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POLAR RELAY CIRCUIT

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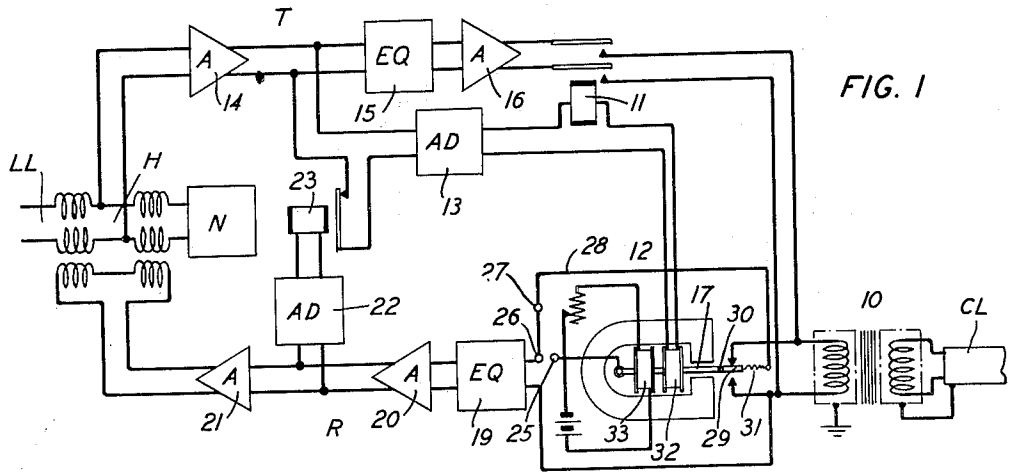

FIG. 1

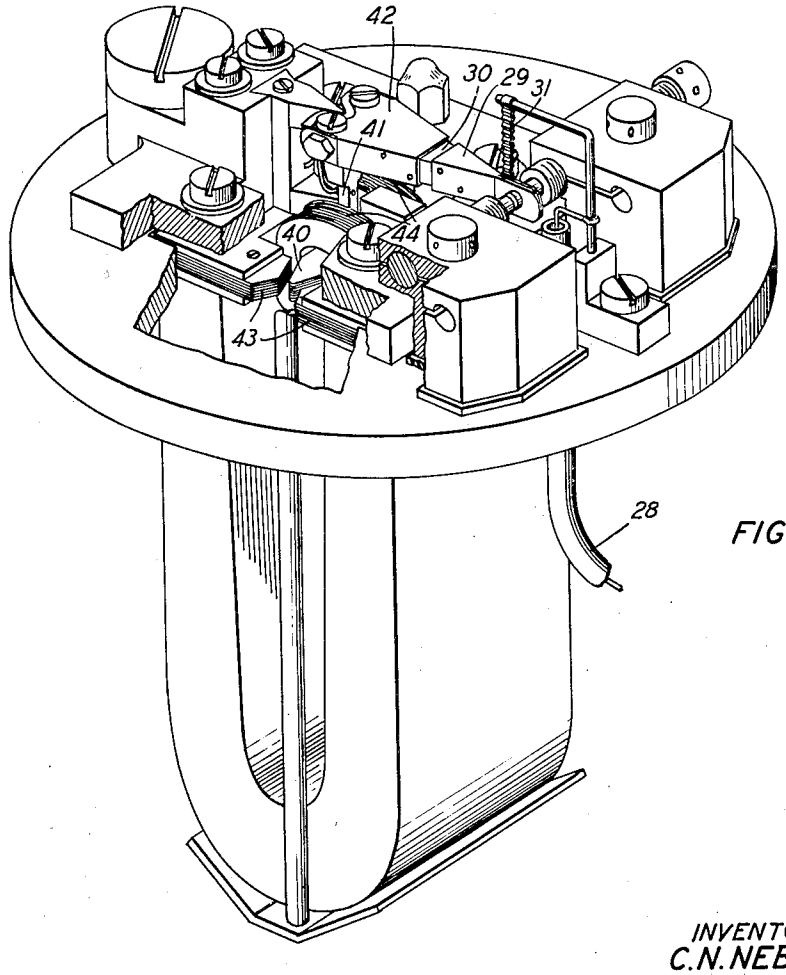

FIG. 2

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POLAR RELAY CIRCUIT

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4 Claims. (Cl. 179—170)

The present invention relates to a switching circuit for opening and closing a signal circuit particularly a receiving path containing high amplification. In circuits of this type where a relay with a moving armature is used applicant has discovered that clicks or noise are produced which may interfere with the satisfactory operation of the system or with the proper reception of signals.

It is an object of the present invention to reduce the noise arising from the operation of a movable switching element in a sensitive circuit such as the input circuit to a high gain amplifier.

A polar relay is equipped with a permanent magnet or polarizing winding for producing a magnetic field of high intensity across a small air gap within which the armature is adapted to move. It also has an operating winding carrying current impulses, and the field of this winding is superposed on the permanent or steady field. When the armature moves in this magnetic field it generates an E. M. F. between its two ends. This E. M. F. is relatively very small and in most uses to which a polar relay is put it may be entirely insignificant. In working with a receiving circuit for a transatlantic telephone cable system where the signals as received are very highly attenuated and are only slightly above the resistance noise level of the cable itself, applicant has found that the potential differences developed in the moving armature of a polar relay may be comparable with the potentials of the signals themselves and may be capable of producing highly disturbing effects in the circuit. It is necessary that the relay contact be located in that portion of the receiving circuit where the signals are the weakest and ahead of all of the amplification in the receiving circuit, since the entire receiving circuit must be isolated from the cable during the time that the transmitting circuit is connected to the cable. It was found that the potentials at the relay contacts produced clicks in the output of the receiving amplifier when the armature was moved by hand between its contacts, and the click became much larger when the relay was operated by sending a current through its winding.

Applicant has found that the switching noise that has been encountered in this type of circuit is due principally to the E. M. F. developed by the movement of the armature or relay tongue in the magnetic field of the polar relay and has reduced these switching noises to a negligible energy level by positioning the movable contacting member of the relay outside the magnetic field.

The nature of the invention will be better understood from the following detailed description in connection with the attached drawing in which

Fig. 1 shows a simplified schematic diagram of a two-way terminal circuit for a deep-sea telephone cable embodying a relay switching mechanism in accordance with this invention; and

Fig. 2 shows in greater detail the constructional features of the polar relay.

Referring to Fig. 1 of the drawing the deep-sea cable CL is shown at the right of the drawing terminating in a two-winding shielded transformer 10. A land line LL is shown at the left for transmitting to and receiving from the cable CL by means of a four-wire circuit comprising a transmitting branch T and a receiving branch R. The land line is equipped with the usual hybrid coil H and balancing network N.

It is important that only one of the two branches T and R be connected to the cable at the same time. For this purpose the transmitting branch T is provided with a switching element in the form of a relay 11 having armatures which hold this branch normally open. The receiving circuit R is normally maintained closed by relay 12 so that the receiving circuit is normally in condition to receive signals from the cable and repeat them into the land line. Relays 11 and 12 are operated in unison from the amplifier-detector 13 under control of speech currents in the transmitting branch T. Relay 12 is provided with an operating winding 32 and biasing winding 33 respectively.

In the circuit of Fig. 1 when speech waves are received from over the land line, in the absence of any speech waves in the receiving circuit R, these waves from the land line pass into the transmitting branch T through amplifier 14, equalizer 15 and amplifier 16. The speech waves in the output of amplifier 14 pass in part into the amplifier-detector 13 where they are amplified and rectified so that they are enabled to actuate relays 11 and 12. Relay 12 shifts its armature 17 to its alternate position, closing a short circuit across the input side of the receiving branch R and cutting the receiving branch off from the cable. Relay 11 in closing its armatures connects the transmitting branch T through to the transformer 10 so that the speech waves may pass out into the cable. Equalizer 15 is a reactance network

for discriminating against low frequencies and in favor of high frequencies so as to properly shape the speech waves for transmission. This is necessary on account of the unequal attenuation of the cable CL which is greater at the high frequencies than at the low.

When speech waves are to be received from the cable relay 12 in its receiving condition maintains the receiving branch closed from transformer 10 at the upper contact of relay 12 so that the speech waves pass into the equalizer circuit 19, amplifier 20 and amplifier 21 and thence into the land line LL. A portion of the speech waves in the output of amplifier 20 pass into amplifier-detector 22 and are rendered capable of actuating relay 23 which opens at its back contact and armature the input branch to amplifier-detector 13 so that this is prevented from false operation. Relay 11 being deenergized during the receiving period maintains the transmitting branch T open at the front contact and armatures of this relay.

It will be observed that polar relay 12 in moving its armature 17 between its two alternate contacts closes either of two circuits, namely, the circuit leading from the cable transformer 10 to the receiving branch R when the armature 17 is in its upper position or the short-circuit across the receiving branch R when the armature 17 is in its lower position.

When polar relays of the ordinary construction are used for relay 12 the armature 17 has been included in series in the receiving branch R either with the conductor leading to transformer 10 or the short-circuiting conductor. For example, the polar relay of the usual construction has a lead from the pivoted end of the armature extending to a binding post 25 for connection into the external circuit. In past practice this binding post 25 would be connected with terminal 26 and terminal 26 would be disconnected from terminal 27. Also the armature 17 would be continuously metallic so that when it made contact with either of its two stationary contacts the armature itself would be included in series between binding post 25 and either of the two stationary contacts as shown.

Under these conditions whenever armature 17 moved between its two pole pieces an E. M. F. would be generated between binding post 25 and the opposite end of armature 17. Let it be considered that armature 17 were at a particular instant moving toward its upper contact. Then at the instant when contact is made the E. M. F. developed in the armature due to its movement in the magnetic field of the polar relay would be applied between the upper stationary contact and the external circuit connected to binding post 25. This E. M. F. would pass along to the equalizer 19 and would be amplified at 20 and 21 and would be heard by the listening subscriber on the line LL as a click or noise. When armature 17 moved to its lower position the E. M. F. generated in the armature would be applied between binding post 25 and the lower stationary contact. This E. M. F. would produce current in the equalizer 19 which would be amplified at 20 and 21 and would be heard as a further click on the line LL.

In accordance with this invention however binding post 25 is not used but the external circuit is connected instead from point 26 to point 27 in conductor 28 which leads in turn through a flexible connection 31 to a metallic member 29 which is mechanically connected to the armature 17 but electrically insulated therefrom by means of the insulation 30. With this construction it will be apparent that the armature 17 itself is never included in the circuit controlled by the relay 12 and hence any E. M. F. developed in the armature 17 is not applied to the circuit which the relay controls. It is important that metallic contacting member 29 be sufficiently outside the magnetic field of the polar relay so that no appreciable E. M. F. is developed in the member 29. When this precaution is observed it has been found in accordance with the invention that the switching noise or clicks experienced in the past from using relay 12 are effectively suppressed.

The preferred construction of the polar relay 12 is shown in more detail in Fig. 2. This relay is of the same general type as that disclosed in U. S. patent to A. M. Curtis 1,757,703, May 6, 1930. In this type of relay the stray field is kept small by using a very small air gap in which the armature 40 is positioned. The movements of the armature 40 are communicated through a rod 41 to the actuating member 42 which is mounted some distance away from the armature 40 and from the pole pieces 43 of the polarizing magnet. The actuating member 42 may be constructed of aluminum or aluminum alloy or some light weight material of sheet form which is bent into the form shown to provide requisite stiffness.

In modifying this type of relay to incorporate the present invention the underside of the actuating member 42 is substantially filled with a piece of bakelite or other suitable insulation which is riveted to the member 42 or otherwise secured to it at various points. A saw cut is then made in the member 42 to separate electrically the end portion 29 from the main portion 42 exposing the insulation at 30 as shown in Fig. 2. The end portion 29 is thus mechanically firmly attached to the main portion 42 but is electrically insulated therefrom. A flexible piece of phosphor bronze or other suitable material at 31 provides for the electrical connection between the member 29 and the external circuit. The two coils 44 may each contain a portion of the turns shown separately as actuating winding 32 of Fig. 1 and biasing winding 33.

With the type of construction shown in Fig. 2, not only are armature 40, rod 41 and actuating member 42 kept out of the circuit which the relay controls, but the contacting member 29 and its flexible connection 31 are located where the stray field is of two low intensity to permit an appreciable E. M. F. to be generated in them.

The circuit of Fig. 1 has been given as a typical instance where the relay of the invention may find application. It is to be understood however, that the invention is not limited to circuits of this character but that it may be used wherever switching is to be introduced into a circuit carrying such low energy level that the E. M. F.'s developed in the armature are of comparable or appreciable magnitude. A deep-sea telephone cable terminal circuit to which the invention is applicable is shown in greater detail in my prior application Serial No. 459,663, filed June 7, 1930. In that system the relay of the present invention would be used for relay 15, and might also if desired be used for the other relays such as 12, 34 and 40 of that application.

What is claimed is:

1. In combination a circuit carrying only currents of extremely low amplitude, a polar relay for altering the connections of said circuit, said relay having a magnetic field and an armature movable therein, and means for reducing noise energy in the circuit comprising a movable contacting element actuated by the armature of said polar relay but located substantially entirely outside the field of said polar relay and electrically insulated from said armature, whereby voltages induced in the armature by movement in said field are prevented from reaching said circuit.

2. A circuit carrying only electrical waves of extremely low energy a polar relay for opening and closing the circuit carrying said waves of low energy, said relay having a normal magnetic field and an armature movable therein and a contacting member actuated by said armature but insulated electrically therefrom, said contacting member performing the opening and closing of said circuit, said member being located substantially outside the magnetic field of said relay, whereby said member and consequently said circuit are kept free of induction effects from said field due to the movement of said member and the moving system of which it is a part.

3. In combination with a circuit having a portion in which the current is of the order of micro-amperes, a relay for opening and closing said circuit portion, having a magnetic field and an armature movable therein and a contacting member actuated by said armature but electrically insulated therefrom, said contacting member performing the opening and closing of said circuit portion, said member being located substantially outside the magnetic field of said relay, whereby said field is prevented from setting up in said member and consequently in said circuit disturbing voltages due to movement of the member.

4. A polar relay having a steady magnetic field and an armature movable in a small air-gap therein, about an axis, a relay tongue mounted for movement with said armature, said tongue being positioned in a direction transverse to the armature and offset from the plane through the axis of said armature and air-gap, and removed a sufficient distance from the field poles to be substantially outside said field, the tongue of said relay having its transversely movable end portion insulated from the armature, and a flexible lead connected to said end portion and also lying outside said field, whereby movement of said armature and tongue induces a substantially zero potential in the contacting end portion thereof.

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