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1,963,618

TELEGRAPH RECEIVING SYSTEM

Filed June 11, 1931

FIG. 1

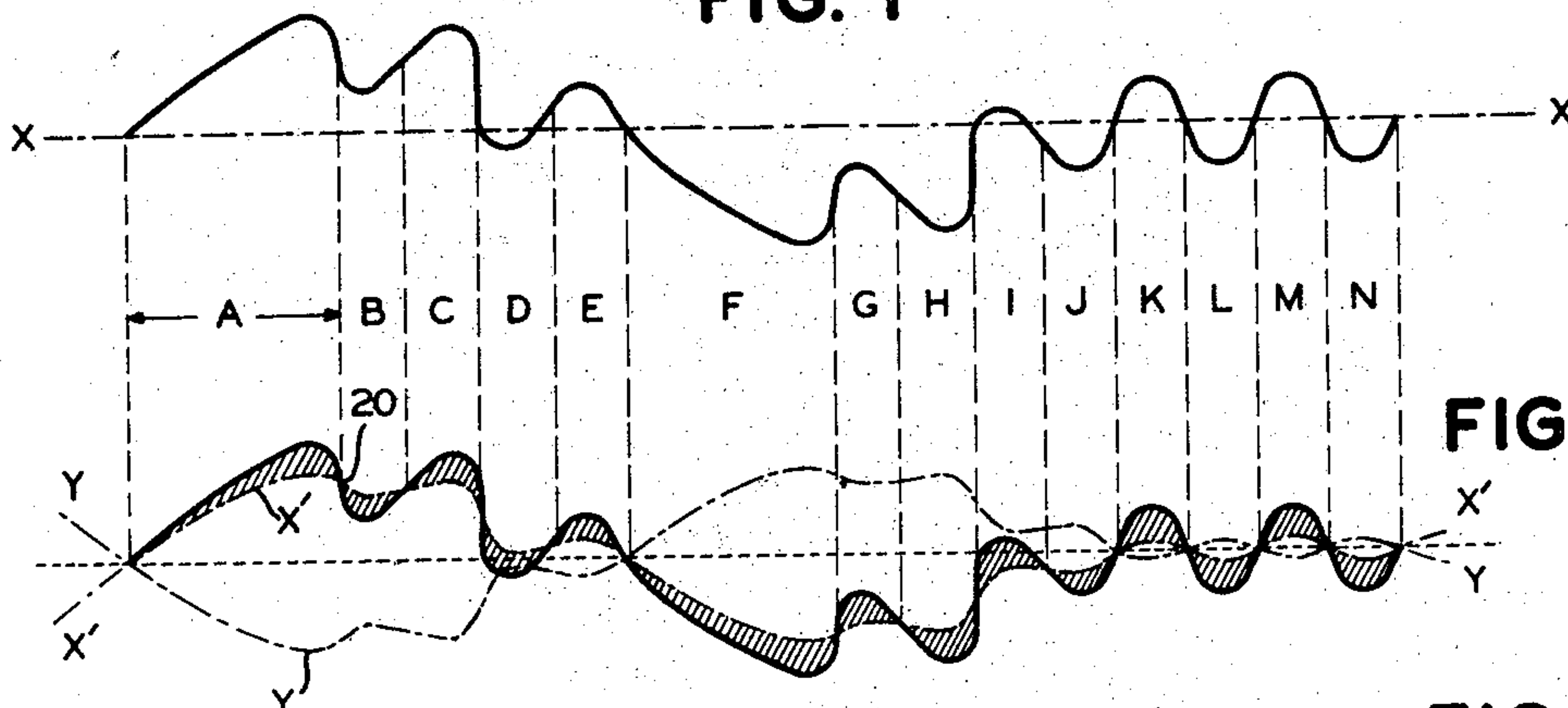


FIG. 2

FIG. 5

FIG. 3

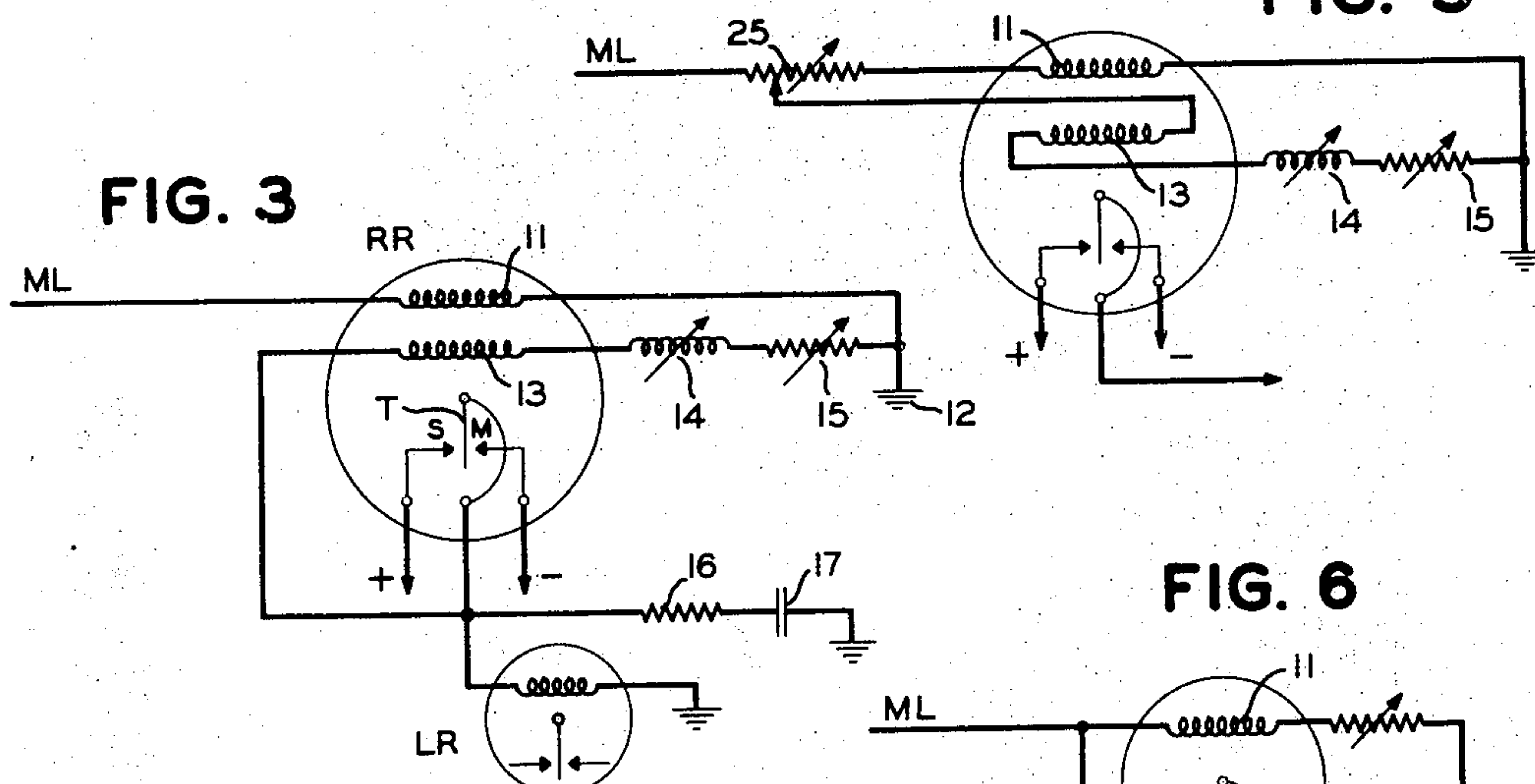


FIG. 6

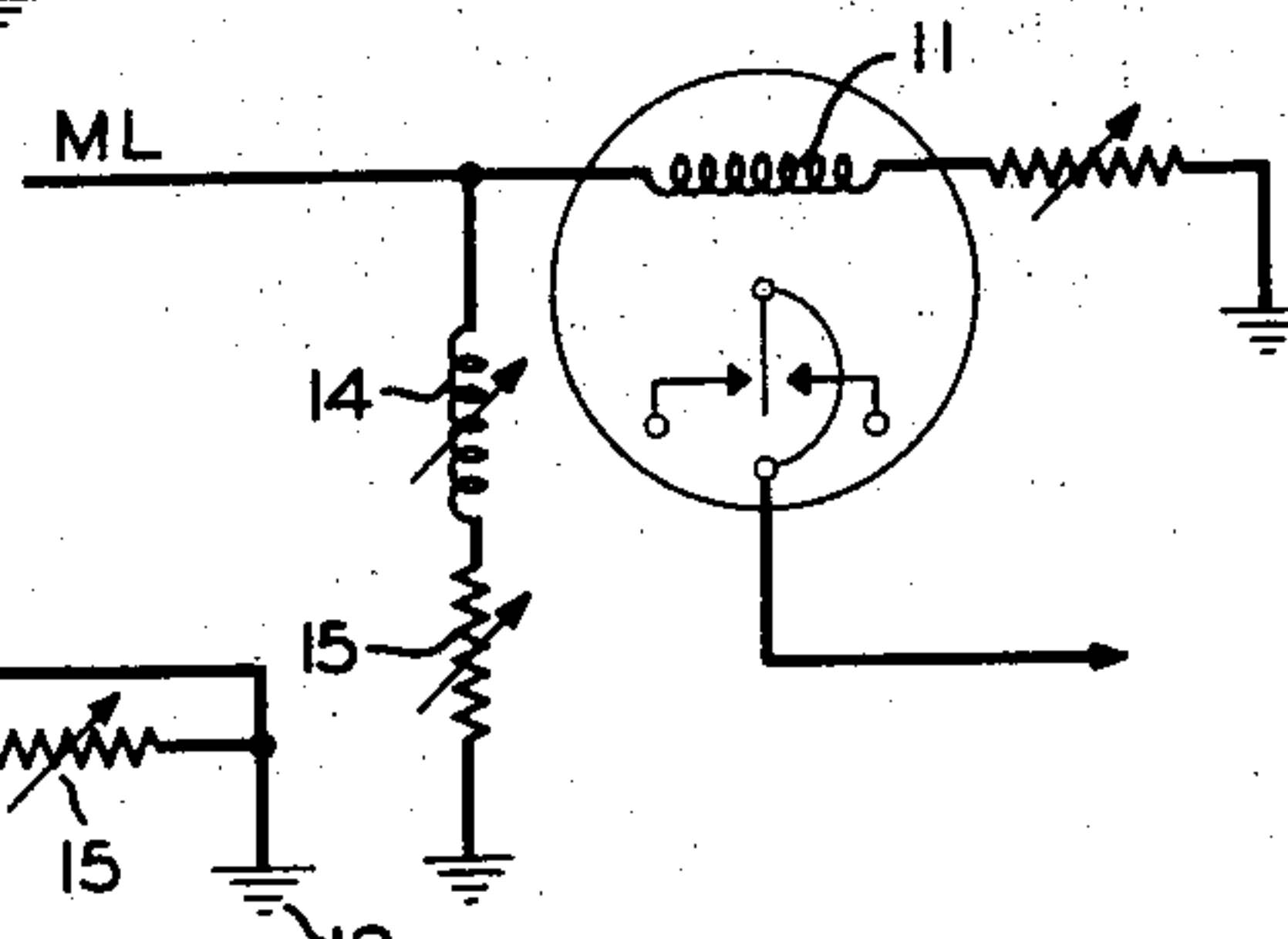
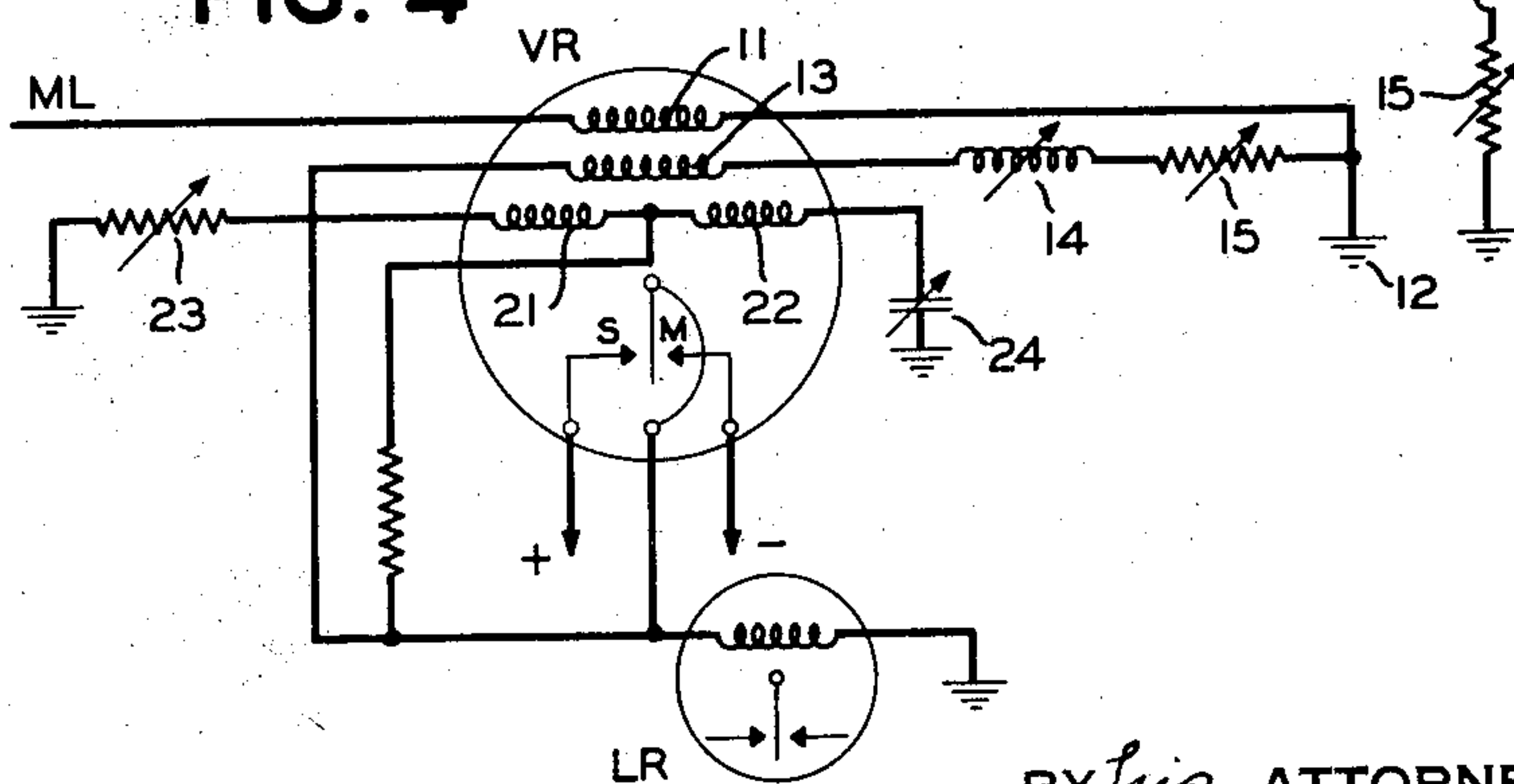


FIG. 4



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TELEGRAPH RECEIVING SYSTEM

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11 Claims. (Cl. 178—88)

This invention relates to a method and apparatus for receiving telegraph signals, and more particularly to the counteracting of the distorting effects of capacity and induction in a long telegraph line or cable.

Long telegraph conductors and cables have a considerable amount of distributed capacity and induction which materially distort the arrival currents so that, in many cases the regular telegraph relays, either single current or polarized, will not accurately respond to signals transmitted at economical frequencies.

The arrival curve of a signal over a line conductor having considerable capacity builds up slowly and ordinarily does not reach its full amplitude or steady state before the succeeding reversal occurs. However, if a long signal is received followed by a short reversal the long signal may attain such amplitude at the time the reversal occurs that the subsequent reversal will not reduce the line current to zero. In such cases there would be no reversal of current through the coils of the polarized receiving relay to actuate its armature and the impulse would be lost.

Various arrangements have been devised in ocean cable work for overcoming these defects or difficulties, such as the usual vibrating circuits or signal interpolating schemes but such apparatus is of a delicate, sensitive character and its use is precluded from overland work due to the initial cost of installation and the cost of maintenance and operation thereof.

It is one of the objects of the present invention, therefore, to produce a simple and inexpensive means for counteracting the signal distortion factors present in transmission line conductors having a large amount of distributed capacity.

Another object is to enable the speed of transmission over such lines to be materially increased.

A further object is to compensate for the effects of the individual signals on the receiving relay due to difference in the length or duration thereof.

A still further object is to create an artificial zero line for received signals such that all signals will have approximately equal amplitudes with respect thereto regardless of the length or duration of the signal.

Other objects and advantages of the invention will hereinafter appear.

In accordance with my invention I employ a polarized receiving relay having a biasing coil which produces a flux neutralizing a portion of the flux produced by the signal current flowing through the main line winding of the relay. The

biasing coil preferably is provided with current from a local source under the control of the relay tongue and has a time constant simulating that of the arrival current so that the instantaneous value of the current in the biasing coil bears a fixed ratio to the instantaneous value of the line current. The time constant of the biasing coil is produced by a variable inductance in series therewith which controls the rate of increase of flux in the coil and a variable resistance also in series therewith for controlling the maximum amplitude of the opposing current.

The biasing coil in effect shifts the zero line relative to the signals so that it bears a fixed relation to the amplitude of each received signal.

The invention will be more fully understood by reference to the accompanying drawing, in which:

Fig. 1 shows the approximate shape of the arrival curves of signals over a telegraph cable or line of considerable length;

Fig. 2 shows the same curve with the absolute zero line replaced by a resultant zero obtained with the arrangement of the present invention.

Fig. 3 is a circuit diagram of a receiving system embodying the invention;

Fig. 4 is a circuit diagram of a modified receiving system employing the invention.

Fig. 5 is a modified arrangement in which the current for the compensating winding is taken from the line, and

Fig. 6 is a further modification in which compensation is effected by a leakage path to ground, for a portion of the signal current.

The principal factors which produce losses upon the arrival currents over long telegraph lines or cables are resistance self-induction and capacity, capacity ordinarily exerting the greatest distorting effect. Figure 1 shows the approximate shape of typical arrival curves over the line conductors containing a large amount of capacity. The first signal A which represents a long spacing signal has a slow rise and attains considerable amplitude. The succeeding marking signal B of opposite polarity is of short duration and does not have time to build up to a sufficient amplitude to cross the zero line $x-x$ before the arrival of the next spacing signal C. Consequently a polarized relay in the line circuit would not respond to the reversal B and this signal would be lost. The marking signal D dips slightly below the zero line and may or may not operate the relay depending on the sensitivity thereof and at best would only cause a momentary operation

thereof registering what is termed a "pin dot". Similarly a long marking signal such as F builds up in amplitude to such an extent that the succeeding spacing signal G may not reach the zero line so as to be recorded. When uniform alternations of the signal occur such as indicated at J, K, L, M, and N, they may be positioned substantially symmetrical of the zero line and will properly actuate the line relay, if it is sufficiently sensitive.

Figure 2 shows the same arrival curve with the absolute zero replaced with a resultant zero $x'-x'$ which approximately intersects the central portion of each wave. It will be noted that all of the signals are of substantially equal amplitude with respect to this artificial zero. I have found that if the receiving line relay be biased in such manner that the opposing flux produced in the biasing winding bears the same relation to the flux produced by the main line winding as the resultant zero $x'-x'$ bears to the signal wave, that all signals will be properly recorded and with signal frequencies far in excess of those ordinarily obtainable with the usual type of receiving relays.

Referring now to Figure 3 the incoming line ML which may be of considerable length, having a large amount of capacity, is terminated in the main line winding 11 of the receiving relay RR and the ground 12. A biasing winding 13 is provided for the relay, having one terminal connected to the tongue T of the relay, whereby battery of either polarity may be applied thereto, and the opposite terminal connected through a variable inductance 14 and a variable resistance 15 to the ground. The local relay LR may be operated from the tongue of the receiving relay and a spark quenching arrangement including the resistance 16 and a condenser 17 may be provided.

The operation of the receiving relay is as follows. Assume that the relay tongue is on its left hand contact when the signal A is received. Positive current will then flow from the spacing contacts through the tongue of the relay and thence to the biasing coil and the adjusted inductance and resistance to ground. The current through the biasing coil is of such duration that it tends to oppose the flux in the main line coil 11, due to the received line current but its rate of rise is controlled by the adjusted inductance in series therewith so that it approximates the rise of flux in the main line coil due to the received signal A. The current through the biasing winding may be represented by the line $y-y$ in Figure 2. Subtracting the opposing flux in the winding 13 from that generated by the line current the resultant effective value thereof is represented by the shaded portion of the signals, shown in Figure 2. At the termination of the signal A when the current crosses the resultant zero $x'-x'$ at the point 20, the tongue of the relay will move over against its marking contact and the reversal B will be satisfactorily recorded, even though the line current does not cross the actual zero line. While the relay tongue is resting against its marking contact current begins to flow in the reverse direction through biasing coil but the series inductance prevents a sudden rise of current, thus enabling the next signal to be properly received. If the values of the inductance and the resistance are properly adjusted the flux on the biasing coil will increase and decrease in definite relation to the received signals and will in effect shift the zero line $x-x$ so that it undulates with the re-

ceived signals, so that each reversal is of substantially equal amplitude with respect thereto.

The inductance 14 may be of the usual laminated core type but preferably I employ an inductance arrangement consisting of a combination of an inductance element having a solid iron core and an inductance element having a laminated iron core. By properly adjusting the values of such inductances the time constant of the biasing winding can be made to approximate very closely the shape of the arrival curve. In Figure 4, I have shown the biasing winding 13 applied to a vibrating relay VR. This relay in addition to the line winding 11 and biasing winding 13 is provided with an opposing winding 21 and an accelerating winding 22. The opposing winding is connected between the relay tongue and the ground through a variable resistance 23 and the accelerating winding 22 is connected between the relay tongue and the ground through a variable condenser 24.

In the operation of the relay, the biasing winding 13 opposes the line winding so as to compensate for the retardation of line signals. With the relay tongue on its left hand contact, current will be supplied to the opposing winding 21 from the relay contact through the resistance 23 and is in such direction as to oppose the current flowing through the line winding 11 thus tending to move the armature towards its right hand or marking contact. As the resultant flux produced by current flowing in the line winding 11 and the biasing winding 13 falls to a value slightly less than the magnetic effect of the opposing current in the coil 21, the armature starts to move away from the spacing contact. When the armature leaves the spacing contact, the accelerating condenser 24 discharges through the accelerating winding 22 thereby causing the current to flow therein in such direction that it acts upon the armature to carry it quickly across to the marking contact. The current in the opposing winding 21 falls to zero during the time in which the armature travels from one contact to the other. When the armature strikes the spacing contact, the accelerating condenser again charges up in such direction as to hold the armature firmly on its contact so as to prevent rebound thereof.

The biasing coil 13 and the coil 21 both oppose the line coil 11 and are controlled by the tongue of the relay. Consequently, if desired, the coil 21 may be omitted and the opposing effect obtained solely by the winding 13.

In Figure 5 the current for the compensating winding 13 is taken directly from the line in opposition of the main winding 11 by a leakage path to ground through the inductance 14 and resistance 15. The scheme has the advantage that the build-up of current in the compensating winding responds more quickly to the reversals of signals, since it does not have to await the operation of the relay tongue. A variable resistance 25 is inserted in series with the winding 11 to enable the current to divide properly between the windings 11 and 13.

While this circuit produces better shaping of the signals, than the arrangements of Figures 3 and 4, it causes a reduction in the current through the main line winding and therefore, in certain instances may not be as suitable for high frequency signaling on lines of high attenuation.

Figure 6 shows a compensating circuit in which the line current is varied at the receiving terminal, to cause the signals to assume a symmet-

rical form relative to the zero line. A portion of the signal current is leaked off through the variable inductance 14 and variable resistance 15. The inductance 14 is of a type which will not vary appreciably within the range of signalling current. The inductance of the relay winding 11 due to the lack of sufficient iron, eddy current losses etc., is of a less efficient nature, whereby the higher frequency signals, such as the short reversals B, C, D and E are very nearly blocked by the inductance 14, flowing mainly through the relay winding 11 and the lower frequency or long signals as A are by-passed through the inductance 14 in a greater proportion. Consequently the flux in the coil 11, due to the long signals is reduced in a greater proportion than the short reversals, and variations in amplitude of the received signals is compensated for.

It is obvious that the essential features of the invention may be incorporated in other types of relay circuits either by providing the biasing winding in addition to the other windings of the relay or by substituting it in place of the opposing winding where such winding is employed. Therefore, I do not desire to be limited to the exact circuit arrangement shown but include all modifications and adaptations that come within the terms of the appended claims.

What I claim is:

1. In a telegraph system, a line over which current variations are received, a relay having a main line winding in said line, an opposing winding for said relay, a variable inductance and a variable resistance in circuit with the opposing winding and means dependent upon said current variations for energizing said opposing winding through said inductance and resistance, said inductance and resistance being proportioned so as to cause the current to build up in the opposing winding in definite relation to the rate at which the current builds up in the main line winding.

2. In a telegraph system, a line over which current variations are received, a relay having a main line winding in said line, an opposing winding for said relay, an inductance in circuit with the opposing winding and means dependent upon said current variations for energizing said opposing winding through said inductance, said inductance being proportioned so as to cause the rate of increase of current therein to bear a definite relation to the rate of increase of current in the main line winding.

3. In a telegraph system, a line having an appreciable amount of distributed capacity, and a relay in said line having a main winding and an opposing winding, said opposing winding being controlled by the armature of the relay and having a time constant which simulates the time constant of the line.

4. In a telegraph system, a line having an appreciable amount of distributed capacity, a relay in said line having a main winding and an opposing winding, said opposing winding being controlled by the armature of the relay and hav-

ing inductance and resistance in series therewith of such value that the time constant of the opposing winding simulates the time constant of the line.

5. In a telegraph system, which includes a transmission line having an appreciable amount of distributed capacity and inductance whereby signals transmitted over said line are materially retarded, a relay in the line, and means for variably biasing said relay in opposition to said signals in proportion to the amplitude of individual received signal impulses in such manner that all impulses have a substantially uniform effect on the relay armature.

6. In a telegraph system, a relay having a main line winding, an accelerating winding and an opposing winding, said opposing and accelerating winding being controlled from the contacts of the relay and said opposing winding being included in a circuit having a time constant approximating that of the line.

7. In a telegraph system, a relay having a main line winding and an opposing winding, means in circuit with the opposing winding for causing the flux therein to vary in proportion to the variations in flux in the main line winding, and means for limiting the current in said opposing winding to a predetermined value.

8. The method of recording telegraph signals received over a line having appreciable distorting effects on the arrived signals whereby said signals vary in amplitude comprising, producing an artificial zero line which fluctuates in accordance with variations in amplitude of individual signal impulses and recording the signals with respect to said artificial zero line.

9. The method of recording telegraph signals received over a line having appreciable distorting effects on the arrived signals whereby said signals vary in amplitude, which comprises producing a flux in proportion to the received signal current, producing an opposing flux of lesser magnitude which varies in definite relation to the received signal currents, and utilizing the resulting flux to actuate a recording device.

10. In a telegraph system a line, a relay having a main winding and an opposing winding, both receiving current from said line, and means in circuit with said opposing winding for causing current to build up therein in proportion to but at a lower rate than in said main line winding.

11. In a telegraph system, a line having an appreciable amount of distributed capacity and inductance whereby signals transmitted over said line are materially retarded, a receiving instrument having a main winding in said line, and a shunt path around said main winding containing an inductance of a value to bypass a greater proportion of low frequency signals, than of the high frequency signals, said shunt path including a winding arranged to produce a flux opposing that in the main winding.

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