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G. L. BUSH
MAGNETIC LOCK RELAY
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2,447,632

FIG. 1

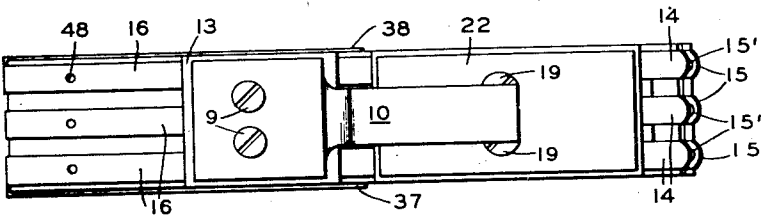


FIG. 2

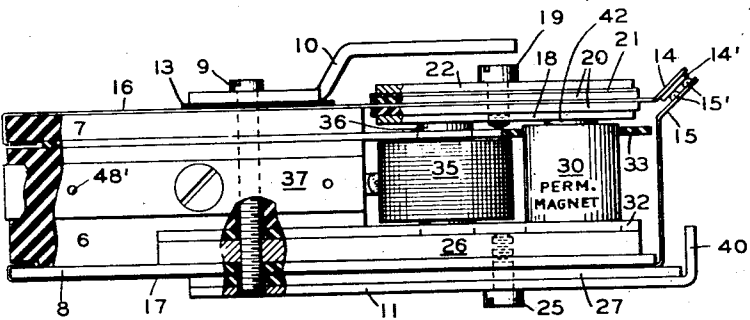


FIG. 3

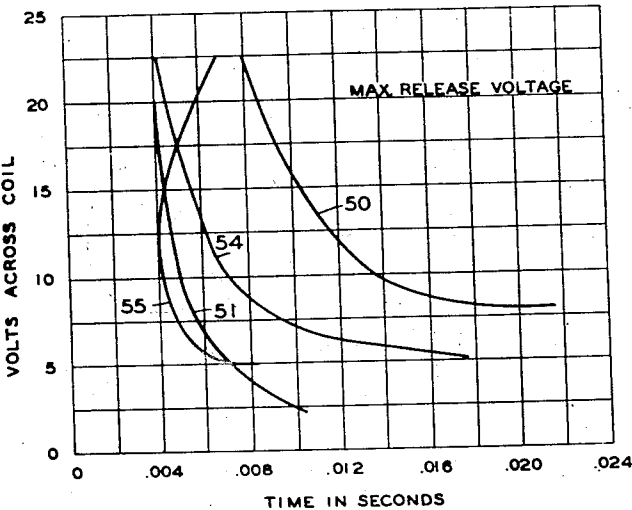
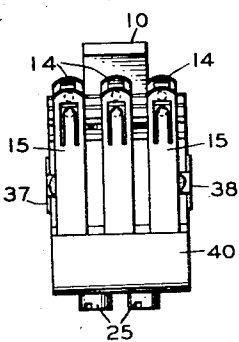
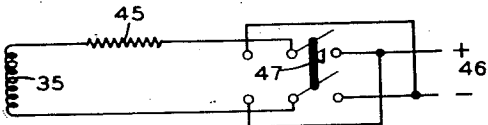


FIG. 4

FIG. 5



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MAGNETIC LOCK RELAY

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6 Claims. (Cl. 200—93)

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This invention relates to magnetic lock relays, and more particularly to an improved relay of this character which is adapted to store electrical signals without requiring holding current or other drain on the power supply while the signals are stored.

In various types of systems in which locking relays are employed for electrically storing information in regard to a number of items in communication and posting systems, for example, airway traffic control systems, thousands of such relays may be required in a single installation. If the mechanical-locking type of storage relay is employed, this not only results in an undesirably expensive unit, but the size of the unit is such that unduly large space requirements have to be provided for the large number of relays employed, and in locations where such equipment is employed space usually is at a premium. If storage relays are employed which have locking windings, these also are unduly expensive and often require more room than is available for the number of relays required. Moreover, there is a considerable drain on the current supply in order to maintain the locking windings of a large number of these relays energized continually, and even more serious is the fact that in the event of a temporary failure of the power supply, the information stored is lost and sometimes is of a nature which cannot again be obtained.

One of the objects of the invention is a compact magnetic lock relay which avoids the foregoing disadvantages, and which retains the stored information irrespective of any interruption in the power supply.

A further object is a magnetic lock relay of the character described which requires only low operating current and low releasing current, and which except for the intervals of operating or releasing the relay, requires no current consumption.

A further object is a magnetic lock relay which is so constructed as to be adapted to quantity production methods and thus may be produced at a relatively low cost.

Still another object is a magnetic lock relay which may readily be removed or replaced for inspection, maintenance or repair purposes, without disturbing existing electrical connections.

Other objects and advantages of the invention will be apparent from the following detailed description, taken in connection with the accompanying drawings in which—

Fig. 1 is a top plan view of a magnetic lock relay embodying the principles of the invention;

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Fig. 2 is a side view, in elevation, of the relay;
Fig. 3 is an end view, in elevation, of the front of the relay;

Fig. 4 is a graph showing certain operating characteristics of the relay; and

Fig. 5 illustrates a simplified control circuit for operating and releasing the relay.

Referring to Figs. 1 to 3 of the drawings, the relay comprises a supporting body of a phenolic condensation product or other suitable insulating material, which preferably is assembled from three pieces 6, 7 and 8 to facilitate quantity production methods during manufacture, which body serves as a support for the elements of the relay. The members 6, 7 and indirectly the member 8, along with other elements of the assembly, are firmly clamped together by machine screws 9 which pass through an armature back stop 10 and are screw-threaded into a magnetic yoke 26. A nonconductive strip 13 insulates the member 10 from the electrical elements of the unit.

The signals are stored on the relay by means of sets of complementary contact springs 14 and 15, three sets of these contacts being shown in Figs. 1 and 3 of the drawings for storing three signals representing items of information, although as many sets of contact springs may be provided as are desirable in view of the nature of the information stored. In the drawings the contact springs are shown in closed circuit position. Preferably, they are of the twin contact type in which each of the relatively stationary springs 15 has two contact points 15' which are engaged by a complementary contact plate 14' on the movable spring 14, so that there is little likelihood of dust or other foreign substances preventing good contact between at least at one of the pairs of complementary contacts. Each of the movable contact members 14 comprises a continuation of a strip 16, preferably of nickel-silver, which extends along the top to the rear or left-hand end of the unit as viewed in Figs. 1 and 2, and the flat surface portions of these strips provide electrical slip connections for the movable contacts 14 of the unit. Also, the spring strips 16 collectively serve as the armature spring of the unit, the armature 18 comprising a strip of magnetic iron which is secured, as by machine screws 19, to a pile-up and insulated from the spring strips 16 by means of an insulation strip 20. Above the strips 16 are two insulation strips 20 and 21, and on top of the pile-up is an iron plate 22, preferably of magnetic iron through which the machine screws pass, these being

screw-threaded into the armature 18 to clamp the pile-up together. The bottom plate member 11 is also secured by machine screws 25 which pass through the strip 8 of insulation, and are screw-threaded into a plate 26 of iron which forms a magnetic yoke for the magnets hereinafter described. The fixed contact springs 15 each comprises a continuation of a nickel-silver strip 17 which extends along the bottom of the unit to the rear thereof, and which like the top strip members 16 provide electrical slip connections for the stationary contacts of the unit. A nonconductive strip 27 insulates the plate 11 from the strip 17. The strips 17 have apertured portions, such as shown in Fig. 2, to provide clearance for the machine screws 9 and 25 and insulate the strips from the screws, and this is likewise the case with the upper strips 16 through which the screws 9 pass.

Secured to the yoke member 26, by magnetic attraction, is a small cylindrical permanent magnet 30; the magnet preferably is composed of a magnetic alloy characterized in that it has a high residual magnetism, so that when an electromagnetic field is set up in the magnet it retains permanently a considerable portion of the flux induced therein. Various such alloys suitable for the purpose are well known, for example, a sintered nickel-iron-aluminum alloy commonly known in the trade as "Alnico No. 5." Surrounding the lower end of the permanent magnet is an insulation strip 32 which has an apertured portion therein that surrounds and closely fits the lower end of the permanent magnet thereby preventing the magnet from sliding out of position, and an upper insulation strip 33 is provided for positioning the upper end or pole of the permanent magnet 30. These strips also provide, in effect, spool ends for an electromagnet 35, the coil having an inner core 36 of magnetizable material such as iron which is secured to the yoke member 26 either by a screw or by riveting. The connections to the operating coil 35 preferably are made by means of nickel-silver strips 37, 38 respectively secured to the opposite sides of the body member 6, these strips serving as slip connections for making contact to the operating coil. The front end of plate member 11 is provided with a turned-up edge portion 40 whereby the unit readily may be removed from its supporting mounting or socket either by the fingers or by a tool.

The resiliency of the spring strip members 16 is such that when the armature 18 is in its uppermost position, against the back stop 10, the residual magnetism in the magnet 30 is not sufficiently strong to attract the armature and cause the contacts 14 and 15 to close. The back stop 10 preferably is made of magnetic iron, and iron machine screws 9 are used; since the screws pass through and engage the yoke member 26, the back stop has some magnetic attraction for the plate 22 and the screws 19, so that it aids in retaining the armature in open-circuit position. When a small operating current is passed through the magnet coil 35, however, this increases the magnetic field about the upper pole of the magnet 30 so that it attracts the armature and closes the several sets of contacts. The signaling pulse or operating current for the electromagnet may be quite short in duration, but since the coil is wound in such direction that the field established by the current through the coils aids the permanent magnet, the armature instantly is attracted to the magnet core. The residual magnetism in the magnet 30

remains sufficiently strong to hold the armature in circuit-closing position and thus electrically store the signals transmitted to the unit. The armature preferably has a small spacer 42, Fig. 2, of nickel-silver or other suitable non-magnetic material, is secured thereto as by brazing or soldering, thereby to maintain a small airgap between the armature and the end of magnet 30 and prevent sticking of the armature when it is to be released.

Whenever it becomes necessary or desirable to release the information stored in the unit or to change it, a small releasing current having a polarity opposite that of the energizing current, momentarily is passed through the winding 35, and this opposes the flux maintained by the permanent magnet and reduces the residual magnetism sufficiently to allow the spring tension of the springs to release and restore the armature to its unoperated position and thus open the contacts 14, 15. Since the residual magnetism is not sufficiently strong to retract the armature from its released position, the unit is thus ready for the reception of other signals.

Fig. 5 shows diagrammatically a manually-controlled operating and releasing circuit for the magnetic relay. In a small size unit, the resistance of the coil 35 may be of the order of 375 ohms, and the coil is preferably composed of approximately 1700 turns of No. 40 magnet wire. A resistance 45 which may be of the order of 1500 ohms in the circuit illustrated, is provided in order that a suitable operating source of potential 46, for example, 50 volts, may be employed. When the switch 47 momentarily is thrown to its right-hand position, as viewed in the figure, current will flow in a direction through the coil 35 to aid the flux of the permanent magnet 30 and thus attract the armature which, as above set forth, remains operated by the residual magnetism until a releasing current subsequently is passed through the coil. When it is desired to clear out the signals stored on the relay contacts, the switch member 47 momentarily is thrown to the left, as viewed in the figure, and this reverses the flow of current through the coil 35, thereby causing the magnetic flux set up by the coil to oppose the residual magnetism of the permanent magnet and release the armature. While a manually operable switch circuit is shown for the sake of simplicity, in practice the unit is operated and released automatically, as by means of cam-controlled contacts, relays or the like. In a unit having the values above set forth, an operating current as low as 27 milliamperes produces satisfactory operation of the relay, and a current of like value causes release of the relay. It will, therefore, be seen that many thousands of the relay units may be employed in a single installation without requiring an excessive strain on the power supply, it being understood that all of the relays are not actuated or released at the same time, since the information regarding different flights or other items is set up or released at different times.

Fig. 4 shows the operating and release characteristics of the relay, with respect to time, for different voltages impressed across the coil 35. Curve 50 depicts the operate characteristics of the relay when the series resistance 45 is omitted, and curve 51 the release characteristics under this condition. Curve 54 shows the operate characteristics when the resistance 45 is included, and curve 55 the release characteristics in this case. The curves 54 and 55 show that a voltage drop of

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the order of 10 volts across the coil 35 gives optimum performance both for operation and release. The upper portion of curve 55 shows that the release voltage impressed across the coil 35 should in no event be in excess of approximately 20 volts, otherwise there is produced a reverse field in the coil which would neutralize the permanent magnet and also produce additional flux that would tend improperly to reoperate the relay during the release operation.

It will be noted that the illustrative embodiment of the storage relay involves only molded and stamped mechanical parts, with the exception of the electromagnet 35, and thus the unit is especially adapted for quantity production, with consequent lowered cost. Only a very small number of different parts are required for the unit, and all of the operating parts including the electrical connections are readily available for inspection, maintenance or repair purposes. For storing signals of the character employed in airway traffic and similar posting system, the unit may be made so small that its overall length is only approximately 2 3/4 inches; its overall width is of the order of 1/2 inch; and the overall height of the unit including the contact springs is less than 1 inch, so that thousands of these units may be inserted adjacent to each other in a relay bank in a manner to conserve valuable space. Preferably, and as shown in Fig. 2, the right-hand end of the strip 35 extends sufficiently to provide a suitable stop for the follow-up movement of the stationary contact springs 15 when the contacts are opened.

The nickel-silver strips are prevented from laterally shifting by means of small dimples or burrs 48, 48' which are punched into the strips and caused to extend for a slight distance into the supporting insulation body members. The strips 16, 17, 37 and 38 not only serve as electrical slip connections for engagement with fixed spring contact members in the relay bank, but also mechanically secure the relay unit in operating position and firmly support the unit on all four sides thereof. The unit thus may be withdrawn readily from the relay bank for inspection, maintenance or repair purposes, and either the same or another unit may as readily be reinserted in the bank.

It will be noted from Fig. 4 that the time required for operating and releasing the relay armature is materially lessened when the resistance 45 is employed. This is because the resistance causes a faster build-up of the current in the coil 35, and hence the flux induced therein, and thus improves both the operate and release characteristics of the unit.

Various modifications of the relay unit illustrated will readily occur to those versed in the art without departing from the spirit or scope of the present invention. The disclosure, therefore, is for the purpose of illustrating the principles of the invention, which is not to be regarded as limited except as indicated by the scope of the appended claims.

What is claimed is:

1. A magnetic lock relay comprising a supporting body of insulation, at least one spring strip conductor secured to and extending longitudinally along a side of said body, an armature secured to said strip whereby the strip provides spring supporting and biasing means for the armature, electrical contact structure on one end of said strip and movable by said armature, at least one other spring strip conductor secured to and extending longitudinally along a side of said body and having on one end thereof relatively station-

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ary contact structure complementary to said movable contact structure, a magnetic yoke secured to said body and a permanent magnet extending from said yoke and operative upon said armature, the permanent magnet being formed from a magnetic material characterized by high residual magnetism, the spring tension of the movable contact spring strip being sufficient to prevent the residual magnetism in said magnet from operating the armature when it is in its released position, but insufficient to cause release of the armature when it has been attracted to said permanent magnet, an electromagnet having a core extending from said yoke and so positioned that when an operating current is passed through the electromagnet in one direction flux is set up to aid the permanent magnet and operate the armature and when current is passed in the opposite direction through the electromagnet flux is set up which opposes the residual magnetism of the permanent magnet and releases the armature, the residual magnetism of the permanent magnet maintaining the armature in its operated position upon deenergization of said electromagnet.

2. A magnetic lock relay comprising a supporting body of insulation, at least one spring strip conductor secured to and extending longitudinally along a side of said body, an armature secured to said strip whereby the strip provides spring supporting and biasing means for the armature, electrical contact structure on one end of said strip and movable by said armature, at least one other spring strip conductor secured to and extending longitudinally along a side of said body and having on one end thereof relatively stationary contact structure complementary to said movable contact structure, a magnetic yoke secured to said body and a permanent magnet extending from said yoke and operative upon said armature, the permanent magnet being formed from a magnetic material characterized by high residual magnetism, the spring tension of the movable contact spring strip being sufficient to prevent the residual magnetism in said magnet from operating the armature when it is in its released position, but insufficient to cause release of the armature when it has been attracted to said permanent magnet, an electromagnet having a core extending from said yoke and so positioned that when an operating current is passed through the electromagnet in one direction flux is set up to aid the permanent magnet and operate the armature and when current is passed in the opposite direction through the electromagnet flux is set up which opposes the residual magnetism of the permanent magnet and releases the armature, the residual magnetism of the permanent magnet maintaining the armature in its operated position upon deenergization of said electromagnet, the longitudinally extending portions of said spring strip conductors providing slip connections for the relay whereby its said contact structures readily may be connected to or disconnected from complementary external connections.

3. A magnetic lock relay comprising a supporting body of insulation, a plurality of spring strip conductors secured to and extending longitudinally along one side of said body, an armature secured to said strips whereby the strips collectively provide spring supporting and biasing means for the armature, electrical contacts on the ends of said strips and movable by said armature, a plurality of other spring strip conductors secured to and extending longitudinally along

another side of said body and having on the ends thereof relatively stationary contacts complementary to said movable contacts, a magnetic yoke secured to said body and a permanent magnet extending from said yoke and operative upon said armature, the permanent magnet being formed from a magnetic material characterized by high residual magnetism, the spring tension of the movable contact spring strips being sufficient to prevent the residual magnetism in said magnet from operating the armature when it is in its released position, but insufficient to cause release of the armature when it has been attracted to said permanent magnet, an electromagnet having a core extending from said yoke and so positioned that when an operating current is passed through the electromagnet in one direction flux is set up to aid the permanent magnet and operate the armature and when current is passed in the opposite direction through the electromagnet flux is set up which opposes the residual magnetism of the permanent magnet and releases the armature, the residual magnetism of the permanent magnet maintaining the armature in its operated position upon deenergization of said electromagnet.

4. A magnetic lock relay comprising a supporting body of insulation, a plurality of strip conductors secured to and extending longitudinally along one side of said body, an armature secured to said strip whereby the strips collectively provide spring supporting and biasing means for the armature, electrical contacts on the ends of said strips and movable by said armature, a plurality of other spring strip conductors secured to and extending longitudinally along another side of said body and having on the ends thereof relatively stationary contacts complementary to said movable contacts, a magnetic yoke secured to said body and a permanent magnet extending from said yoke and positioned between the sets of longitudinally extending strips and operative upon said armature, the permanent magnet being formed from a magnetic material characterized by high residual magnetism, the spring tension of the movable contact spring strips being sufficient to prevent the residual magnetism in said magnet from operating the armature when it is in its released position, but insufficient to cause release of the armature when it has been attracted to said permanent magnet, an electromagnet having a core extending from said yoke and positioned between the sets of longitudinally extending strips and adjacent to said permanent magnet so that when an operating current is passed through the electromagnet in one direction flux is set up to aid the permanent magnet and operate the armature and when current is passed in the opposite direction through the electromagnet flux is set up which opposes the residual magnetism of the permanent magnet and releases the armature, the residual magnetism of the permanent magnet maintaining the armature in its operated position upon deenergization of said electromagnet.

5. A magnetic lock relay comprising a supporting body of insulation, at least one spring strip conductor secured to and extending longitudinally along one side of said body, an armature secured to said strip whereby the strip provides spring supporting and biasing means for the armature, electrical contact structure on one end of said strip and movable by said armature, at least one other spring strip conductor secured to and extending longitudinally along another side

of said body and having on one end thereof relatively stationary contact structure complementary to said movable contact structure, a magnetic yoke secured to said body and a permanent magnet extending from said yoke and operative upon said armature, the permanent magnet being formed from a magnetic material characterized by high residual magnetism, the spring tension of the movable contact spring strip being sufficient to prevent the residual magnetism in said magnet from operating the armature when it is in its released position, but insufficient to cause release of the armature when it has been attracted to said permanent magnet, an electromagnet having a core extending from said yoke and so positioned that when an operating current is passed through the electromagnet in one direction flux is set up to aid the permanent magnet and operate the armature and when current is passed in the opposite direction through the electromagnet flux is set up which opposes the residual magnetism of the permanent magnet and releases the armature, the residual magnetism of the permanent magnet maintaining the armature in its operated position upon deenergization of said electromagnet, a plurality of other strip conductors secured to and extending longitudinally along at least one other side of said body and connected to said electromagnet, the longitudinally extending portions of all of said strip conductors providing slip connections for the relay whereby the relay readily may be connected to or disconnected from complementary external connections.

6. A magnetic lock relay comprising a supporting body of insulation, at least one spring strip conductor secured to and extending longitudinally along a first side of said body, an armature secured to said strip whereby the strip comprises spring supporting and biasing means for the armature, electrical contact structure on one end of said strip member and movable by said armature, at least one other spring strip conductor secured to and extending longitudinally along a second side of said body and having on one end thereof relatively stationary contact structure complementary to said movable contact structure, a magnetic yoke secured to said body and a permanent magnet extending from said yoke and operative upon said armature, the permanent magnet being formed from a magnetic material characterized by high residual magnetism, the spring tension of the movable contact spring strip comprising means to prevent the residual magnetism in said magnet from operating the armature when it is in its released position, but insufficient to cause release of the armature when it has been attracted to said permanent magnet, an electromagnet having a core extending from said yoke and so positioned that when an operating current is passed through the electromagnet in one direction flux is set up to aid the permanent magnet and operate the armature and when current is passed in the opposite direction through the electromagnet flux is set up which opposes the residual magnetism of the permanent magnet and releases the armature, the residual magnetism of the permanent magnet maintaining the armature in its operated position upon deenergization of said electromagnet, two other strip conductors respectively secured to and extending longitudinally along two other sides of said body and connected to said electromagnet, the longitudinally extending portions of all of said strip

conductors providing means for connecting the relay to external circuit connections.

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