July 1, 1947. W. H. D. YULE 2,423,135

ELECTROMAGNETIC RELAY

Filed Nov. 6, 1943

FIG. 1.

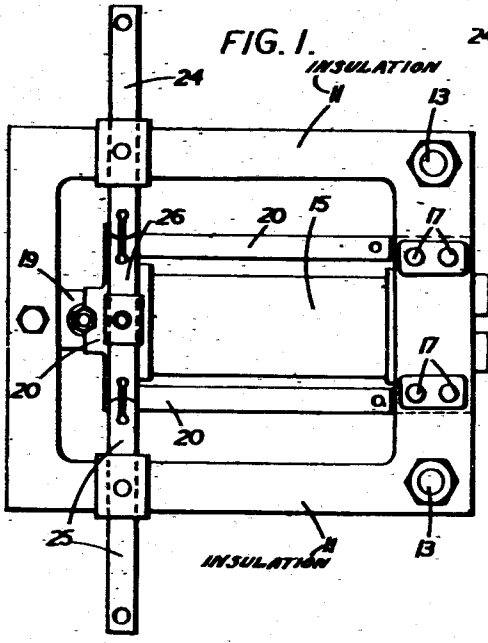


FIG. 2.

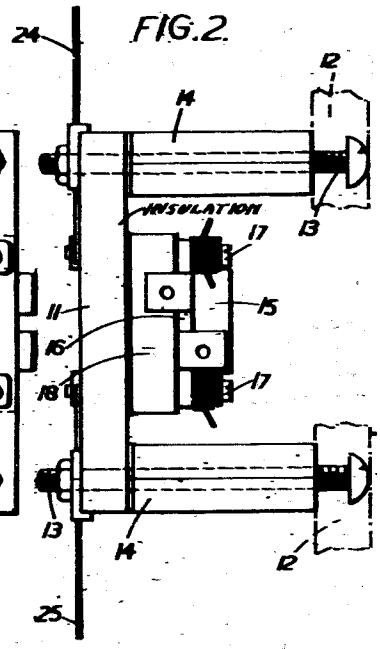


FIG. 4.

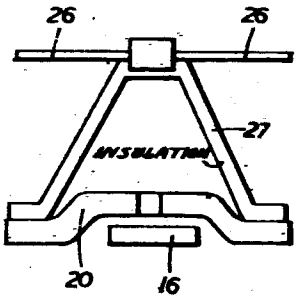
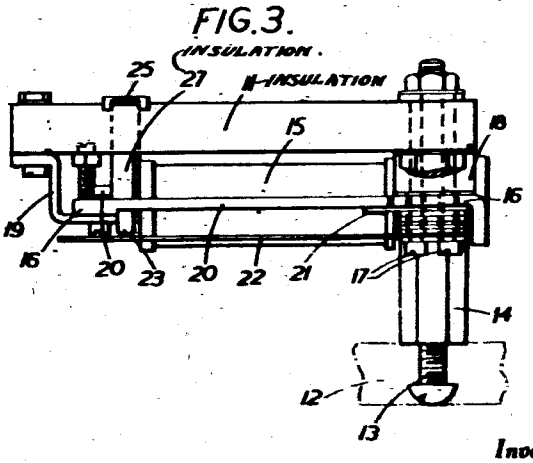


FIG. 3.



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ELECTROMAGNETIC RELAY

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12 Claims. (Cl. 200—87)

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This invention relates to electromagnetic relays, and more particularly to relays used in radio-frequency circuits especially at higher frequencies (above 100 mc.). For example, in certain radio-signalling systems, two relays are used on each installation, one having a "make" contact, and the other a "break" contact, adjusted so as to give a closely controlled interval (e. g. 2 to 6 milliseconds) between the functioning of their contacts on both operation and release. Such relays are provided to make or break connection between the dipoles of reflector antennae used in radio-navigation systems. The requirements are that they should have low capacitance between contacts and from contacts to frame, a straight path between dipoles, and that they should be capable of close adjustment for time of operation and release. They are also required to be stable over a wide range of temperature and climatic variation and have a useful life of several millions of operations at a rate of one per second continuously.

The several features and the scope of the invention will more clearly appear from the following description and the appended claims.

The invention will be described with reference to the accompanying drawing in which:

Fig. 1 is a plan view of a relay in accordance with the invention;

Fig. 2 is a view of that end of the relay which appears on the right of Fig. 1;

Fig. 3 is a view of that side of the relay which appears at the bottom of Fig. 1; and

Fig. 4 is a view of a detail.

The main supporting structure of the relay is in the form of a hollow or ring-like rectangular base-frame 11 which is of insulating material such as ebonite, but preferably of ceramic or moulded material. This frame 11 is itself mounted upon a panel or other member 12 by means of two bolts 13 and spacers 14. The operating magnet 15 includes a core 16 which has an enlargement or cross-piece formed at its right-hand or rear end for attachment by means of screws 17 and spacer 18 to the overlying portion of the frame 11. At the left-hand or front end the core is supported for additional rigidity on the frame 11 through the intermediary of a bracket 19. The armature 20 is U-shaped, with its legs straddling the magnet and hinged to the core at the rear

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end by flat springs 21. Flat springs 22 are engaged by studs 23 depending from the underside of the armature, and serve to hold the armature in its unoperated or released position when the magnet is not energised.

The relay contacts which are to open or close the circuit under control consist of two fixed contacts spaced apart and a bridge between them which is displaceable by the armature. In the embodiment now being described, the contacts are "normally closed," i. e. the circuit is broken when the magnet is energised. As shown the fixed contacts are mounted upon the inner extremities of spring strips 24 and 25 which are fixed in line with one another on opposite sides of the frame 11. Cooperating with these fixed contacts are moving contacts which are mounted upon a spring strip 26 which bridges the gap between the two fixed strips and is mounted on the top of an insulating bracket 27 itself fixed upon the armature.

The features and advantages of this arrangement will now be described.

The use of an open or ring-shaped frame 11 of considerable thickness, which may be made either of ceramic or synthetic moulded material, ensures a high degree of mechanical rigidity and stability, while allowing the amount of dielectric material between springs to be reduced to a minimum. If the frame is sufficiently thick, and the core is rigid in itself, the frame may be of a U-shape instead of being ring-shaped. Paths for possible stray capacities, which normally contribute an appreciable proportion of the inter-electrode capacitance, are also considerably lengthened.

The wide spacing (about ¾") of the contact members 24, 25 and 26 from the main relay frame (coil 15 and armature 20), their disposition at right angles to the main axis, and the design of the bracket 27 supporting the centre spring (see Fig. 4), reduce the capacitance between contacts and the relay frame.

The end-to-end arrangement of contact springs 24, 26, 25 greatly reduces the capacitance between them, and places it at the centre-point of the reflector, which greatly facilitates the accurate lining-up of the antenna array.

The feature of using two contact openings in series is specially important as giving very low

capacitance between contacts when open, by halving the capacitance between adjacent springs, and greatly reducing the effect of capacitance between the moving spring and the main relay frame.

Rigid attachment of the moving spring 26 to the armature assembly 20 eliminates the friction which exists between the armature and "lever" spring on relays of normal construction, and which is a common source of instability and early failure.

There is a sharper change in capacitance when the contacts open as compared with a single opening. This is important with very high frequencies in ensuring clean keying.

Another feature of interest concerns the attachment of the contact springs without the use of screws or rivets. One of the commonest causes of instability under conditions of vibration or wide variations of temperature and humidity is the loosening of screws, nuts and rivets. Two methods of overcoming this have been tried, and found satisfactory. The spring support may be made from ceramic material, and a film of metal (such as silver or platinum) deposited on it at the point of attachment, either with or without local glazing of the ceramic. The contact springs can then be soldered to the metallic deposit, using a non-corrosive flux. It has been found beneficial to provide a thin metal cap fitting over the contact springs and formed over the support, and soldered to them, thus providing soldered surfaces in which the strain on the metal film is perpendicular to that imposed by the flexing of the contact spring itself when the relay operates. A similar technique has been applied for attaching the support of the centre spring to the armature.

Alternatively the spring support may be in the form of a high grade synthetic moulding, the springs being attached by fitting over them a suitably shaped cap of similar material secured to the support and keyed to the spring itself by a suitable cement. Such caps are shown at 28, 29 and 30 in the drawing. Although ceramic is believed to be more stable than synthetic moulding, assembly may be easier using cemented mouldings: in either case a reduction in the amount of metal associated with the contact springs assists in reducing stray capacitance.

It has been found that timing requirements can be met without difficulty, and are maintained within permissible limits over a relatively wide range of keying current and applied voltage. Operating time can be controlled by variation of the pressure of the restoring springs 22 and such adjustment does not appreciably affect the release time. The latter has been found substantially independent of adjustment variations, and the required timing difference on release has been obtained by applying a non-inductive shunt to one of the relays (the "break"), which may be of sufficiently high resistance not to affect the operating timing. It is therefore possible to adjust operate and release timing independently of each other which facilitates maintenance.

What is claimed is:

1. An electromagnetic relay comprising a frame of insulating material defining a hollow space, an electromagnetic coil supported in spaced relation to said frame with its axis extending across said hollow space defined by said frame, an armature supported in operative relation to said electromagnetic coil and in spaced relation to said frame, a pair of contact members supported on

opposite sides of said frame across said hollow space with their contact surfaces positioned inwardly of said hollow space in spaced relation to said frame and in spaced relation to each other, said contact members also being supported in spaced relation to said coil and its armature, whereby a low capacitance is maintained between said contact members themselves and between said contact members on the one hand and said coil and its armature on the other hand, and a bridging contact member carried by said armature in spaced relation thereto and positioned so as to bridge the gap between said spaced contact surfaces of said pair of contact members and to make and break contact therewith upon repeated operation of said armature by said electromagnetic coil.

2. An electromagnetic relay comprising a frame of insulating material defining a hollow space open at opposite ends thereof, an electromagnetic coil supported with its axis extending centrally across said hollow space transversely of the direction from one open end of said space toward the other, an armature supported so as to be positioned adjacent said coil axis and in operative relation to said coil, a pair of contact members supported on opposite sides of said frame across said hollow space in spaced relation to each other and in spaced relation to said coil and its armature so as to maintain a low capacitance between said pair of contact members themselves and between said contact members on the one hand and said coil and its armature on the other hand, and a bridging contact member carried by said armature in spaced relation thereto and positioned so as to bridge the gap between said pair of contact members and to make and break contact therewith upon repeated operation of said armature by said electromagnetic coil.

3. An electromagnetic relay comprising a frame of insulating material extending about a hollow space open at opposite ends thereof, an electromagnet having a core and a coil wound about said core, said magnet being supported at an end thereof upon one side of said frame with the axis of said core extending from said side of the frame centrally across said hollow space in a plane which is transverse to the direction from one of said opposite open ends of said hollow space toward the other, an armature supported upon said frame adjacent said magnet core in operative relation thereto so as to move transversely of said plane, a pair of elongated contact members mounted on opposite sides of said frame across said hollow space in spaced relation to each other and extending toward each other transversely of the axis of said core to provide a low capacitance therebetween, said contacts being supported in spaced relation to said electromagnet and its armature to maintain a low capacitance between said contact members on the one hand and said electromagnet and its armature on the other hand, and a bridging contact member carried by said armature in spaced relation thereto and positioned so as to bridge the gap between said pair of elongated contact members and to make and break contact therewith upon repeated operation of said armature concomitantly with energization and de-energization of said electromagnet.

4. An electromagnetic relay as defined in claim 3 which comprises means to bias said bridging contact to bridging position with respect to said pair of contact members, said electromagnet and

its armature being constructed to open said contacts against said bias means upon energization of said electromagnet.

5. An electromagnetic relay comprising a frame of insulating material extending about a rectangular hollow space open at opposite faces of said frame, an electromagnet having a core supported at its ends upon opposite sides of the rectangle of said frame so as to extend centrally across said rectangular space generally parallel to the faces of said frame, a magnetizing coil wound about said core, a U shaped member carrying an armature for cooperation with said core and hingedly supported on one of said opposite sides of said frame so as to straddle said coil substantially in the plane of the axis thereof to provide movement of said armature in the direction transversely of said faces of said frame, two contact strips respectively attached to the other opposite sides of said rectangular frame and extending inwardly across said hollow space with their contact surfaces positioned in spaced relation to said frame, said strips being positioned in line with each other on a line extending transversely of the axis of said coil with their contact surfaces in spaced relation to one another to provide a low capacitance between said strips, said contact strips also being spaced from said electromagnet and said armature to provide a low capacitance between said strips on the one hand and said coil and said armature on the other hand, and a bridging contact strip carried by said armature in spaced relation thereto and positioned so as to bridge the gap between said two contact strips and to make and break contact therewith upon hinging movement of said U shaped member effected by said electromagnet.

6. An electromagnetic relay comprising a frame of insulating material extending about a hollow space open at opposite ends thereof, an electromagnet having a core supported on said frame so as to extend centrally across said hollow space transversely of the direction from one open end of said space toward the other, a magnetizing coil wound about said core, a pair of contact strips mounted at points on said frame oppositely positioned across said hollow space and with their ends spaced from each other and extending toward each other in a line transverse to the axis of said core, an armature associated with said electromagnet, a hinging flat spring rigidly connected adjacent its ends respectively to said armature and to said frame to provide hinging movement of said armature about an axis parallel to said line of said pair of contact strips upon energization and de-energization of said electromagnet, and a bridging contact strip carried by said hinging flat spring in position to bridge the gap between the ends of said spaced contact strips to make and break contact therewith upon hinging movement of said armature upon said flat spring, said bridging contact being mounted on said armature in spaced relation thereto so as to provide a low capacitance between said two contact strips and said bridging contact strip on the one hand and said electromagnet and said armature and its support on the other hand.

7. An electromagnetic relay comprising a frame of insulating material defining an open-ended hollow space, a magnet supported at an end thereof upon one side of said frame with the axis of the magnet extending toward the opposite side of the hollow space defined by said frame and offset laterally with respect to said frame in the direction from one open end of said hollow space toward the other, an armature pivotally supported on said frame adjacent said supported end of said magnet for movement to and fro relative to the other end of said magnet in said direction laterally with respect to said frame, a pair of contact members respectively mounted on opposite sides of said frame with their contact surfaces positioned inwardly of said hollow space in spaced relation to said frame and on a line extending across the hollow space defined by said frame transversely to the axis of said magnet, said contacts being spaced from said magnet and its armature to maintain a low capacitance between said contacts on the one hand and said magnet and its armature on the other hand, said contact members forming a gap therebetween, and a bridging contact member carried by said armature so as to make contact with the contact surfaces of said pair of contact members upon operation of said armature and to bridge the gap therebetween, said bridging contact member being carried by said armature in spaced relation thereto so as to maintain a low capacitance between said bridging contact member and said armature.

8. In an electrical relay, in combination, a frame of insulating material defining a hollow space open at opposite ends thereof, a pair of elongated contact members supported with their lengths in alignment with each other on opposite sides of said frame across said hollow space with the contact surfaces thereof positioned inwardly of said hollow space in spaced relation to said frame and in spaced relation to each other to provide a low capacitance therebetween, a bridging contact supported in spaced relation to said frame and for movement into and out of bridging contact with said spaced contact surfaces of said pair of contact members in the direction from one of said opposite open ends of said hollow space toward the other, and electrically energized means for effecting said movement of said bridging contact, said means being positioned in spaced relation to said bridging contact and to said pair of contact members in said direction from one of said open ends of said hollow space toward the other so as to maintain a low capacitance between said bridging contact and said contact members on the one hand and said means for effecting movement of said bridging contact on the other hand.

9. An electromagnetic relay for controlling currents of radio frequency comprising a frame of insulating material defining an open-ended hollow space, mounting means for supporting said frame in spaced relation to a supporting surface, an electromagnet supported with the axis of said magnet extending centrally across said hollow space and in spaced relation to said frame between said frame and said supporting surface, an armature mounted in operative relation to said magnet in spaced relation to said frame, a pair of contact members supported on said frame in spaced relation to each other with their contact ends extending toward one another across the hollow space defined by said frame transversely of the axis of said magnet, and a bridging contact member supported in spaced relation to said armature and said magnet for movement into and out of engagement with said spaced contact members upon energization and de-energization of said magnet.

10. The relay as set forth in claim 1, in which said frame is of ceramic material, and the relay

includes metallic deposits on the frame to which said contacts are soldered.

11. The relay as set forth in claim 1, in which said frame is of ceramic material having metallic deposits adjacent the contacts, and the relay includes a metal cap fitted over and soldered to each contact and to the adjacent metallic deposit.

12. The relay as set forth in claim 1, in which said frame is of synthetic moulded material, and the relay includes a cap of said material fitted over and cemented to each contact and the frame.

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