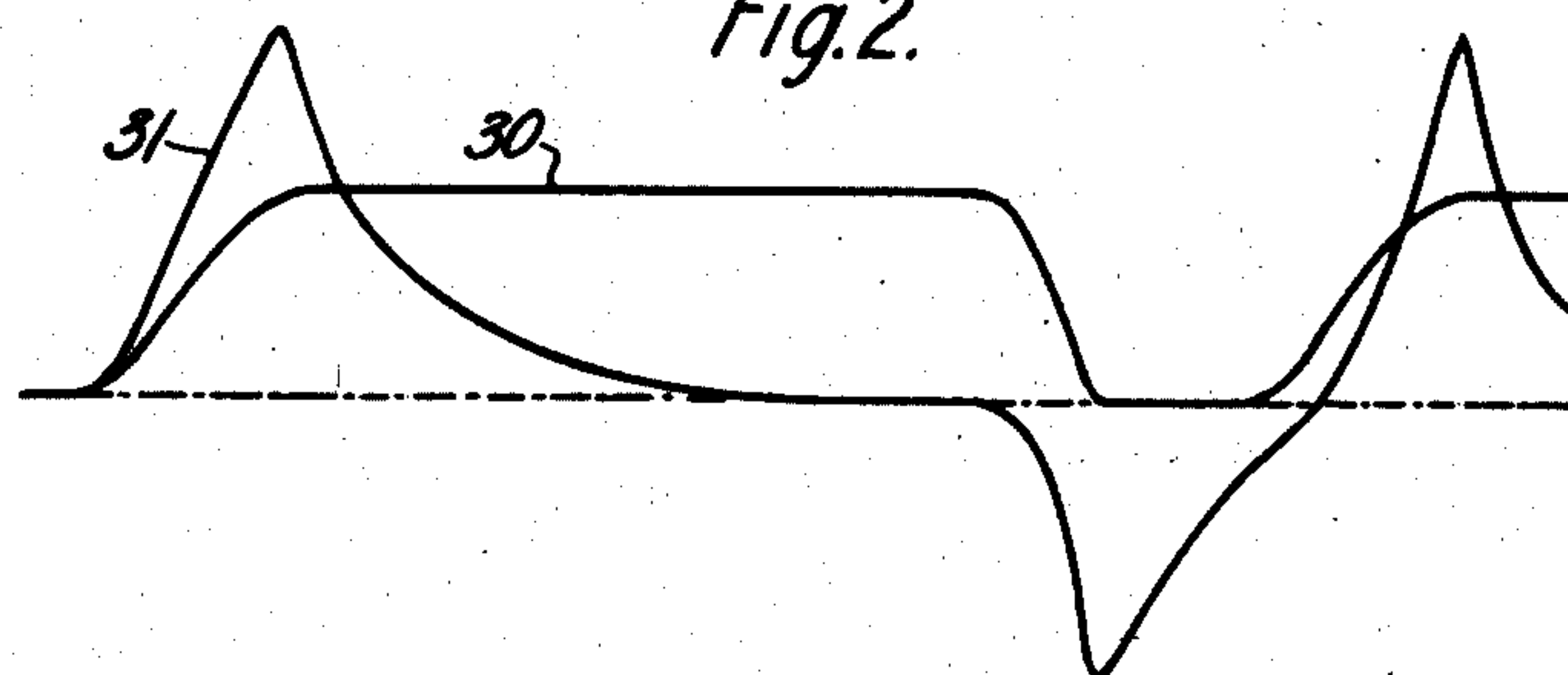


Fig. 3.

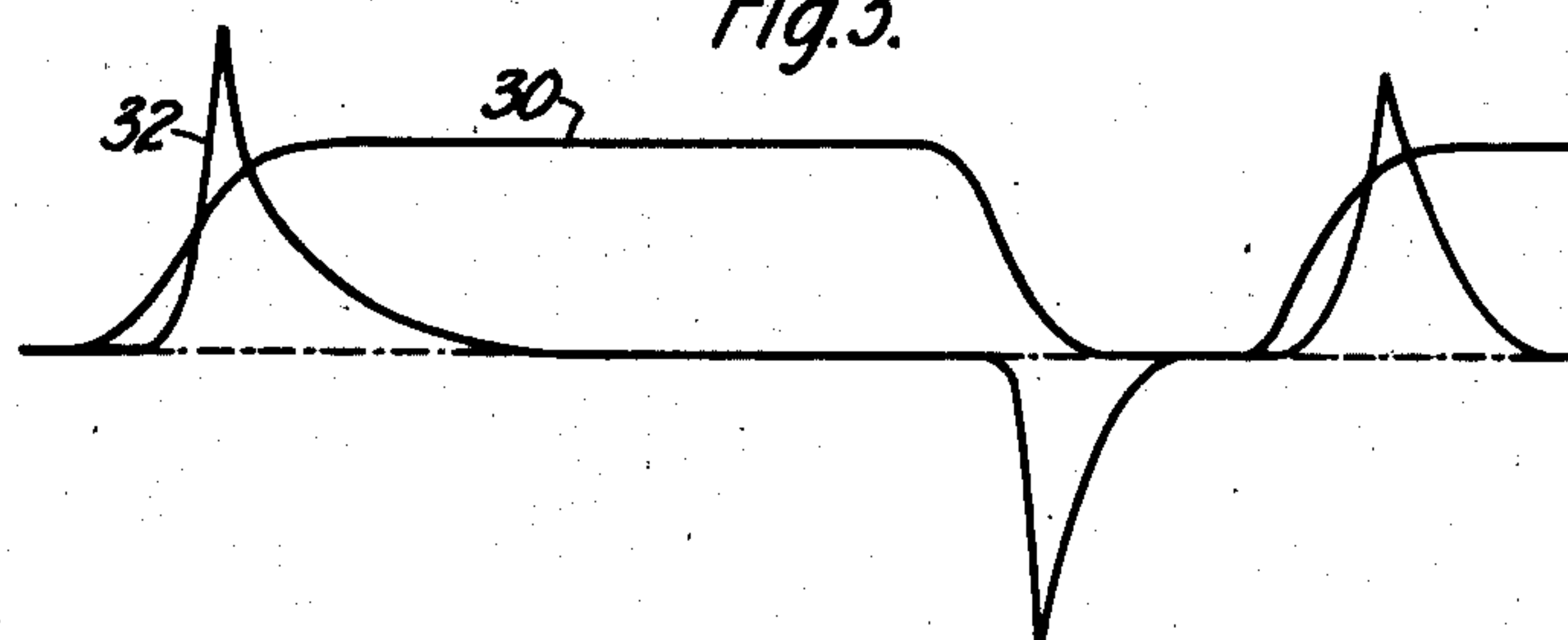
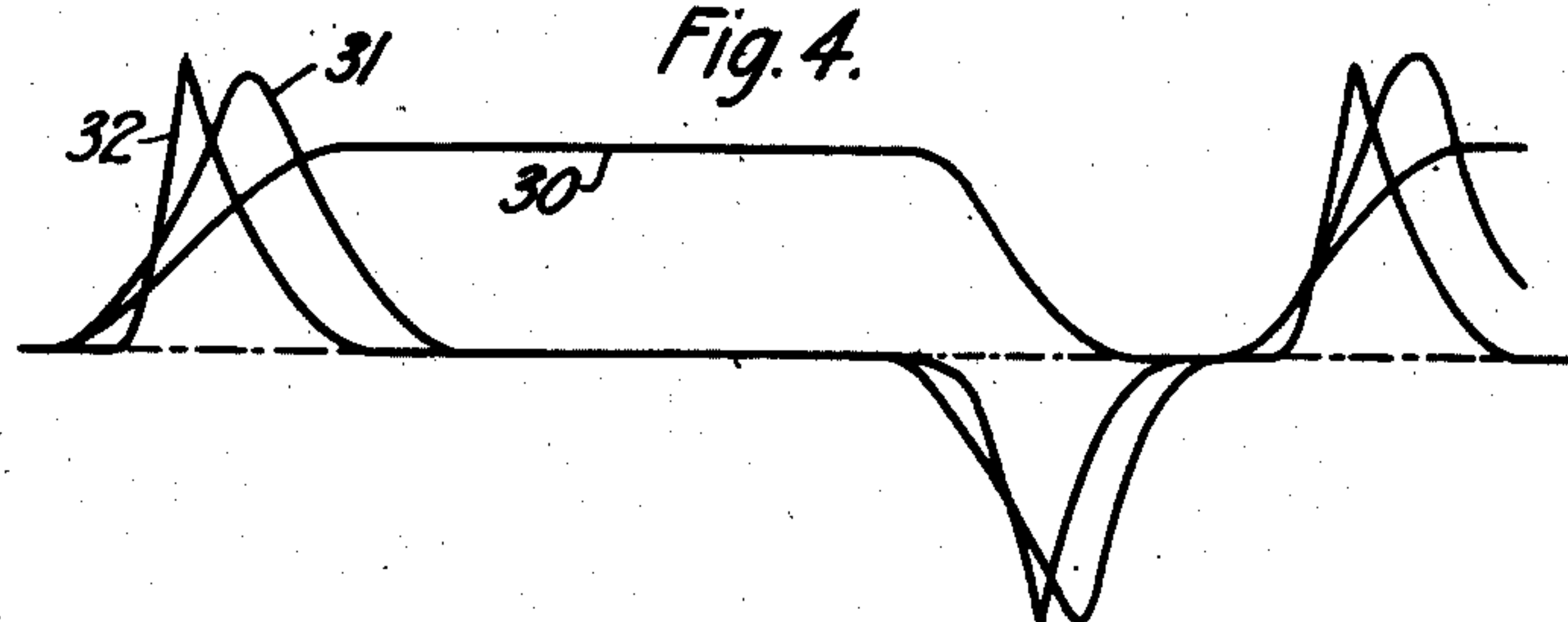


Fig. 4.



Inventor:
Walter A. Phelps.
by E. V. Briggs
Attorney.

Patented May 8, 1928.

1,668,656

UNITED STATES PATENT OFFICE.

WALTER ALFRED PHELPS, OF CLIFTON, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

RELAY CIRCUIT.

Application filed December 10, 1926; Serial No. 154,022.

This invention relates to signaling systems employing relays and has for an object to increase the efficiency, rapidity and accuracy of operation of the relays.

5 In the use of the so-called kick transformer, in which current proportional to the rate of change of the signaling current is supplied to the relay to accelerate its operation, it has been found that when the kick effect is made large enough compared to the signal wave to obtain high speed operation, for example, such as is required for printing telegraph systems, the falling current at the end of the signal is prolonged, 10 causing one signal to tail over into the next. On the other hand with the use of the vibrating or self-aiding relay of the Gulstad type, no effect is produced by the vibratory circuit until after the armature is moved from its contact. With this type of relay, it is therefore necessary to maintain the signaling current at a high energy level in order to produce the initial movement. If the circuit is so adjusted that slight changes in the signaling current will produce an initial 20 movement of the armature it has been found that small variations in line constants produced by changes in weather conditions and the like will cause the relay to vibrate, which action is known as "singing".

30 In accordance with a feature of this invention a kick transformer is employed with a Gulstad type vibrating relay, both effects being preferably lower than when either is employed alone. With this combination the transformer acts to start the relay armature quickly at the beginning of the signaling impulse and the vibratory circuit aids in the movement of the armature immediately 40 it is started, giving a high speed relay which requires very little signaling energy to operate and has a large singing margin.

The kick transformer effect is preferably made lower than when it is employed by itself and the armature is magnetically 45 biased to prevent vibration in the absence of signaling current.

The arrangement of this invention is particularly well suited for use in circuits of the carrier telegraph type in which the relay is operated by rectified signaling current.

This invention can be more readily un-

derstood by reference to the following detailed description in connection with the drawing in which:

Fig. 1 shows one embodiment of the invention in a carrier current telegraph system; and

Figs. 2, 3 and 4 illustrate graphically the operation of the system of this invention and those of the prior art.

Fig. 1 shows one receiving channel of a carrier current telegraph system. Signaling currents in this channel are separated from those of the other channels by means of the filter or other selective circuit F, amplified by means of the vacuum tube amplifier A and rectified in the detector circuit D to produce rectified currents for operating the relay 6. This relay has six windings 7, 8, 9, 10, 11 and 12. Windings 7 and 8 are connected in the plate circuit of the detector D in series with a space current source 13. Connected in series with these windings in the plate circuit is the primary winding of a kick transformer 14. The secondary winding of this transformer is connected to the winding 9 of the relay 6. The winding 10 is connected to a battery 15 for biasing the relay to prevent vibration in the absence of signaling current. Each of the windings 11 and 12 has one terminal connecting to the vibrating armature 16. The other terminal of winding 11 is connected through a condenser 17 to ground, and the other terminal of winding 12 is similarly connected through a resistance 18 to ground. A line 19 leads from the vibrating armature to a suitable telegraph receiving device or to circuits suitable for repeating into another telegraph circuit. Oppositely poled batteries 20 and 21 are connected to the armature stops so that the portion of the circuit connected to the armature is alternately poled as the armature vibrates.

The windings 11 and 12 operate as the vibrating windings of a Gulstad relay in the usual manner. Since the condenser 17 may be charged only by current routed over the connection from the armature, the circuits of windings 11 and 12 are usually proportioned to provide that the steady current flowing in the coil 12 by way of the resistance 18 to ground will be differentially over-

come by current through the coil 11 while it is flowing to charge the condenser 17. During such condenser charging periods, therefore, the coil 11 exerts an influence on the armature 16 to increase the pressure on the stop through which the condenser may be charging. Immediately on cessation of the condenser charging current through the coil 11, however, the steady current in the coil 12 becomes effective to move the armature toward its opposite position. Therefore, by adjusting the values of condenser 17 and resistance 18, it is possible to vary the electrical time constant of the circuit through the windings 11 and 12 to secure this differential aiding effect.

Assuming that the armature is normally biased so as to contact with its negatively poled stop, when rectified signaling current flows through the windings 7 and 8 the armature is forced in the direction of the other stop. As soon as the force produced by the current is sufficient to break the contact with the negative right-hand stop, the condenser 17 will discharge through the windings 11 and 12 to ground, accelerating the movement of the armature until the armature comes in contact with the positive stop when the condenser 17 will charge. The charging current will be in such a direction as to hold the armature against the stop. Similarly, on the movement of the armature from that stop, which occurs substantially at the cessation of rectified current, the condenser 17 which is now oppositely charged, will discharge through the windings to cause a movement in the other direction. As the rectified signaling current is increased or decreased, a voltage is induced in the secondary winding of the kick transformer 14, proportional to the rate of increase or decrease. This voltage causes current to flow in the winding 9, accelerating the initial movement of the armature. The operation of the circuit, particularly with regard to the co-operation between the vibrating windings and the kick transformer, will be better understood by reference to Figs. 2, 3 and 4.

Fig. 2 illustrates the operation of the circuit with the kick transformer alone. In this figure, the rectified signaling current is represented by the curve 30. Curve 31 represents the current flowing in the secondary circuit of the kick transformer. Since this current is proportional to the rate of change in the signaling current 30, it increases rapidly as the signaling current increases, thus producing a flux in the relay which tends to accelerate the initial movement of the armature. When the rectified current reaches its peak value, the kick transformer current slowly drops to zero. Similarly, when the rectified current decreases, a kick transformer current is produced in the opposite direction. This current increases to a maxi-

mum at the point where the change in rectified current is a maximum and then slowly dies out. If the signaling waves are closely spaced, this dying out will tail over into the next signal and will produce an effect at the beginning of the signal which opposes the effect of the rectified signaling current, which is disadvantageous. It is difficult to reduce this kick transformer effect to a point where tailing over does not occur and still obtain the accelerating effect necessary for good operation.

Fig. 3 shows the operation of the vibrating windings alone. In this figure, curve 30 again represents the rectified signaling current and curve 32 represents the current in the vibrating windings. In this case, no current is produced in the vibrating windings until the value of the signaling current has become sufficiently great to produce an initial movement of the armature so that the first part of the signaling current wave is lost unless a large rectified current is used to produce the initial movement.

Fig. 4 illustrates the operation of the circuit of Fig. 1 in which both the kick transformer and vibrating windings are used. In this case, the kick transformer current 31 is reduced to such a point that tailing over into the next signal does not take place. However, the effect of the kick transformer is sufficient to produce an early initial movement of the armature, after which the current 32 through the vibrating windings causes a rapid movement of the armature. It is possible to operate this circuit with a very low value of rectified current.

With the circuit of this invention, therefore, the disadvantages of either the kick transformer or vibrating relay alone are avoided and a highly efficient, high speed operation is obtained. By relying on the kick transformer primarily for an initial movement of the armature it is possible to eliminate the tailing over effect. And since this kick transformer effect is employed the effect of the vibrating windings may be kept below that point at which singing is produced by variations in line conditions and the like.

What is claimed is:

1. In a signaling system, a source of signaling current, a relay having an armature, an operating winding adapted to receive current from said source, a second winding supplied with current proportional to the rate of change in current from said source and a third winding, and means controlled by an initial movement of the armature and operating through said third winding as an intermediary to aid in the movement of the armature.

2. In a signaling system, a source of rectified signaling current, a relay having an armature and a plurality of windings, 120

means for supplying current from said source to one of side windings, a transformer having a primary connected to receive current from said source and a secondary connected to supply current to another of said windings, and means controlled by the initial movement of the armature and operating through the third of said windings as an intermediary to aid in the movement of the armature.

3. In a signaling system, a source of signaling current, a relay having an armature and a plurality of windings, means for supplying current from said source to one of said windings for operating said relay, means for supplying current proportional to the rate of change in current from said source to a second of said windings, and means including capacity and resistance controlled by the initial movement of the armature and operating through a third of said windings as an intermediary to aid in the movement of the armature.

4. A combination according to the preceding claim in which the means for supplying

current proportional to the change in current from the source comprises a transformer having a primary winding connected to the source and a secondary winding connected to the second relay winding.

5. In a signaling system, a source of rectified signaling current, a relay having an armature, a plurality of windings, means for supplying direct current to one of said windings for biasing the relay, means for supplying current from said source to a second of said windings for operating the relay, means for supplying current proportional to the rate of change in current from said source to a third of said windings for accelerating the initial movement of the armature, and means controlled by the initial movement of the armature and operating through a fourth of said windings as an intermediary to aid in the movement of the armature.

In witness whereof, I hereunto subscribe my name this 9th day of December A. D., 1926.

WALTER A. PHELPS.