W. H. MARTIN.

CORRECTING CIRCUITS FOR HIGH DISTORTION LINES.

APPLICATION FILED JUNE 18, 1918.

1,347,049. Patented July 20, 1920.

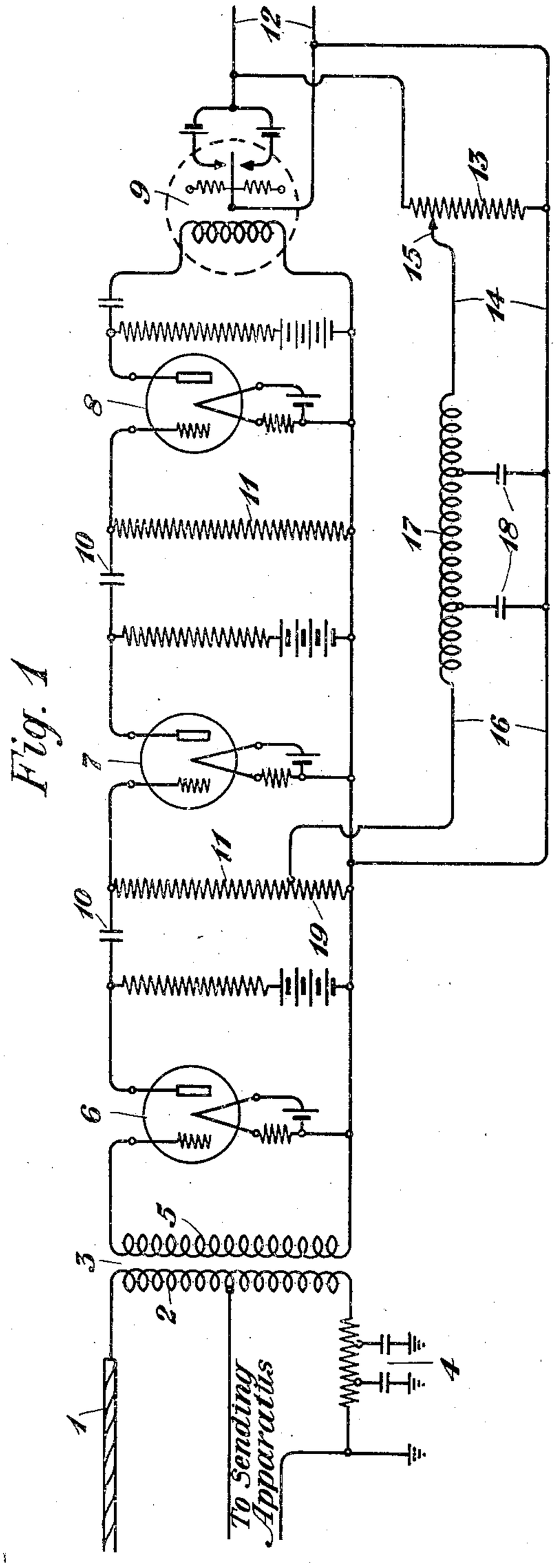

Fig. 1

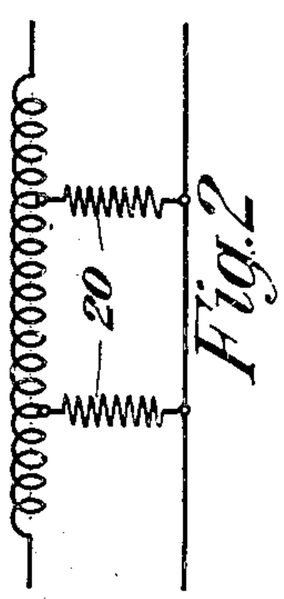

Fig. 2

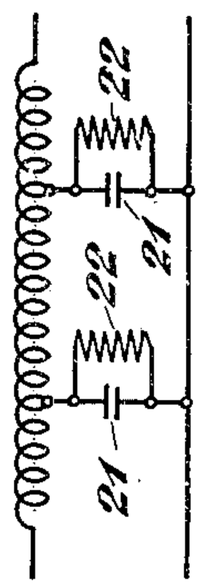

Fig. 3

Fig. 4

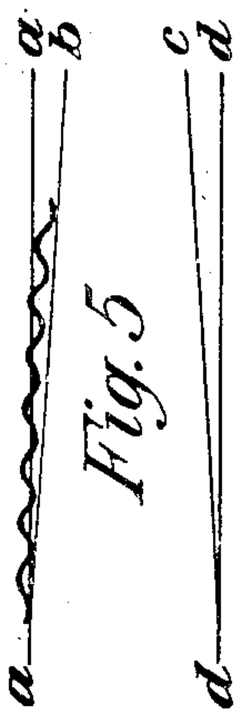

Fig. 5

Fig. 6

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CORRECTING CIRCUITS FOR HIGH-DISTORTION LINES.

1,347,049. Specification of Letters Patent. Patented July 20, 1920.

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To all whom it may concern:

Be it known that I, WILLIAM H. MARTIN, residing at New York, in the county of New York and State of New York, have invented certain Improvements in Correcting Circuits for High-Distortion Lines, of which the following is a specification.

This invention relates to signal transmitting systems in which the circuit has characteristics which give rise to the phenomenon known as wandering zero; and is applicable especially to systems in which it is desired to record the signals from such a circuit by means of relays, or to couple the circuit with another of like or different character for forwarding the signals.

In signaling circuits having high attenuation and distortion, such as ocean cables, where the signals are customarily transmitted by impulses of varying sign, it is a well known fact that the zero in a succession of impulses of like sign tends to depart, at the receiving end, from the normal horizontal. The signals over such a circuit are but faint at best and are recorded only by delicate instruments. This wandering of the zero adds to the difficulty and is particularly objectionable where it is desired to record or forward the impulses by means of polarized relays or like apparatus. It is the object of the present invention to provide a system for overcoming this difficulty and to arrange for the forwarding of such signals from one circuit to another, as for instance from an ocean cable to a land line. The invention will be described in connection with the accompanying drawing in which Figure 1 is a diagrammatic illustration of a system showing one embodiment thereof, Figs. 2 and 3 are modifications of the distortion circuit shown in Fig. 1, and Figs. 4, 5 and 6 are curves illustrating the operation of the invention.

Referring to Fig. 1 the transmission line of high distortion and attenuation is indicated at 1 and may represent one terminal of an ocean cable. This line is connected to one end of the primary winding 2 of transformer 3, the opposite end of the winding being connected to the artificial line 4 commonly used for duplex operation. The sending apparatus of the duplex set may conveniently be connected between the ground and the midpoint of the primary winding 2. The secondary winding 5 of the transformer 3 supplies the incoming signals to a compound amplifier here represented as having three stages 6, 7 and 8, each consisting of an amplifier of the thermionic type. The output circuit of the amplifier 8 supplies the windings of the relay 9 which serves to repeat the received impulses to a recording device or to another line over which it is desired to forward them. It will be understood that the relay 9 is properly polarized in accordance with the known practice, so that impulses of opposite sign passing through the winding of the relay will cause the tongue to move in opposite directions from the neutral position in which it is normally maintained, by any suitable means, as, for example, the springs indicated on the drawing. The amplifiers 6, 7 and 8 are of the usual type and require no detailed description. They are coupled to form a multistage amplifier in a known way by the use of condensers 10 in series between the output circuit of one amplifier and the input circuit of the succeeding amplifier and the input circuits are provided with high resistances 11 as usual. This resistance may be omitted in the case of the initial amplifier 6 where the transformer 3 is used. The amplifier as a whole is designed to strengthen the received impulses to a point where they can be used to operate the relay 9 for recording or repeating the signals in the circuit 12.

In a circuit constituted only as described above the wandering zero effecting a series of successive impulses of the same sign will materially interfere with the operation of the relay 9. To illustrate suppose a series of impulses are initiated at the sending end of the line 1 of the character indicated by Fig. 4. The impulses received in the transformer 3 and amplifier and supplied to the winding of the relay 9 will, in general, be represented by the curve shown in Fig. 5 in which *a*—*a* is the normal zero line. In other words the zero of the received oscillations tends to be displaced downward with respect to the normal zero, as indicated at *b*. Thus the actual current value delivered to the winding of the relay will soon become effectively weakened, having a component of the opposite sign, or it may actually reverse if the series is continued sufficiently long. In the case of the impulses illustrated in Fig. 5 it is probable that the first three would give positive impulses in the circuit 12 corresponding to

the positive impulses transmitted. The fourth impulse would probably be inoperative while the following ones would give negative impulses in the circuit 12 by reason of the reversal of the effective current in the winding of relay 9.

For the correction of this condition a high resistance shunt 13 is connected across the circuit 12 and a circuit 14 is connected to this resistance in a way to permit of adjusting the voltage across its conductors to the desired amount, as by the variable connection 15 indicated on the drawing. In the circuit 14 is included a distortion net work so designed that if successive pulses of the same polarity are impressed thereon from the circuit 12, its output at 16 will be a gradually rising current of the same polarity as the impressed pulses or substantially this,—the ideal condition being illustrated in Fig. 6 by the gradually rising line *c* with reference to the zero line *d*—*d*. This net work is shown in Fig. 1 as comprising inductance 17 connected in series and capacities 18, connected in shunt to the circuit. The effect of the capacities is to let through the alternating component of the received current while the effect of the inductance is to store up and prolong the impulses, thus giving a cumulative effect in the output circuit 16. This gradually rising voltage is applied to the input circuit of one of the stages of the amplifier as indicated at 19. This is conveniently done by connecting the circuit 16 to points on the resistance 11 in the input circuit. Inasmuch as the polarity of the impulses is reversed by each stage of the amplifier, the circuit 16 should be applied to the second or some other even numbered amplifier, counting back from the relay 9.

With the circuit thus arranged, if a series of impulses such as illustrated at 5 are received, the first two or three will build up an increasing voltage in the circuit 16 which, applied to the amplifier 7, will boost up the voltage of the received impulses at the same rate at which it tends to decline, with the result that the series will maintain substantially its normal zero line.

The exact composition of the distortion circuit will vary in accordance with the circumstances of the particular case. Two modified arrangements are shown in the Figs. 2 and 3. In Fig. 2 the shunts are composed of resistances 20 in place of the capacities and in Fig. 3 they are composed of capacities 21 and resistances 22 connected in parallel.

It will be understood that the invention is not limited to the details herein shown and described as it is obvious that various modifications may be made without departing from the spirit of the invention.

What is claimed is:

1. The combination with a transmitting line of high distortion and attenuation, of a thermionic amplifier for increasing the strength of the received current impulses, a relay for responding to the amplified impulses, and means for applying to the input circuit of the thermionic amplifier a gradually increasing potential proportional to the number of successive impulses of like sign arriving in the output circuit of said relay.

2. In a signal transmitting system, a circuit of high distortion and attenuation, a second circuit of comparatively low distortion and attenuation, a relay associated with said latter circuit, a thermionic amplifier for receiving the impulses arriving over the former circuit and applying them to said relay, an impedance connected across the input circuit of the amplifier and means connecting the circuit of low distortion and attenuation with a point in said impedance in the input circuit of said amplifier, for correcting the zero of the received impulses in proportion to the number of successive impulses of like sign arriving in the circuit of low impedance and attenuation.

3. In a signaling system, a circuit in which the zero of successive impulses of like sign tends to depart from the normal, a second circuit including a relay for forwarding impulses received over the said first mentioned circuit, a multistage thermionic amplifier for connecting said circuits and supplying the winding of said relay, and means connecting said second circuit with one of the stages of the amplifier for correcting the tendency of the zero of the received impulses to depart from normal.

In testimony whereof, I have signed my name to this specification this 17th day of June, 1918.

WILLIAM H. MARTIN.