June 21, 1932. F. G. CREED ET AL 1,864,296

ELECTROMAGNETIC SWITCH

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Fig. 1.

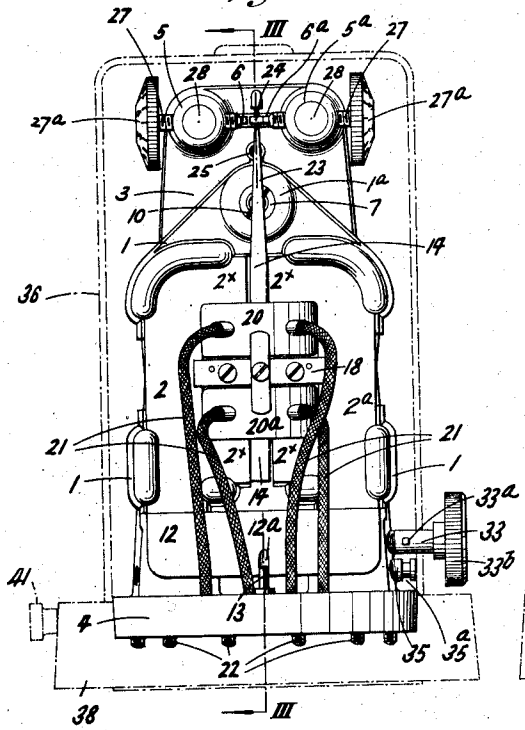


Fig. 2.

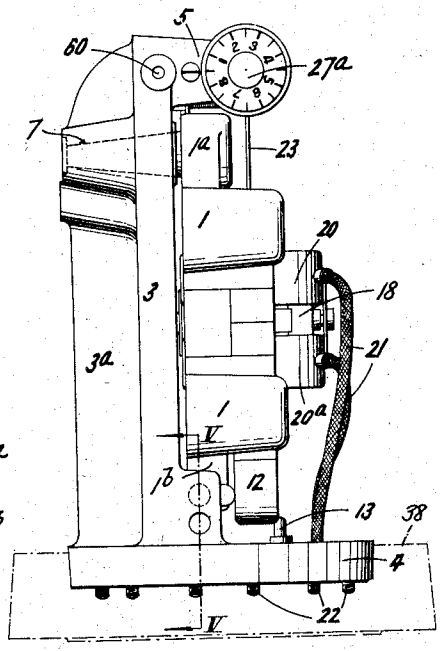


Fig. 4.

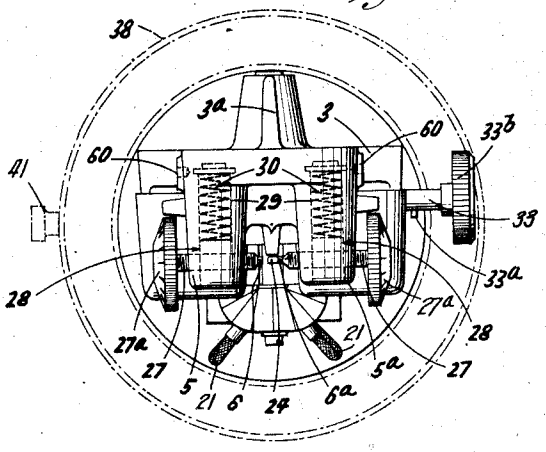
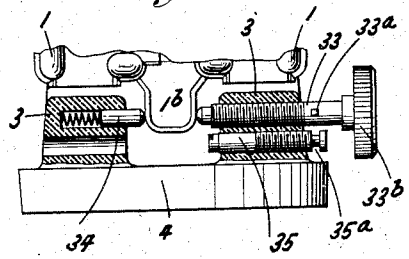


Fig. 5.



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June 21, 1932. F. G. CREED ET AL 1,864,296

ELECTROMAGNETIC SWITCH

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Fig. 3.

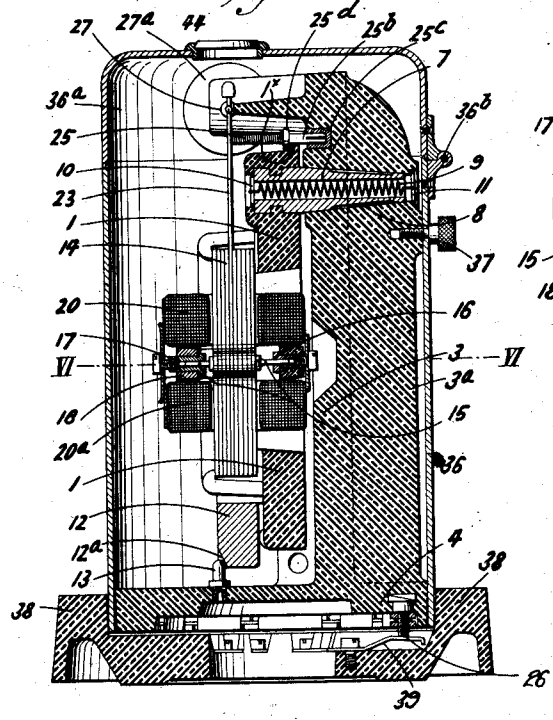


Fig. 6.

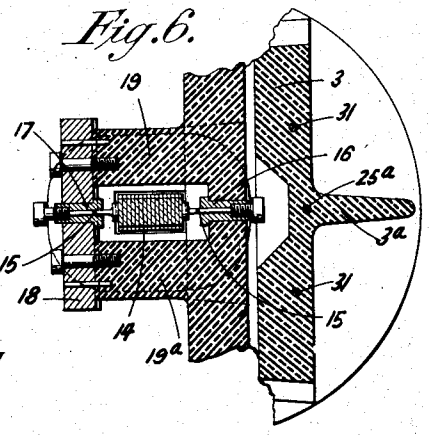


Fig. 7.

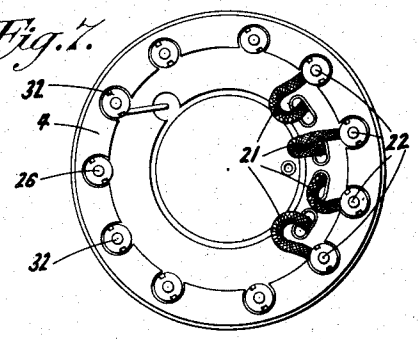


Fig. 19.

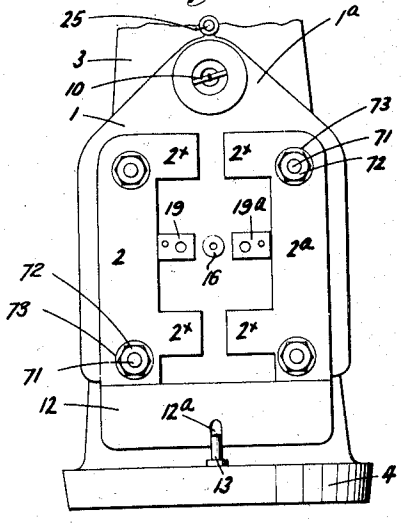
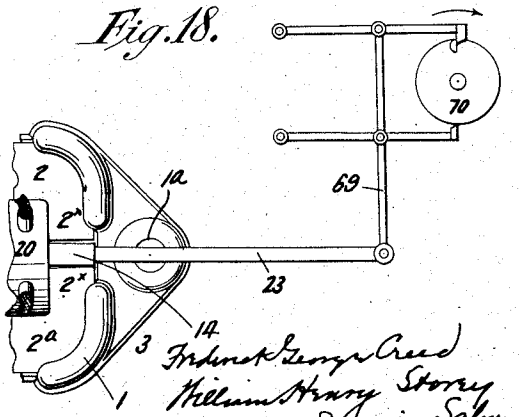


Fig. 18.



Inventors: Frederick George Creed, William Henry Storey, Reginald Dennis Salmon

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June 21, 1932. F. G. CREED ET AL 1,864,296

ELECTROMAGNETIC SWITCH

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Fig. 8.

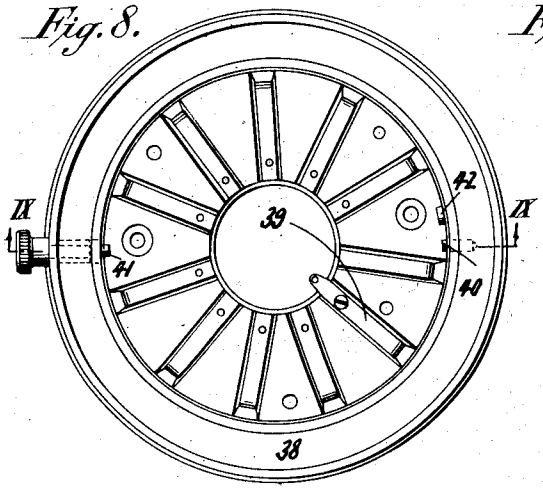


Fig. 9.

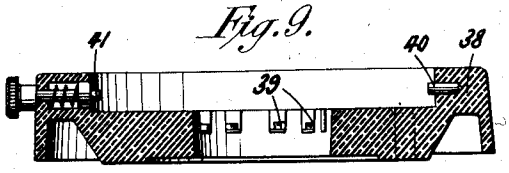


Fig. 10.

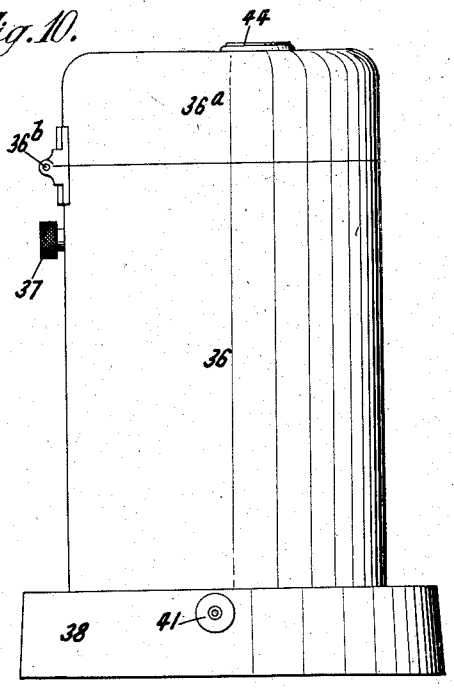


Fig. 15.

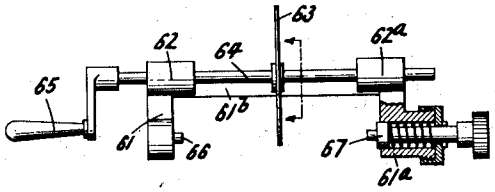


Fig. 16.

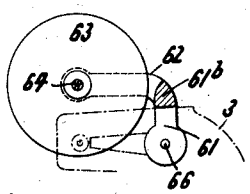


Fig. 17.

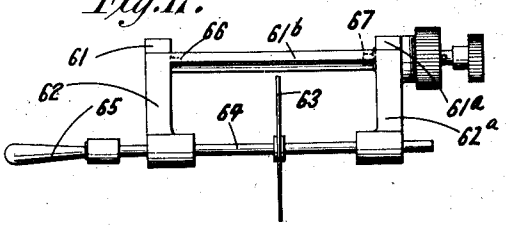
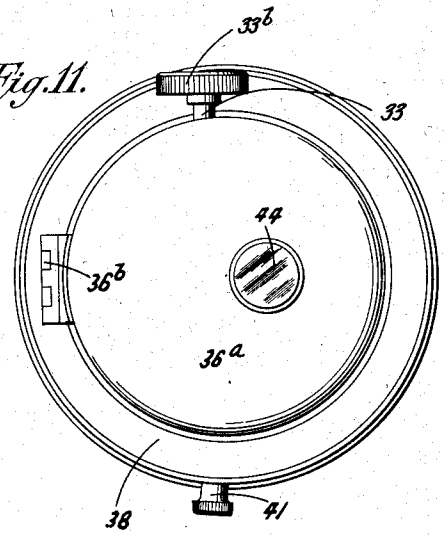


Fig. 11.



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ELECTROMAGNETIC SWITCH

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Fig. 12.

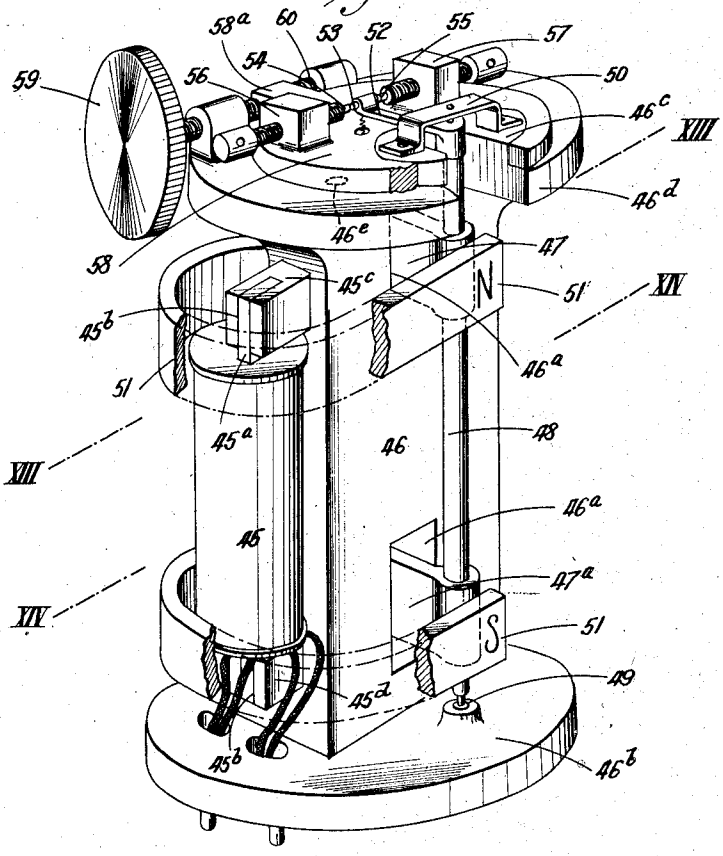


Fig. 13.

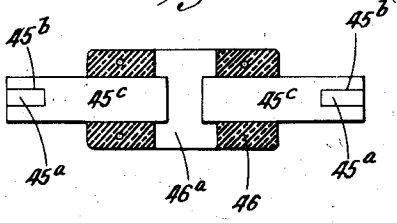
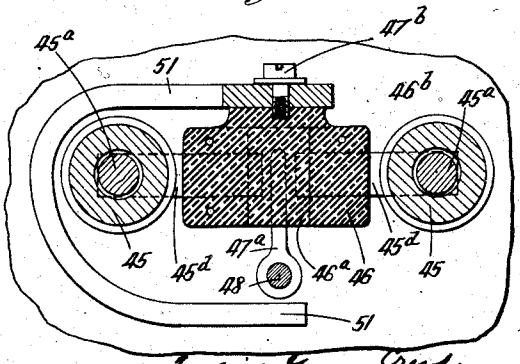


Fig. 14.



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Patented June 21, 1932

1,864,296

UNITED STATES PATENT OFFICE

FREDERICK GEORGE CREED, WILLIAM HENRY STOREY, AND REGINALD DENNIS SALMON, OF CROYDON, ENGLAND, ASSIGNORS TO CREED & COMPANY LIMITED, A COMPANY OF GREAT BRITAIN

ELECTROMAGNETIC SWITCH

Application filed December 5, 1927, Serial No. 237,921, and in Great Britain September 8, 1927.

This invention has reference to improvements in electro-magnetic apparatus of the kind adapted for use as a relay, switch, motor or like device (hereinafter referred to for brevity as a relay) in which one or more armatures is or are mounted to oscillate in relation to an electro-magnetic system comprising one or more magnetic pole pieces and one or more windings subject to the action of electric currents or impulses.

The invention has for its object to ensure that those portions of such a relay which are ordinarily required to be fixed in relation to each other, as for instance, the magnetic pole piece or pieces, a bearing, or one at least of the bearings, for the armature or armatures associated therewith, and a pivot whereby the associated pole piece or pieces and armature bearing or bearings can be adjusted in relation to separate supporting means, shall be maintained in rigid and unalterable relationship to each other.

It also has for its object, in the case of an electric relay in which the armature is provided with a contact adapted to oscillate between normally stationary but adjustable contacts carried by separate supporting means, to enable the electro-magnetic system to be readily and accurately adjusted in relation to the armature whilst the armature contact is bearing against one or other of its associated stationary contacts, in order to vary the bias of the armature.

It also has for its object to enable the normally stationary but adjustable contacts to become automatically clamped in position after adjustment.

It also has for its object to enable the electrical connections to the movable and normally stationary contacts to be maintained in rigid and unalterable relationship to the stationary contacts and to supporting means carrying such stationary contacts.

It also has for its object to enable a permanent magnet used to polarize the pole piece or pieces formed of soft iron to be readily removed and replaced but in such manner that it cannot be replaced with its poles in a wrong position in relation to the pole pieces.

It also has for its object to simplify and cheapen the construction of relays of the kind referred to, to admit of easy adjustment of parts thereof without the aid of tools such as screw-drivers, spanners and the like, and to enable them to be maintained in good working order without the aid of a skilled mechanic.

For attaining the first mentioned object, a portion of electro-magnetic apparatus of the kind herein referred to, which is required to be in adjustable relationship to the remainder of the apparatus, is, broadly considered, formed as a unit embodying a carrier or casing of insulating material, which is provided with a pivot pin or like device that is fixed in relation thereto by being moulded in or formed integrally with the carrier or casing. More specifically considered, the portion of the electro-magnetic apparatus which is required to be in adjustable relationship to the remainder of the apparatus, is formed as a unit by having moulded around it, or partly around it, a carrier or casing of insulating material provided with a pivot pin or like device that is fixed in relation thereto by being moulded therein or formed integrally therewith. The portion of the apparatus in relation to which the said unit is adjustably mounted, is provided with a bearing for the pivot or like device. The moulding material used for the carrier or casing may be of a kind that can be softened or melted by heat and becomes hard and rigid at normal temperatures and cannot afterwards be softened or melted by heat. Moulding materials suitable for the purpose mentioned, are well known, such for instance as phenolic condensation products. The moulding material which it is at present preferred to use, is material of the kind known under the trade name of "Mouldensite." The other above mentioned objects of the invention are attained in a manner that will hereinafter be explained with the aid of the accompanying drawings.

The invention is applicable generally to various constructions of electric relay of the type herein referred to. Thus, it may advantageously be applied in connection with electric relays of the kind in which an arma-

ture is mounted to oscillate in the gaps formed between the pairs of poles of two oppositely arranged [shaped pole pieces formed of magnetic material, in which the said poles are constantly and oppositely polarized by a permanent magnet placed in contact with them, and in which the armature winding is placed within the rectangularly shaped opening formed between the two pole pieces and surrounds the armature one end of which is provided with an extended portion or tongue that may be provided with a contact arranged to oscillate between two stationary but adjustable contacts, when the relay is to be used as a switch for closing and opening electric circuits, or is adapted to actuate some mechanical device when the relay is to be used as a power relay or motor.

The invention may also advantageously be applied in connection with a relay of the kind well known as the British Post Office standard relay, which comprises two complete electromagnets, double wound on the differential principle and so connected and arranged that when a current is passed through their windings their opposite poles are adjacent to one another, a vertical spindle carrying two soft iron tongues or armatures arranged to oscillate in the gaps between the two pairs of opposite poles, a fixed permanent magnet for polarizing the said tongues or armatures and a third tongue fixed to the said spindle and carrying a movable contact arranged to oscillate between two stationary but adjustable contacts.

In order that the manner of carrying the invention into practice for attaining the objects hereinbefore set forth, the same will now be further described with the aid of the accompanying illustrative drawings.

In these drawings, Fig. 1 is a front elevation showing one construction of electro-magnetic apparatus of the general type hereinbefore referred to, embodying the invention, and suitable for use as an electric relay or switch. Fig. 2 is a side elevation of such apparatus. Fig. 3 is a section on the line III—III of Fig. 1. Fig. 4 is a plan of the apparatus shown in Fig. 1. Fig. 5 is a section on the line V—V of Fig. 2, Fig. 6 is a section on line VI—VI of Fig. 3, Fig. 7 is an underside view of Fig. 2. Fig. 8 is a plan of a base piece used with such apparatus, and Fig. 9 is a section thereof on the line IX—IX of Fig. 8. Figs. 10 and 11 show respectively in elevation and plan, a casing enclosing apparatus according to the invention and mounted in a base piece. Fig. 12 is a perspective view showing a relay of the kind known as the British Post Office standard relay but modified to embody the present invention. Figs. 13 and 14 are horizontal sections thereof taken on the lines XIII—XIII and XIV—XIV respectively of Fig. 12. Fig. 15 shows partly in front elevation and partly in longitudinal section, Fig. 16 partly in end elevation and part in cross section, and Fig. 17 in plan, a device that can be applied to the apparatus when the same is constructed for use as an electric relay, for cleaning the contacts of the apparatus. Fig. 18 shows in plan, how the relay shown in Figs. 1 to 7 inclusive, can be modified for use as a motor. Fig. 19 shows in front view, a modified construction of the relay shown in Figs. 1 to 7 inclusive.

In the example shown in Figs. 1 to 11 inclusive of the drawings, 1 is a plate of insulating material, of the kind hereinbefore described, in which the two [shaped pole pieces 2 and 2^a are permanently fixed by moulding them therein. It is arranged vertically and pivoted at its upper end 1^a to the front side of a vertical support 3 that is carried by a circular base piece 4. This support is provided at its upper end portion with a pair of forwardly extending bosses 5, 5^a that are moulded in one piece with the support and are arranged with their axes in a common horizontal plane for carrying the stationary but adjustable contacts 6, 6^a. The pivoting of the plate 1 to the support 3 is effected by a hollow conical metal pin 7 one end portion of which is permanently fixed in the said plate 1 by moulding it therein and the other end portion of which is fitted in a companion bearing 8 in the vertical support 3. The plate 1 and support 3 are firmly and closely held together, but so as to allow of movement of the plate 1 in its own plane, by spring means, conveniently by the aid of a coiled spring 9 extending through the conical pin 7 and attached at one end to a transverse pin 10 carried by the pin 7, or by the adjacent portion of the plate 1, and at the other end to another transverse pin 11 carried by the rear end of the bearing, or adjacent portion of the support 3. By this means any wear of the pin 7 or bearing 8, will automatically be taken up. The plate 1 with its pivot pin 7 are detachable from the support, when this may become necessary or desirable. The two pole pieces 2 and 2^a are permanently magnetized by a permanent bar magnet 12 adapted to be inserted endways between the lower ends of the pole pieces 2 and 2^a and the base piece 4 of the support and to be held magnetically against the lower ends of the pole pieces. Means are provided to ensure that the permanent magnet shall be inserted in place with its north and south poles in proper position relatively to the pole pieces. For this purpose, a pin 13 for example, fixed in the base piece 4, may be arranged to fit into a notch 12^a, formed in the lower front edge of the permanent magnet 12, only when the said edge is at the front, when putting the magnet in place, the said notch being formed in the correct edge, relatively

to the north and south poles of the said magnet.

The armature 14, arranged to extend vertically through the two gaps between the two pairs of magnetic poles formed by the inturned ends 2^x of the pole pieces 2 and 2^a, is provided with a horizontal spindle 15 (Figs. 3 and 6) mounted in two bearings 16, 17 consisting of tubes, one of which, namely 16, is fixed in the insulated plate 1 by moulding it therein and the other 17 is carried by a metal cross piece 18 secured to the outer ends of two horizontal supports 19 and 19^a arranged in the same horizontal plane and at the opposite sides of the spindle and midway of the height of the rectangular space between the pole pieces 2 and 2^a. Such supports 19 and 19^a are also moulded in one piece with the insulating plate 1.

The energizing windings 20 and 20^a for the armature 14, are arranged to extend into the said rectangular space between the pole pieces 2 and 2^a, and above and below the two horizontal supports 19 and 19^a, therein and so as to surround the armature 14. Conductors 21 from the ends of each winding extend downward through the base piece 4 of the support and are connected to terminals 22 fixed in the bottom thereof (Fig. 7).

A tongue 23 extending upwardly from the armature 14, carries a movable contact 24 arranged between the two stationary but adjustable contacts 6, 6^a carried by the aforesaid pair of bosses 5, 5^a on the insulating support 3. The tongue 23 should be made as light as possible to reduce its amount of inertia. For this purpose, it may advantageously be made, as shown, of tapering shape outwardly to its free end which may almost be a point and to which the movable contact 24, also made very light, is attached. The movable contact 24 is connected by means of a flexible connection 25, in the form of a coiled spring, to a conductor 25^a extending downwardly through the support 3 (Fig. 6) to a terminal 26 in the bottom of the base piece 4. To enable the flexible connection 25 to be readily disconnected from the conductor 25^a when the plate 1 and associated parts are removed from the support 3, one end of the flexible connection is fixed to a plug 25^b adapted to fit into a socket 25^c mounted in the support 3, and connected to the conductor 25^a and the plug is provided with a collar 25^d against which a projection 1^x on the plate 1 will act to withdraw the plug automatically from the socket when the plate 1 is detached from the support 3. Each of the stationary but adjustable contacts 6, 6^a is carried by a horizontal screw 27 that is screwed transversely through an endways movable metal pin 28 fitted to slide in a hole 29 in the corresponding boss 5 or 5^a, the pin 28 being acted upon by a coiled spring 30 within the boss, in a direction to press the screw 27 firmly against the surface of the hole in the boss through which it extends, so as to hold the screw firmly in its adjusted position. This arrangement constitutes an automatic clamping device for the adjusting screw 27. Thus, when the contacts have been set, they cannot accidentally become unset, as they would be liable to do if a separate clamping device were used, and such device was left in its unclamped position, due to forgetfulness on the part of the operator. Further, the risk of the adjustment becoming unset during the clamping operation is avoided. The arrangement described also avoids the use of a tommy bar, or a screw driver, for adjusting purposes. The heads 27^a of the adjusting screws 27 are preferably, and as shown, of large diameter, and milled and may advantageously be provided with index lines to facilitate accurate adjustment of the contacts. Each of the springs 30 referred to, is connected to conductor 31 that extends downward through the support 3 (Fig. 6) to a terminal 32 in the base 4 of the support. The conductors 25^a and 31 are fixed in the support 3 by moulding them therein. The support 3 may, as shown, be stiffened by a vertical rib 3^a at the back thereof and integral therewith.

To adjust the position of the pole pieces 2 and 2^a relatively to the armature 14, the lower end of the insulating plate 1 carrying the pole pieces, is provided with an extension 1^b (Fig. 5) against one side of which bears the inner end of a horizontal bias adjusting screw 33 that is screwed through the lower portion of the support 3, the other side of the extension being acted upon by a spring pressed pin 34. To limit the turning movement of the adjusting screw 33 in each direction, the screw is provided beyond the support with a lateral projection 33^a, and arranged near to and parallel with the screw extension and fixed to the support, is a pin 35 formed with an annular recess 35^a. The arrangement is such that the groove 35^a in the pin 35 will allow the screw 33 to be rotated in each direction, to an extent limited by the projection 33^a abutting against one or other side of the groove 35^a in the pin 35. This prevents an operator turning the bias adjusting screw 33 too far in either direction and thereby possibly straining the armature, or in any other way damaging the relay. Also, by turning the said screw 33 to the middle position of its travel and then adjusting the contact screws 6, 6^a to correspond, the relay can be brought to its correct adjustment in the shortest possible time. To facilitate accurate adjustment, the head 33^b of the bias adjusting screw 33 may be provided with index lines and arrows. The middle portion of the travel of the bias adjusting screw may be visibly depicted by means of an arrow on the screw head and a zero mark on the sup-

port 3, base 4 or other fixed part of the apparatus.

The support 3 with base 4 is provided with a removable cylindrical metal or other opaque casing 36 that surrounds it and the parts carried thereby, except the head 33^b of the bias adjusting screw 33. This casing can be fixed to the support 3 by a set screw 37 (Fig. 3). The combined support, with attached parts, including the casing, is adapted to be inserted in a recessed base piece 38 (Figs. 8 to 11) provided, in known manner, with a number of spring contacts 39 arranged to bear against the aforesaid terminals in the bottom of the base 4 of the support 3. Suitable line wires and other conductors corresponding to the parts of the relay to which connections have to be made, are permanently connected, as by soldering, to the spring contacts in the base piece 38, as heretofore. The said recessed base piece 38 is provided with means, as for instance, a fixed pin 40 and a spring pin 41, adapted to co-act with holes in the said casing 36 so as to lock the two parts together. A projection 42 on the recessed base 38, co-acts with a slot in the casing 36 in such manner that the casing and base piece can only be connected together when the various terminals on the base piece 4 are in proper register with the spring contacts 39 with which they are to co-operate.

To enable sparking between the associated movable and stationary contacts 6, 6^a and 24 of apparatus of the kind referred to, to be readily observed, the top of the casing 36 is provided with a glass window or lens 44 that is located over the contacts and made of small dimensions so as to keep the interior of the casing dark and render any sparking that may take place between the contacts more readily discernible.

The upper portion 36^a of the casing 36 is made separate from the lower portion and either hinged thereto, as indicated at 36^b, or be made entirely detachable therefrom, so that in either case, ready access can be gained to the contacts, without having, for that purpose, to remove the whole casing from the apparatus.

By the construction described, the whole of the apparatus, except the armature and associated contacts, is insulated and safe to handle, whatever voltage may be used.

In the modified construction of Post Office standard relay shown in Figs. 12, 13 and 14, the soft iron cores 45^a of two vertical electromagnets 45 are each detachably connected at its upper and lower ends by knife joints 45^b to soft iron pole pieces 45^c and 45^d that are moulded in a vertical carrier 46 formed of insulating material of the character hereinbefore described. The vertical polar faces of each pair of pole pieces 45^c and 45^d are spaced apart to form between them a gap into which extends one of the two soft iron tongues or armatures 47, 47^a. The two tongues or armatures extend through holes 46^a in the carrier 46 and are fixed to a vertical spindle 48 the lower end of which is pivoted in a metal bearing 49 moulded in the base 46^b of the carrier 46. By the construction described the pole pieces 45^c and 45^d and armature spindle bearing 49 are fixed in rigid and unalterable relationship to one another. The upper end of the armature spindle 48 is journalled in a removable bearing 50 secured to an extension 46^c moulded in one piece with the head 46^d of the carrier 46 which as well as the base 46^b, is integral with the vertical portion of the said carrier. 51 is a bent permanent magnet detachably secured to the carrier 46, as by a screw 51^x, and the polar ends N and S of which terminate in close proximity to the armatures 47, 47^a respectively, so as to polarize them. When the permanent magnet is detached from the carrier 46, the electro-magnets 45, 45^a can each be connected to its upper and lower fixed pole pieces 45^c and 45^d, or be detached therefrom if desired. To the armature spindle 48 is fixed a tongue 52 carrying a movable contact 53 arranged to oscillate between normally stationary contacts 54 and 55. These contacts are endways adjustable in bosses 56 and 57 respectively of insulating material made integral with a flat horizontal plate like support 58 formed of insulating material of the character hereinbefore mentioned. Each contact 54 and 55 may be acted upon by a self-acting clamping device, as in the relay shown in Figs. 1 to 6 inclusive and be in electrical connection with conductors extending downward through holes 46^e in the carrier 46 to contacts fixed to the bottom of the base 46^b. The movable contact 53 may be connected through a flexible connection to a similarly arranged conductor.

To enable the bias of the armatures 47, 47^a in relation to the polar faces of the pole pieces 45^c, 45^d to be capable of accurate adjustment, the upward extension 46^c of the head 46^d of the carrier 46 is made of circular shape and the plate-like support 58 is arranged to fit it closely and is provided with an extension 58^a adapted to be acted upon on one side by a bias adjusting screw 59 and on the other side by a spring 60. Means such as those used in the relay shown in Figs. 1 to 7 inclusive, are or may be provided to regulate the extent of turning of the bias adjusting screw 59 in each direction.

This modified relay can be enclosed in a casing of opaque material having a spark inspection window, like that shown in Figs. 1, 3, 10 and 11.

To enable the faces of the stationary but adjustable contacts 6, 6^a and movable contact 24 of the relay shown in Figs. 1 to 11 inclusive, to be easily and effectively cleaned, when this may become necessary, the opposite sides of the upper portion of the support 3 are

formed with aligned holes 60 to admit of a contact cleaning device being pivotally attached thereto when desired. A cleaning device suitable for the purpose mentioned, is shown in Figs. 15, 16 and 17 and comprises a frame consisting of side members 61 and 61ª connected by a longitudinal member 61ᵇ and two overhanging members 62 and 62ª, and a rotary disc 63 mounted to slide along but to rotate with a spindle 64 adapted to be rotated in the members 62 and 62ª by a crank handle 65. The side member 61 is provided with a fixed pin 66 adapted to pivot in one of the aligned holes 60 and the member 61ª is provided with an endways movable spring pin 67 adapted to pivot in the other aligned hole 60. The arrangement is such that the frame 61, 61ª, 61ᵇ can readily be pivoted to the support 3 and the disc 63 be inserted between the faces of the movable contact 24 and each of the adjustable contacts 6, 6ª and rotated in contact with each contact face to clean it. A similar contact cleaning device may be applied to the head 46ᵈ of the carrier 46 of the relay shown in Figs. 12, 13 and 14 for a like purpose.

When the electro-magnetic apparatus is to be used as a power relay or motor, the insulating plate 1, Figs. 1 to 7, carrying the pole pieces 2 and 2ª, armature 14, coils 20 and 20ª and associated parts, may, as shown in Fig. 18, be mounted on any suitable base or support 3, the electric contacts hereinbefore described as associated with the armature, be dispensed with, and the armature extension 23, be adapted, as shown, to mechanically actuate any desired device, as for instance a bar 69, for actuating or controlling an escapement device 70, ratchet wheel or other mechanism.

Instead of permanently fixing the laminated pole pieces 2, 2ª to the plate 1 of insulating material by moulding them therein, as hereinbefore described with reference to Figs. 1 to 7 inclusive, they may be, as shown in Fig. 19, permanently fixed to the face of the plate by placing them over pins 71 that are permanently fixed in the plate and have their front ends provided with nuts 72 and washers 73 bearing against the outer sides of the pole pieces, so as to clamp the pole pieces permanently to the plate. The pins 71 may be metal pins permanently fixed in the plate. The inner bearing for the armature spindle 15 may be permanently fixed in the plate, as by screwing, or, it may be moulded in the plate when the plate is of insulating material of the kind heretofore referred to. The supports 19 and 19ª to carry the cross piece 18 for holding the outer bearing for the armature spindle, may be made integral with the plate, or be made separate and be permanently fixed to the plate. The arrangement is such that the pole pieces and the inner bearing for the armature spindle are fixed in permanent and unalterable relation to each other and to the plate.

What we claim is:—

1. An electro-magnetic apparatus comprising magnetic pole pieces arranged opposite each other and at a distance apart, an armature arranged to operate between said pole pieces, a spindle to which said armature is fixed, bearings for said spindle and a carrier of moulded insulating material carrying said pole pieces and one of the armature spindle bearings.

2. Electro-magnetic apparatus of the kind herein referred to, comprising two relatively adjustable portions carrying components of the apparatus, each formed of insulating material and one of which is provided with a pivotal projection moulded thereon and the other has a companion bearing moulded therein, and means carried partly by each of said portions, adapted to admit of one portion being positively adjusted in relation to the other.

3. In electro-magnetic apparatus of the kind herein referred to, a unit comprising oppositely arranged magnetic pole pieces, an armature mounted to oscillate between said pole pieces, a spindle fixed to said armature, bearings for said spindle, a carrier of moulded insulating material for said pole pieces and one of said bearings and a pivotal projection for the unit.

4. Electro-magnetic apparatus of the kind herein referred to, comprising two relatively adjustable units, co-acting pivotal members between said units, one of said units comprising oppositely arranged magnetic pole pieces, an armature mounted to oscillate between said pole pieces, a spindle fixed to said armature, bearings for said spindle and a carrier of moulded insulating material for said pole pieces, one of said bearings and one of said pivotal members.

5. Electro-magnetic apparatus of the kind herein referred to, comprising two relatively adjustable units, one of said units comprising a carrier of insulating material, oppositely arranged magnetic pole pieces moulded in said carrier, an armature mounted to oscillate between said pole pieces, an electric contact movable with said armature, a spindle fixed to said armature, bearings for said spindle, one of which is permanently fixed in said carrier, and a pivotal member in permanent fixed relationship to said carrier, the second unit comprising a carrier of insulating material provided with a pivotal member companion to that carried by the first mentioned unit, and stationary but adjustable contacts between which the contact movable with said armature can oscillate, and means for positively adjusting said units relatively to one another about the pivotal connection between them.

6. Electro-magnetic apparatus of the kind herein referred to, comprising movable and

stationary units, a pivotal connection between said units, and adjusting means whereby the movable unit can be positively moved in relation to said stationary unit, the movable unit comprising a carrier of insulating material, oppositely arranged magnetic pole pieces moulded in said carrier, an armature mounted to oscillate between said pole pieces, an electric contact carried by said armature, a spindle fixed to said armature, bearings for said spindle, one of which is permanently fixed in said carrier, and a pivot pin forming one member of said pivotal connection, permanently fixed to and projecting from said carrier, and the stationary unit comprising a carrier of insulating material formed with a bearing for said pivot pin, and fixed but adjustable contacts carried by said stationary unit and between which the contact carried by said armature can oscillate.

7. Electro-magnetic apparatus of the kind herein referred to, comprising two oppositely arranged [shaped pole pieces, a plate of insulating material in which said pole pieces are moulded and thereby permanently and unalterably fixed in relation to each other and to said plate, a permanent magnet for polarizing said pole pieces, a support to which said plate is pivotally connected so that it can move in its own plane, supports carried by said plate and extending through the space between said pole pieces, about midway of the length thereof, aligned bearings carried by said plate, one of which is moulded in said plate, a spindle mounted in said bearings, a laminated armature fixed to said spindle and extending through the gaps between the faces of the polar projections of said pole pieces, said armature having a laterally proecting arm, windings fixed within the space between the pole pieces and at opposite sides of the bearing supports therein and through which said armature extends and means whereby said plate with pole pieces and windings can be adjusted around its pivotal connection with said support relatively to said armature.

8. Electro-magnetic apparatus of the kind herein referred to, comprising a plate of insulating material, two oppositely arranged [shaped pole pieces moulded in said plate, a permanent magnet for polarizing said pole pieces, an armature mounted to oscillate between the polar faces of said pole pieces, a spindle fixed to said armature, bearings for said spindle one of which is moulded in said plate, armature windings carried by said plate, a trunnion moulded in said plate and extending from one side thereof and at right angles thereto, a support wherein said trunnion is mounted to turn, spring means acting constantly to press said trunnion endways in its bearing in said support, and means whereby said plate can be adjusted about the axis of said trunnion.

9. Electro-magnetic apparatus of the kind herein referred to, comprising a plate of insulating material, two oppositely arranged [shaped pole pieces moulded in said plate, a permanent magnet for polarizing said pole pieces, an armature and armature windings carried by said plate, a support to which said plate is pivotally connected, so that it can turn in its own plane, and means for adjusting said plate about its pivotal connection with said support, said adjusting means comprising a spring device adapted to act against said plate in one direction and an adjustable screw adapted to act against the plate in the opposite direction.

10. Electro-magnetic apparatus of the kind herein referred to, comprising a plate of insulating material, two oppositely arranged [shaped pole pieces moulded in said plate, a permanent magnet for magnetizing said pole pieces, an armature and armature windings carried by said plate, a support to which said plate is pivotally connected so that it can turn in its own plane, and means for adjusting said plate about its pivotal connection with said support, said adjusting means comprising a spring device carried by said support and adapted to act against said plate in one direction, an adjustable screw also carried by said support and adapted to act against the plate in the opposite direction and means for limiting rotation of said screw in each direction.

11. Electro-magnetic apparatus of the kind herein referred to, comprising two oppositely arranged [shaped pole pieces, a plate of insulating material wherein said pole pieces are moulded and thereby permanently fixed in position relatively to one another and to said plate, a support to which said plate is pivotally connected, a removable permanent magnet for magnetizing said pole pieces, and means for correctly positioning the poles of said magnet in relation to the respective pole pieces.

12. Electro-magnetic apparatus of the kind herein referred to, comprising two oppositely arranged [shaped pole pieces, a plate of insulating material wherein said pole pieces are moulded and thereby permanently and unalterably fixed in position in relation to each other and to said plate, a permanent magnet for magnetizing said pole pieces, a support to which said plate is pivotally connected so that it can move in its own plane, an armature arranged to extend through the gaps between the polar projections of said pole pieces and provided with an outwardly extending tongue, a spindle to which said armature is fixed, bearings for said spindle one of which is moulded in said plate, a movable contact carried by said tongue, armature windings fixed within the space between said pole pieces and surrounding said armature and ad-

justable contacts carried by said support and between which said movable contact can oscillate.

13. Electro-magnetic apparatus according to claim 12, wherein said support is formed of insulating material with two hollow extensions integral therewith for carrying the adjustable contacts, each such contact being carried by a screw extending transversely through holes in one of said hollow extensions and through a screw threaded hole in a spring pressed pin movable endways in the corresponding extensions, and each adjustable and movable contact being connected to a separate conductor extending through said support to a terminal at one end thereof.

14. Electro-magnetic apparatus according to claim 12, wherein the movable contact is connected by a flexible conductor to a metal plug fitting a metal socket fixed in the support and connected to a conductor extending through said support, said plug having a collar thereon and the pivoted plate having a part thereof adapted to co-act with said collar for the purpose set forth.

15. Electro-magnetic apparatus of the kind herein referred to comprising a vertical carrier having a base, head and upper circular trunnion all formed in one piece of insulating material that is capable of being softened or melted by heat and of becoming hard and rigid at normal temperatures, upper and lower pairs of oppositely arranged pole pieces moulded in the central portion of said carrier, two vertical electro-magnets each having its core detachably connected at its ends to one of the upper and lower pole pieces, armatures mounted to oscillate between the adjacent faces of the pairs of pole pieces, a spindle fixed to said armatures, a lower bearing for said spindle moulded in the base of said carrier and an upper bearing for the spindle carried by the said circular trunnion, a permanent magnet detachably fixed to said carrier and having its poles arranged in proximity to said armatures, a plate of insulating material journalled to said trunnion, stationary but adjustable contacts carried by said plate, a tongue fixed to said spindle, a contact carried by said tongue and arranged to oscillate between said stationary contacts and bias adjusting means adapted to turn said plate about said trunnion.

16. Electro-magnetic apparatus of the kind herein referred to, comprising a plate of insulating material, two oppositely arranged [shaped pole pieces permanently and unalterably fixed in position to said plate, a permanent magnet for polarizing said pole pieces, aligned bearings carried by said plate, a spindle mounted in said bearings, an armature fixed to said spindle and arranged to oscillate between the polar faces of said pole pieces and provided with an outwardly extending tongue, windings fixed within the rectangular space between said pole pieces and surrounding said armature, a fixed support to which said plate is pivotally connected so that it can move in its own plane, and bias adjusting means whereby the position of said plate and pole pieces can be varied in relation to said armature.

17. The combination with electro-magnetic apparatus of the kind herein referred to, comprising stationary but endways adjustable contacts and a movable contact arranged to oscillate between said stationary contacts, of a contact cleaning device, comprising a frame adapted to be attached to the electro-magnetic apparatus, a disc mounted to rotate in said frame and to be inserted between the movable contact and each of the stationary contacts, means whereby said disc can be moved axially and caused to bear against any of said contacts, at will, and means for rotating said disc against the contact with which it has been caused to bear.

Signed at London, England, this 25th day of November, 1927.

FREDERICK GEORGE CREED.
WILLIAM HENRY STOREY.
REGINALD DENNIS SALMON.