Dec. 28, 1943. M. R. DOUGLASS 2,337,651

POLARIZED ELECTROMAGNETIC CONTROL DEVICE

Filed Jan. 1, 1942 2 Sheets-Sheet 1

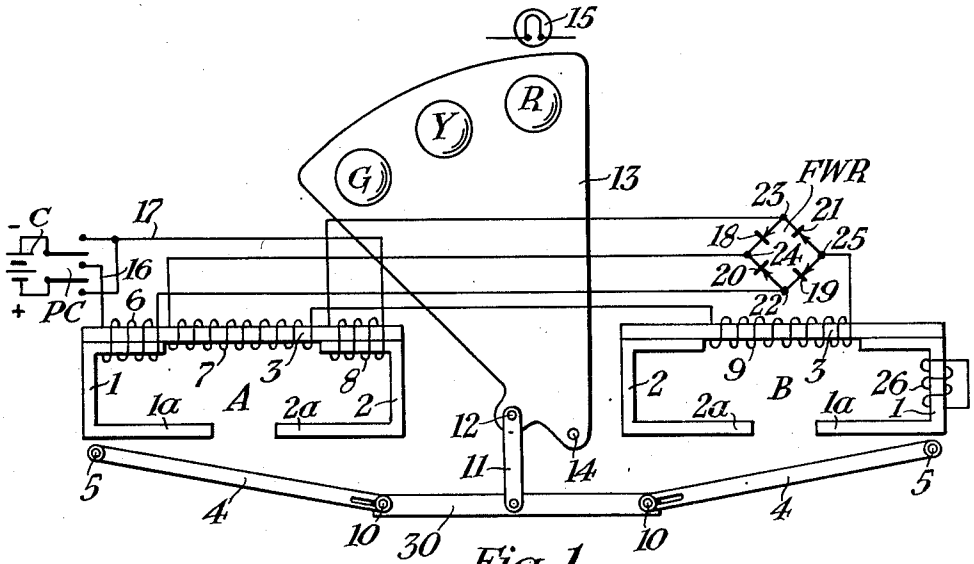


Fig. 1.

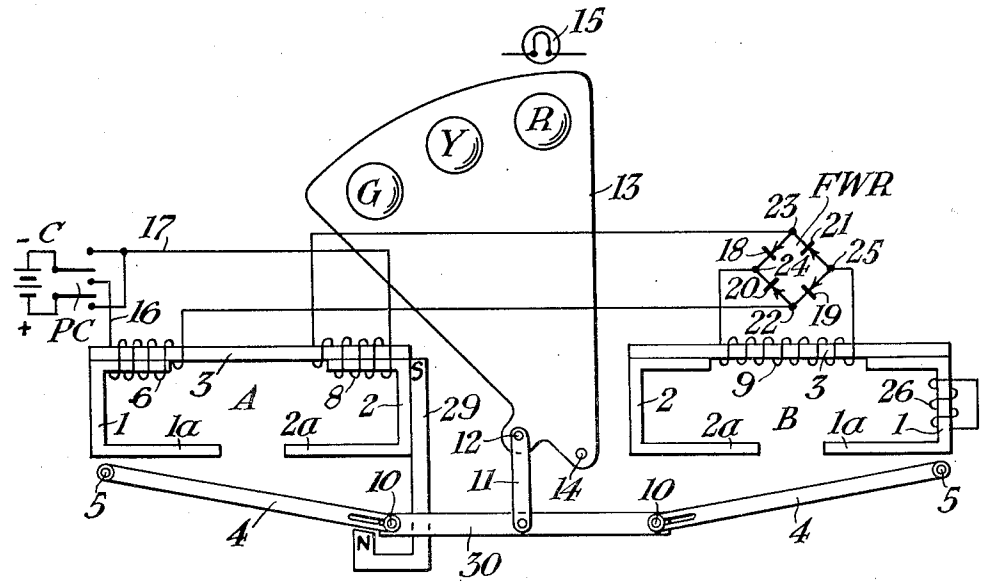


Fig. 2.

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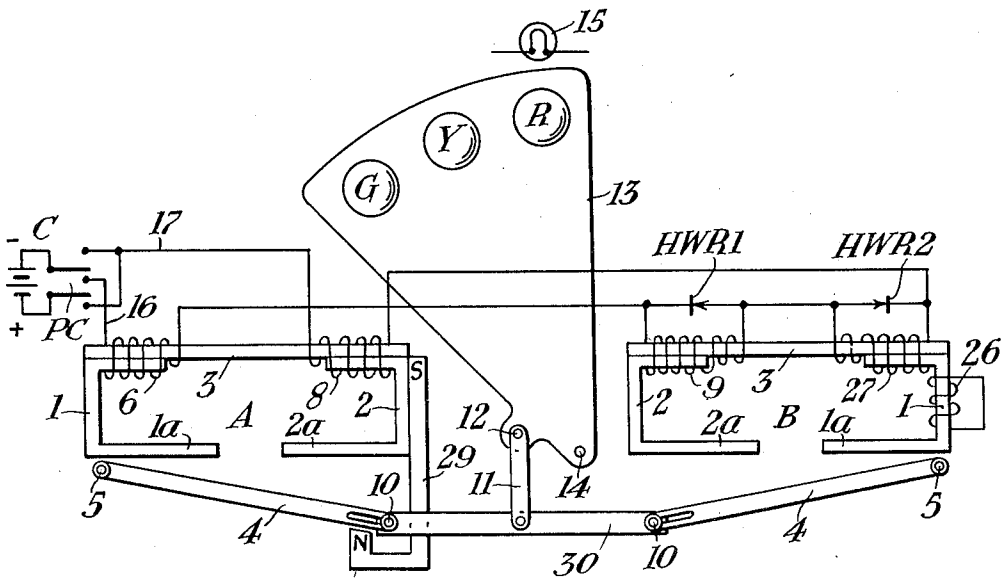


Fig. 3.

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Patented Dec. 28, 1943 2,337,651

UNITED STATES PATENT OFFICE

2,337,651

POLARIZED ELECTROMAGNETIC CONTROL DEVICE

Myrl R. Douglass, Edgewood, Pa., assignor to The Union Switch & Signal Company, Swissvale, Pa., a corporation of Pennsylvania

Application January 1, 1942, Serial No. 425,263

6 Claims. (Cl. 175—335)

My invention relates to light signals, and particularly to searchlight signals which are capable of selectively projecting a plurality of beams of light of different colors from a single light source.

More particularly, my present invention relates to searchlight signals of the type in which a spectacle arm provided with red, yellow and green color filters is operatively connected with the armatures of two tractive type electromagnets in such manner that when both electromagnets are deenergized the spectacle arm is biased to the position in which the red filter is disposed in the light beam, when one electromagnet only is energized the spectacle arm is moved to the position in which the yellow filter is disposed in the light beam and when both electromagnets are energized the spectacle arm is moved to the position in which the green filter is disposed in the light beam.

Heretofore, the control of signals of the type described has usually been effected by means of neutral line circuits, and one object of my present invention is to provide a signal of this type which can be safely controlled over a polarized line circuit.

Another object of my invention is to provide a signal of the type described which will not display a red blink when it is controlled over a polarized line circuit and the polarity of the current is changed to change the signal indication from yellow to green or vice versa.

According to my invention, it is proposed to energize the one electromagnet through one or more asymmetric units which function to cause the induced flux to always thread the armature in the same direction regardless of the polarity of the line circuit and also to delay the decay of flux in the armature when the electromagnet becomes deenergized, whereby the armature will pick up on current of either polarity and is made slow releasing. It is further proposed to energize the other electromagnet in series with the one electromagnet but to so construct the other electromagnet that it will attract its armature when and only when current of a particular polarity is supplied to the line circuit.

Other objects and characteristic features of my invention will become apparent as the description proceeds.

I shall describe three forms of searchlight signals constructed and controlled in accordance with my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view showing one form of light signal constructed and controlled in accordance with my invention. Figs. 2 and 3 are views similar to Fig. 1 showing modifications of the signal illustrated in Fig. 1.

Similar reference characters refer to similar parts in each of the several views.

Referring first to Fig. 1, a light signal embodying my invention is here shown as comprising two electromagnets A and B, each consisting of two magnetizable pole pieces 1 and 2 connected at one end by a backstrap 3, and cooperating at the other end with a tractive type armature 4 pivotally mounted at 5 for swinging movement toward and away from the pole faces 1*a* and 2*a* of the pole pieces 1 and 2. The backstrap 3 of electromagnet A is provided with three energizing windings 6, 7 and 8, while the backstrap 3 of electromagnet B is provided with a single energizing winding 9. The windings 6 and 8 preferably each have one-half as many turns as winding 7, while the winding 9 preferably has as many turns as the sum of the turns in windings 6, 7 and 8.

The windings 6, 7, 8 and 9 are arranged to be energized by means of a polarized control circuit here shown as comprising two line wires 16 and 17 reversibly connected with a battery C over a pole changer PC. Associated with this circuit is an asymmetric device FWR for supplying the windings 7 and 9 with current of the same polarity regardless of the polarity of the current supplied to the line wires 16 and 17. As here illustrated, this asymmetric device is a full wave rectifier comprising four asymmetric units 18, 19, 20 and 21 of the well known copper oxide variety connected in bridge formation between input terminals 22 and 23 and output terminals 24 and 25 to thereby provide two multiple circuit paths.

The winding 6 is connected in the control circuit between the line wire 16 and the input terminal 22 of rectifier FWR, and the winding 8 is connected in the control circuit between the line wire 17 and the input terminal 23 of rectifier FWR, while the windings 7 and 9 are connected in series between the output terminals 24 and 25 of rectifier FWR.

With the control circuit arranged in this manner, when the pole changer PC is shifted to its upper position, current flows from battery C through the lower arm of pole changer PC, line wire 16, winding 6, input terminal 22 of rectifier FWR, asymmetric unit 20 in its low resistance direction, output terminal 24 of rectifier FWR, windings 7 and 9 in series, output terminal 25 of rectifier FWR, asymmetric unit 21 in its low resistance direction, input terminal 23 of rectifier FWR, winding 8, line wire 17, and the upper arm of pole changer PC to battery C. When, however, pole changer PC is shifted to its lower position, current will then flow from battery C through the lower arm of pole changer PC, line wire 17, winding 8, input terminal 23 of rectifier FWR, asymmetric unit 18 in its low resistance direction, output terminal 24 of rectifier FWR,

windings 7 and 9 in series, output terminal 25 of rectifier FWR, asymmetric unit 19 in its low resistance direction, input terminal 22 of rectifier FWR, winding 6, line wire 16, and the upper arm of pole changer PC to battery C. It will be seen, therefore, that when the pole changer PC is reversed, the direction of current flow in the windings 6 and 8 is reversed, but the direction of current flow in the windings 7 and 9 remains the same.

The windings 6 and 8 are so arranged that whenever these windings are energized, they will set up cumulative fluxes in the magnetic circuit of electromagnet A, and it follows, therefore, that when the line wire 16 is positive with respect to the line wire 17, the fluxes set up in the magnetic circuit of electromagnet A by all three windings 6, 7 and 8 will be cumulative, but that, when line wire 17 is positive with respect to line wire 16, the flux due to winding 7 will buck that due to windings 6 and 8. It will be remembered that the windings 6 and 8 each have half as many turns as the winding 7, and since all four windings 6, 7, 8 and 9 are connected in series in the control circuit, it follows that when line wire 17 is positive with respect to line wire 16, the resultant flux in the magnetic circuit of electromagnet A will be zero.

It will be apparent from the foregoing that when the line wires 16 and 17 are supplied with current of either relative polarity, the armature 4 of electromagnet B will pick up, but that the armature 4 of electromagnet A will pick up when and only when the line wire 16 is positive with respect to the line wire 17.

A floating lever 30 is operatively connected at its ends with the free ends of both armatures 4 by means of pin and slot connections 10, and is pivotally connected intermediate its ends with one end of a link 11. The other end of the link 11 is pivotally connected with a lug 12 formed on one side of a spectacle arm 13. The spectacle arm 13 is pivotally supported at 14 and is provided with three color filters or roundels R, Y and G arranged to cooperate with an electric lamp 15.

The parts are so proportioned that when both armatures 4 are released, the spectacle arm 13 is biased by the armatures to the position in which the red filter is disposed in front of the lamp 15, when either armature is picked up and the other released, the spectacle arm will be moved to the position in which the yellow filter is disposed in front of the lamp 15, and when both armatures are picked up, the spectacle arm will be moved to the position in which the green filter is disposed in front of the lamp 15. The signal will, of course, display a red, yellow or green aspect according as the red, yellow or green filter is in front of the lamp 15, and as is well understood, when the signal displays a red aspect it indicates stop, when it displays a yellow aspect it indicates approach, and when it displays a green aspect it indicates clear.

As shown in the drawings, the lamp 15 is disposed above the roundels R, Y and G, but the lamp is placed in this location for purposes of illustration only, and it is to be understood that in actual practice the lamp will be directly behind the roundels.

It will be obvious from the foregoing that when the line wires 16 and 17 are both deenergized, the signal will display its stop indication, when these line wires are energized by current of one relative polarity, the signal will display its approach indication, and when these line wires are energized by current of the other relative polarity, the signal will display its clear indication.

It should be pointed out that when the polarity of the line circuit is reversed, the asymmetric units 18 and 20 provide one low resistance path for the current induced in windings 7 and 9 by the decaying flux in the magnetic circuits of the electromagnets A and B, and the asymmetric units 21 and 18 provide another low resistance path for the current induced in the windings 7 and 9 by this decaying flux. These low resistance paths retard the decay of the flux in the winding 9, and if the pole changer is reversed quickly enough, the armature 4 of electromagnet B will not open during reversals of the polarity of the current supplied to the line circuit. This prevents the spectacle arm from returning to its normally deenergized position while the polarity of the line circuit is being reversed, and thus avoids the possibility of an undesirable red blink during changes in the signal indication from approach to clear or vice versa.

If additional retardation of the electromagnet B is desired, the winding 9 may be made slow acting by winding it on a copper sleeve in accordance with well known practice, or a short circuited winding 26 may be provided on some part of the magnetic circuit of the electromagnet.

It should also be pointed out that since the windings 6 and 8 are connected in the control circuit in the manner described, any current which flows in rectifier FWR must flow through one or the other or both of the windings 6 and 8, and as a result, these windings function as choke coils to prevent damage to the rectifier due to line surges. The choking effect of these windings is also effective to prevent false operation of the signal in the event that alternating current is induced in the line circuit due, for example, to the proximity of power lines.

It should further be pointed out that with the signal controlled in the manner described it incorporates certain safety features which are considered as essential in a railway signaling system. For example, since all four electromagnet windings are connected in series in the control circuit, an open circuit in any of these windings will deenergize all of the windings and will cause the signal to display its stop aspect.

A breakdown of the asymmetric units 18 or 19 of the rectifier FWR will short circuit the windings 7 and 9 when the signal is supplied with current of positive polarity, while a breakdown of the rectifier units 20 or 21 will cause a similar effect when the signal is supplied with current of the opposite polarity. When either of the rectifier units 18 or 19 is broken down and the signal is supplied with current of negative polarity, the remaining units will permit the signal to function in the proper manner. Likewise, when either of the rectifier units 20 or 21 is broken down and the signal is supplied with energy of positive polarity, the signal will again function in the proper manner due to the remaining units. Since neither of the two armatures by itself will move the spectacle arm past its approach position, the worst that could happen due to a failure of any of the asymmetric units of rectifier FWR would be to cause the signal to display an approach aspect when it should display its clear aspect, which is a failure on the safe side.

Referring now to Fig. 2, in the modified form of signal here illustrated the winding 7 of electromagnet A has been eliminated, and the electro-

magnet A has been rendered ineffective to pick up on current of one polarity but not on current of the other polarity by the addition of an L-shaped permanent magnet 29 one end of which is secured to the pole piece 2 and the other end of which extends underneath the associated armature 4 opposite the pole face 2a of the pole piece 2 in such manner that when the armature 4 is swung away from the pole pieces 1 and 2, it will be swung toward the permanent magnet and vice versa.

Assuming that the lower end of the permanent magnet 29 is a north magnetic pole and the upper end a south magnetic pole, as indicated by the letters N and S in the drawings, when the windings 6 and 8 of electromagnet A are deenergized, the associated armature 4 will drop under the influence of gravity to the position shown, and under these conditions a part of the flux from the permanent magnet will pass lengthwise through the armature and will exert a torque on the armature which assists the pull of gravity in holding the armature in its lowermost position.

When, however, the windings 6 and 8 of the electromagnet A are energized in such manner that the pole piece 2 becomes a south pole and the pole piece 1 becomes a north pole, the permanent magnet and the electromagnet fluxes will buck each other in the armature 4, and as the electromagnet flux builds up in the armature, a point will be reached at which the upward pull exerted on the armature by this flux will exceed the downward pull due to the permanent magnet flux and the force of gravity. When this happens, the armature 4 of the electromagnet A will swing toward the pole pieces 1 and 2 to its upper or attracted position.

If when the armature 4 of electromagnet A occupies its released position, the windings 6 and 8 are energized in such manner that the pole piece 2 becomes a north pole and the pole piece 1 becomes a south pole, the flux due to both the electromagnet and the permanent magnet will then thread the armature 4 in the same direction, and under these conditions the armature 4 will remain in the position shown even though the energization of the windings 6 and 8 is increased to many times its normal value.

If the polarity of the permanent magnet 29 is reversed from that shown in the drawings, the electromagnet A will operate in a manner similar to that just described, except for the fact that the polarity of the current which must be supplied to the windings 6 and 8 to cause the armature 4 to pick up will be reversed.

The operation as a whole of the signal shown in Fig. 2 is generally similar to the operation of the signal shown in Fig. 1. That is to say, when the line wires 16 and 17 are deenergized, both armatures 4 will occupy their released positions, and the signal will display its stop indication; when line wires 16 and 17 are supplied with current of one relative polarity, armature 4 of electromagnet B will pick up and armature 4 of electromagnet A will remain released to thereby cause the signal to display its approach indication, and when the line wires 16 and 17 are supplied with current of the other relative polarity, both armatures 4 will pick up, so that the signal will then display its clear indication.

The signal shown in Fig. 2 embodies the same safety features as the signal shown in Fig. 1, and in addition minimizes the possibility of failure due to short circuited windings.

Referring now to Fig. 3, the signal here shown differs from that shown in Fig. 2 in that the electromagnet B is provided with an additional winding 27 which is connected in series with the winding 9 between the windings 6 and 8, and that the full wave rectifier FWR has been replaced by two asymmetric units or half wave rectifiers, one of which HWR1 is shunted across winding 9 and the other of which HWR2 is shunted across winding 27. The rectifiers HWR1 and HWR2 are oppositely poled and are so disposed that when the line wire 16 is positive with respect to the line wire 17, the current will flow through winding 9 and will be shunted away from winding 27, but that when line wire 16 is negative with respect to line wire 17, current will flow through winding 27 and will be shunted away from winding 9. The windings 9 and 27 are so arranged that when either winding is energized, the flux induced in the magnetic circuit of the electromagnet B will traverse the magnetic circuit in the same direction, and the parts are so proportioned that when either winding is energized with current of the proper magnitude, the resulting flux will be sufficient to move armature 4 to its attracted position.

With the signal constructed as shown in Fig. 3, it will be apparent that electromagnet B will pick up its armature 4 when the polarized line circuit is supplied with current of either polarity, but that electromagnet A will pick up its armature only when the line circuit is supplied with current of a particular polarity. It follows, therefore, that the signal will display its stop, approach, or clear aspect according as the line circuit is deenergized, or is energized with current of one relative polarity or the other in the same manner as the signals shown in Figs. 1 and 2.

It should be pointed out that with the signal constructed as shown in Fig. 3 when the polarity of the current supplied to the line circuit is changed, the rectifier which is shunted around the winding of electromagnet B which was last energized will provide a low resistance path for the current induced in this winding by the decaying flux, and will thereby retard the decay of the flux for a sufficient length of time to retain the armature 4 in its picked-up position until flux is reestablished in the same direction by the energization of the other winding of the electromagnet. This prevents the spectacle arm from returning to its normally deenergized position while the polarity of the line circuit is being changed in the same manner as when a single winding and a full wave rectifier are employed.

It should also be pointed out that with the signal constructed as shown in Fig. 3, an open circuit in either winding of electromagnet A will render the signal inoperative and will cause it to display a stop indication.

A short circuit of either winding of electromagnet A will permit the signal to move to its caution position only if electromagnet B is in proper operating condition.

An open circuit or a short circuit of the winding 9 of electromagnet B will make the signal inoperative for normal operation from the stop to the approach position, but will permit its initial operation to the approach position in the event that the line circuit is provided with current of the polarity which would normally cause a signal to display its clear indication.

An open circuit or a short circuit on the other winding of electromagnet B will not be indicated in the initial move from stop to approach provided windings 6 and 8 are intact, but when the

polarity of the line circuit is changed to cause the signal to move from its approach to its clear position, the electromagnet B will become deenergized at the same time that the electromagnet A becomes energized and the signal will therefore continue to display its approach aspect. This is a failure on the safe side.

It will be seen, therefore, that I have provided a searchlight signal having two electromagnets for moving the spectacle arm from its stop to its approach to its clear position by consecutive operation, which signal has been rendered safe for operation on a polarized line circuit by constructing the one electromagnet so that it will pick up its armature on current of either polarity and the other electromagnet so that it will pick up its armature on current of one polarity only, and in which a red flash or blink is prevented during reversals of the polarity of the line circuit by virtue of the fact that the flux induced in the magnetic circuit of the one electromagnet is rendered unidirectional by one or more asymmetric units or rectifiers shunted or associated with its energizing winding or windings.

Although I have herein shown and described only three forms of light signals embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. An electroresponsive device comprising two electromagnets each provided with an armature, a polarized energizing circuit for said electromagnets, means for causing the flux to traverse the one electromagnet in the same direction regardless of the polarity of the current supplied to said energizing circuit, means for preventing the armature of the other electromagnet from moving to its attracted position when said circuit is supplied with current of one relative polarity but not when it is supplied with current of the other relative polarity, and a member controlled jointly by said two armatures.

2. An electroresponsive device comprising two electromagnets each provided with an armature, a polarized energizing circuit for said electromagnets, means for causing the flux to traverse the one electromagnet in the same direction regardless of the polarity of the current supplied to said energizing circuit, means for preventing the armature of the other electromagnet from moving to its attracted position when said circuit is supplied with current of one relative polarity but not when it is supplied with current of the other relative polarity, and a member operatively connected with said armatures and movable thereby to a first, second, or third position according as both armatures are released, one armature is picked up and the other released, or both armatures are picked up.

3. An electroresponsive device comprising two electromagnets each provided with an armature, an energizing circuit for said electromagnets including the windings of both electromagnets in series, means for supplying current of one polarity or the other to said circuit, means for causing the flux to traverse the one electromagnet in the same direction regardless of the polarity of the current supplied to said circuit, whereby the armature of said one electromagnet will pick up when said circuit is supplied with current of either polarity and will remain picked up during reversals of the polarity of the current supplied to said circuit, means for preventing the armature of the other electromagnet from picking up when the circuit is supplied with current of one relative polarity but not when it is supplied with current of the other relative polarity, and a member controlled jointly by said armatures.

4. An electroresponsive device comprising two electromagnets each provided with an armature, an energizing circuit for said electromagnets including the windings of both electromagnets in series, means for supplying current of one polarity or the other to said circuit, asymmetric means connected in said energizing circuit and associated with the winding of said one electromagnet in a manner to cause current of one polarity only to flow in such winding when said circuit is energized with current of either polarity for causing the flux to traverse said one electromagnet in the same direction regardless of the polarity of the current supplied to said circuit, said asymmetric means being effective to retard the decay of flux in the magnetic circuit of said one electromagnet when the polarity of the current supplied to said circuit is reversed, means for preventing the armature of the other electromagnet from picking up when the circuit is supplied with current of one relative polarity but not when it is supplied with current of the other relative polarity, and a member controlled jointly by said armatures.

5. An electroresponsive device comprising two electromagnets adapted to be energized in series from a polarized control circuit and each provided with an armature, means for supplying the one electromagnet with current of the same relative polarity regardless of the relative polarity of the current supplied to the other electromagnet, whereby the armature of the one electromagnet will pick up on current of either polarity but that the flux induced in the armature of said one electromagnet will always traverse the armature in the same direction, means for rendering the armature of the other electromagnet effective to pick up when said other electromagnet is supplied with current of one relative polarity but not when it is supplied with current of the other relative polarity, and a member operatively connected with said armatures.

6. An electroresponsive device comprising two electromagnets adapted to be energized in series from a polarized control circuit and each provided with an armature, means for supplying the one electromagnet with current of the same relative polarity regardless of the relative polarity of the current supplied to the other electromagnet, whereby the armature of the one electromagnet will pick up on current of either polarity but that the flux induced in the armature of said one electromagnet will always traverse the armature in the same direction, means for rendering the armature of the other electromagnet effective to pick up when said other electromagnet is supplied with current of one relative polarity but not when it is supplied with current of the other relative polarity, and a member operatively connected with said armatures and movable thereby to a first, second or third position according as both armatures are released, one armature is picked up and the other released, or both armatures are picked up.

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