June 13, 1944. A. WARSHER 2,351,377

ELECTRO-MAGNET STRUCTURE

Filed Sept. 25, 1940 2 Sheets-Sheet 1

FIG. 1.

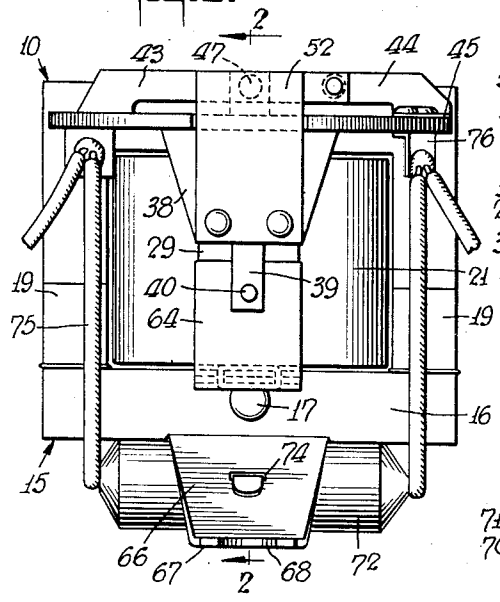


FIG. 2.

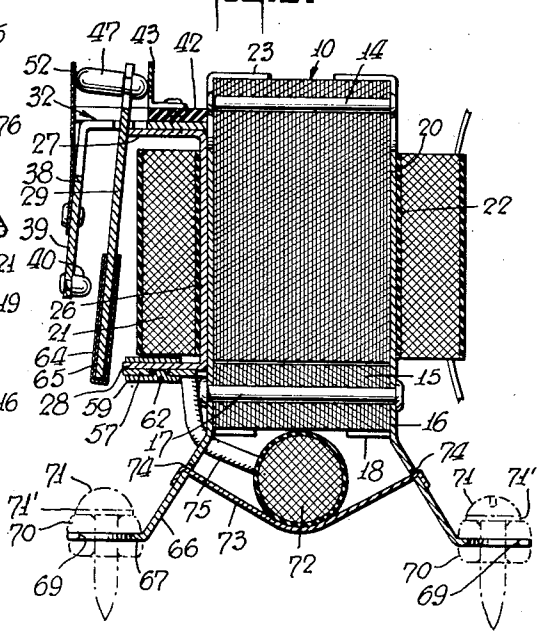


FIG. 4.

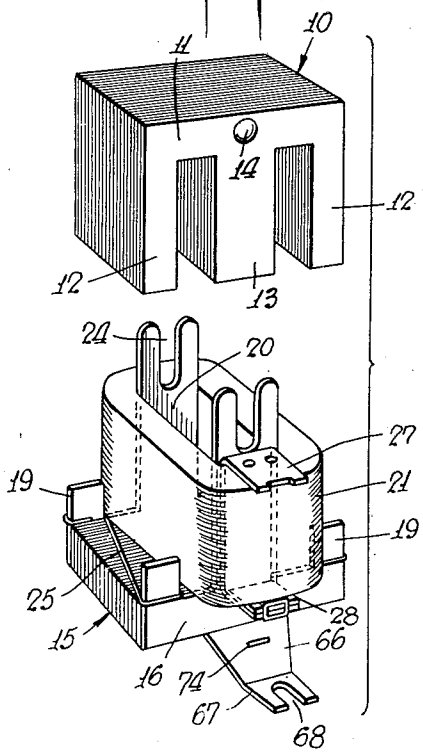
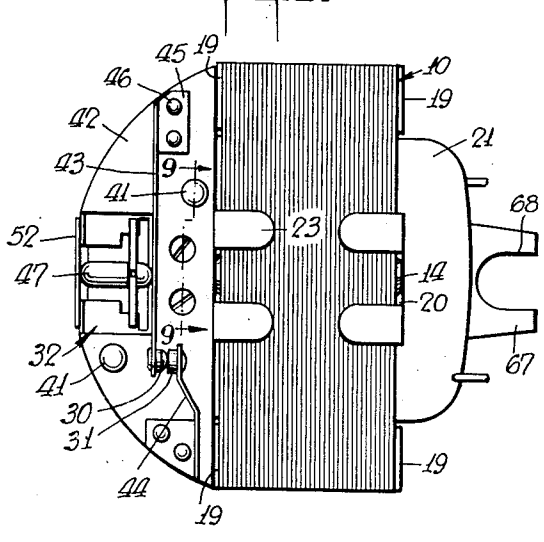


FIG. 3.



INVENTOR
Adolph Warsher
BY
Dean Fairbank & Hirsel
ATTORNEYS

40-130

June 13, 1944. A. WARSHER 2,351,377

ELECTRO-MAGNET STRUCTURE

Filed Sept. 25, 1940 2 Sheets-Sheet 2

Fig. 7.

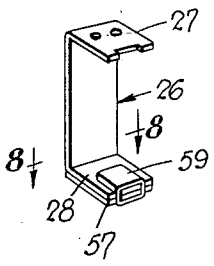


Fig. 8.

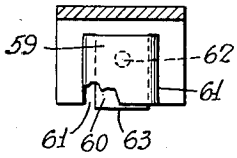


Fig. 6.

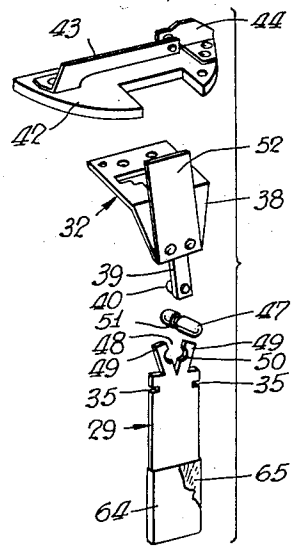


Fig. 5.

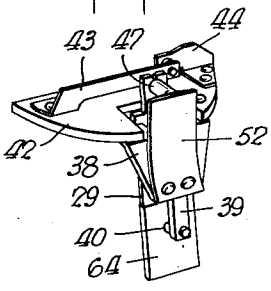


Fig. 9.

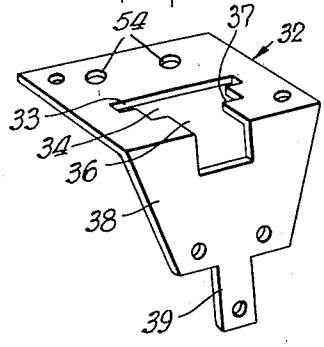
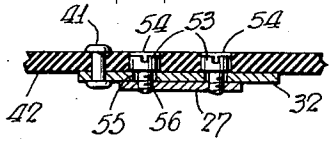


Fig. 10.



INVENTOR
Adolph Warsher
BY
Dean Fairbank & Hirsch
ATTORNEYS

40-130

Patented June 13, 1944

2,351,377

UNITED STATES PATENT OFFICE

2,351,377

ELECTROMAGNET STRUCTURE

Adolph Warsher, Maywood, N. J., assignor, by mesne assignments, to Maxwell M. Bilofsky, Newark, N. J.

Application September 25, 1940, Serial No. 358,190

6 Claims. (Cl. 200—87)

The present invention, while shown applied to an electromagnetic relay of special utility in the starting and operation of thermionic lamps is of more general application to other constructions of electromagnets and relays for other purposes.

The invention constitutes an improvement upon that described and claimed in the prior Patent No. 2,159,837 granted to Duro Test Corporation on May 23, 1939, on application filed by Maynard A. Babb and Samuel J. A. M. Bagno.

Among the objects of the invention are to provide a relay comprising readily stamped parts, easily assembled with a high degree of accuracy from a number of sub-assemblies each of which in turn is readily and accurately assembled.

Another object is to provide a magnetic yoke structure the relative sliding displacement or lateral separation of the laminations of which is precluded in the course of impregnation, adjustment and use, and assembly of which with the electromagnetic coil is easily effected, without the likelihood of tearing or scuffing the paper liner thereof or short circuiting or otherwise disturbing the predetermined fixed small air gap of the yoke structure.

Another object is to provide an electromagnet structure of the foregoing type, in which without the need for annealing and heat treating the magnetic parts to that end, release of the armature is promptly effected without delay due to magnetic retentivity upon collapse of the magnetic field, and this without imposing an undue mechanical load upon the coil in effecting attraction of the armature.

Another object is to provide a relay of the above type in which the effectiveness of contact operation is not impaired by any stresses evolved in the course of use as for example those due to heat, that might cause among other disturbances the warping of heat insulating carrying parts, and in which contact is resiliently maintained closed with a minimum of contact resistance and is inherently released by the resilience of a contact carrying arm, in response to movement of the armature.

In the accompanying drawings in which is shown one of various possible embodiments of the several features of the invention,

Fig. 1 is a front elevation of the relay,

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1,

Fig. 3 is a plan view thereof,

Fig. 4 is a dropped perspective of the portions of the yoke, showing the mode of assembling the same,

Fig. 5 is a perspective view of the armature and contact sub-assembly,

Fig. 6 is an exploded perspective view of the armature and contact sub-assembly,

Fig. 7 is a perspective view of the auxiliary yoke,

Fig. 8 is a transverse sectional view on line 8—8 of Fig. 7, and on a larger scale,

Fig. 9 is a perspective view on a larger scale of the armature holder bracket, and

Fig. 10 is a transverse sectional detail view taken on line 9—9 of Fig. 3.

Referring now to the drawings, the yoke is desirably made up of a stack 10 of E-shaped plates of suitable ferrous metal, each lamination including a beam 11, lateral legs 12 and a median leg 13. The stack is held together prior to impregnation by means of a single rivet 14 midway through the beam.

Coating with the assembly of E-shaped laminations is a stack 15 of I-shaped laminations which has lateral keeper plates 16 of non-magnetic metal, desirably of brass, between which the stack of I-laminations is sandwiched, the said members being held together by a rivet 17 midway therethrough.

The keeper plates are desirably provided with ears 18 at the lower edges thereof bent under the I-stack and serving thereby to prevent the laminations from pivotal or sliding relative displacement about the rivet 17. The keeper plates also have short lateral lugs 19 which in the assembled construction extend over the extreme laminations of the E-stack at the lateral legs thereof. Likewise the keeper plates have unitary therewith longer arms 20 protruding upward from midway between the ends thereof to have sandwiched therebetween the stack of laminated portions making up the median leg 13 of the E-stacks.

The electromagnetic coil 21 may be readily passed over the upstanding median arms 20 of the keeper plates, without the danger or likelihood of tearing or scuffing the paper liner 22 upon which the coil is usually wound. Thereupon, the E-stack may be readily assembled with respect to the coil and the I stack by passing the median leg 13 of the E-stack between the two upstanding arms 20 of the keeper pieces, thereby pressing the arms 20 firmly against the coil liner 22. Thus the magnetic parts are kept out of contact with coil 21 by the interposed brass

arms 20 and all danger of short circuiting the air gap described below is obviated. The extremities of the keeper arms 20 may now be turned inward as at 23 thereby to maintain the two stacks of laminations securely assembled. Desirably the ends of the keeper arms 20 are bifurcated as at 24 near the top for facility of assembly, without interference from the heads of the rivet 14 which is exposed between the arms of the bifurcations.

While the air gap of the magnet may be made in conventional manner, it is preferred for this purpose to follow the teachings of the prior application of John P. Glass, Serial No. 346,678, filed July 22, 1940. It may be briefly set forth that for this purpose, there is interposed between the contiguous faces of the lateral legs 12 of the E-stack and the ends of the I-stack, a metal rod or wire 25 that fixedly determines the size of the air gap and the ends of which may be hooked around the lateral lugs 19 on the keeper plates 16, or if desired, they may be threaded through corresponding apertures (not shown) in said keeper lugs.

The assembly is vacuum impregnated with suitable synthetic resin varnish which is later baked to form a hard insulating coating on the outside of the yoke and coil structure.

The assembled yoke as described is a fixed, invariant unit which will suffer no changes in its magnetic constants as a result of vacuum impregnation, installation or use, for the keeper plates 16 prevent at all times any rotary displacement of any of the laminations about the rivets or any lateral spreading of the laminations otherwise likely to occur particularly at their ends.

In the particular form of relay shown, an auxiliary yoke 26 is passed through the electromagnetic coil prior to passing the latter over the keeper arms 16 and is disposed in snug engagement with one of said keeper arms 20, and thereby magnetically spaced from the laminated stack 10. The auxiliary yoke 26 has a pair of poles 27 and 28 extending in parallel relation and straddling the coil 21.

The armature 29 and the associated relay contacts 30 and 31 are desirably built as a sub-assembly to be affixed to the main yoke assembly. This sub-assembly in a preferred embodiment comprises an armature holder plate 32 of non-magnetic sheet metal, desirably of brass, which has a transverse stepped slot therein. The widest portion 33 of the slot accommodates the entier width of the armature 29 for convenience of assembly. A contiguous slightly narrower portion 34 of the slot is of width to be straddled by lateral hinging notches 35 in the armature plate. The narrowest portion 36 of the slot defines shoulders 37 to be engaged by one face of the armature plate at the region between the hinging notches 35, the opposite face of the armature plate being engaged by the outer edge of the pole 27, when the holder plate is affixed in place upon the pole 27 in manner to be set forth below.

Desirably, the armature holder plate 32 is in the form of a bracket which includes a unitary wing 38 extending generally lengthwise of the armature, with a tongue 39 at its extremity, which mounts an insulating fiber button 40 that serves as a limiting stop for the armature in its hinging movement on notches 35.

Riveted as at 41 to the armature holder plate is a fiber plate 42 upon which are mounted the relay contacts 30 and 31. Each of these contacts is at the end of a corresponding arm, 43 and 44 respectively, the width of which rises from the plate 42 and the length of which extends longitudinally of the plate, each of said arms having an outturned base lug 45 riveted as at 46 to the fiber plate. The arm 43 is desirably of substantial length, nearly that of the fiber plate and of phosphor bronze, spring-hard to have sufficeint resiliency to bias the contact 30 carried thereby away from the companion contact 31 to open circuit position.

The reduced extremity of the armature 29 at the hinge end thereof desirably carries a rod 47 of hard fiber extending from opposite faces of saaid armature. To mount said fiber rod the end of the armature is preferably bifurcated as at 48 to form fingers 49 which may be spread apart for insertion of the fiber rod therebetween and upon forcing the arms back to original position, the notches 50 therein will lodge in a corresponding peripheral groove 51 in the rod for securely mounting the same.

Riveted to the wing 38 of the armature holder bracket is a spring steel plate 52, the end of which engages the corresponding extremity of fiber rod 47 and transmits thrust through the other end of the rod which engages the spring contact arm 43. The spring 52 which may be of Swedish spring steel of .006 inch to .008 inch gauge exerts sufficient thrust through the rod 47 to overcome the resilience of contact spring 43 and when no current is passing through the relay to maintain the contacts in closed position. By varying the angle of wing 38, the pressure of spring 52 may be adjusted in accordance with requirements.

The sub-assembly of armature and contacts is affixed upon the main assembly by a pair of machine screws 53 the heads of which are lodged in corresponding apertures 54 in the fiber plate, the shanks of which extend through corresponding small apertures 55 in the armature holder plate 32 and the points of which are threaded into corresponding apertures 56 in the pole 27. Slight enlargement of the screw apertures 54 and 55 permits minor lateral adjustment in the position of the sub-assembly, prior to tightening the screws into the pole 27 to assure correctness in the alignment of the armature 29 with respect to the poles 27 and 28.

When the sub-assembly of armature and contacts is thus installed upon the main yoke assembly, the end of pole 27 contacts the under face of the armature 29 and prevents displacement of the hinged part of the latter toward the otherwise open larger part 33 of the slot in the armature holder plate 32.

The hinge mount of the armature is thus especially simple and efficient, in that it dispenses with pintle pins and it affords a non-magnetic hinge for the armature.

In operation, the free end of the armature 29 strikes the end of pole 28. To assure dependable operation, that pole is desirably made of double thickness of magnetic material for concentration of magnetic flux thereat to enhance its effectiveness. For this purpose, an extra layer 57 of magnetic stock may be spot welded to the leg or pole 28.

To prevent operation of the armature with the frequency of the alternating current, a split phase operation is provided by resort to a shading coil. This coil comprises a flat loop 59 of copper passed over a median tongue 60 formed by slitting said pole 28 as at 61 to accommodate the lateral walls

of the shading coil. The latter is securely affixed by indenting the same into the pole as at 62. Thus the shading coil does not protrude to any considerable extent from the pole of the auxiliary yoke, and the length of the yoke need not be much greater than the height of coil 21, so that the reluctance of the magnetic circuit through yoke 26 and armature 29 is kept low. Desirably, the tongue 60 protrudes slightly beyond the shading coil as at 63, and the lateral portions of the pole 28 terminate somewhat below the central portion to avoid engagement by the armature and to give the proper flux ratios of the split phases, thereby to provide a limited area of impact for the armature and to prevent undesirable vibrations of the armature.

For further assurance of retraction of the armature upon collapse of the magnetic field, means is provided to overcome the residual magnetic attraction of the pole faces for the armature when the coil is de-energized. To this end a non-magnetic plated coat is provided at the magnetic area where the armature strikes the pole. This plated area may be provided either on the pole or on the armature, but preferably on the latter. To this end, the plated region of the armature that strikes the pole must present a thickness of non-magnetic character and a striking surface area of sufficient hardness to withstand the repeated impacts without appreciable wear or deformation. This coating may be plated upon the armature according to any approved practice, desirably by electroplating. A desirable striking contact metal is hard chromium, but since that metal has magnetic properties, it would, if plated directly upon the ferrous metal of the armature lack complete effectiveness for quick release. Therefore, hard chromium is used as the facing layer 64 and is plated upon a base plated layer 65 of non-magnetic metal, desirably of copper, which latter is too soft to withstand the impact. Desirably the non-magnetic layer 65 of copper by which the magnetic flux dissipation at the striking area is promoted, has a thickness in the order of .0025 inch, while the hard chromium facing 64 may have a thickness in the order of .0005 inch.

For ease and neatness of installation it is desirable to extend downward and outward from the middle portion of the keeper plates 16, a pair of supporting or carrying legs 66 for the unit. These legs may be bent out as unitary parts of said keepers extending between the ears 18 downward and outward, desirably at an angle of about 45 degrees, with horizontal diverging toes or feet 67 bifurcated as at 68. These feet may straddle annular grooves 69 in small rubber grommets 70 through which headed fastening screws 71 extend for mounting the unit in position, a washer 71' transmitting the thrust from the screw head to the grommet. The mounting means set forth affords a secure foundation for the relay, which will transmit no mechanical noises of operation or residual lamination hum to the socket or other device to which the relay is attached.

The legs 66 also afford a convenient location for the small condenser 72 disposed under the magnetic yoke and desirably held in place against said yoke by a phosphor bronze band 73 threaded at its ends through corresponding slots 74 in said legs. The leads 75 from the ends of the condenser extend upward to the contact lugs 45 to be soldered to contact tabs 76 riveted to the under face of the fiber plate 42 at the respective regions at which the contact lugs 45 are riveted in place.

The entire assembly may be installed in a socket or other casing which constitutes no part of the present invention, and is, therefore, not shown.

When no current traverses the apparatus, the spring 52 by pressure transmitted through button 47 maintains the armature 29 against stop 40 and over-powers the resilient contact carrying arm 43 to retain it in closed circuit position. In the use in thermionic lighting circuits for instance, when the circuit is closed, the armature 29 is attracted to pole 28 by pivotal movement and the rod 47 engaging spring 52 moves toward said spring and displaces it and moves away from the spring arm 43, which by virtue of its inherent bias moves the contact 30 to open circuit position, which open position is maintained as long as sufficient current is passing through the coil 21, a condition maintained during the normal operation of the lamp. In the starting operation, the stop 40 not only limits the maximum opening movement of the armature, and therefore the maximum air gap between the armature and the poles of yoke 26, but it also cushions the vibratory action of the armature. The damped operation of armature as set forth results in improved action, in that blackening of the fluorescent lamps on their ends occurs only after a much larger number of starts than if an undamped armature mount were provided.

As soon as the magnetic flux through the yoke 10—15 collapses either due to disturbance in operation or opening of the circuit, the spring 52 by pressure upon rod 47 moves the armature away from the pole 28 and the thrust transmitted through said rod 47 urges the arm 43 to contact closing position. The prompt release action results from the fact that the non-magnetic copper plated layer 65 upon the armature avoids the magnetic retentivity which otherwise would delay release of the armature and reclosure of the relay contacts. The reduced area of contact between yoke and armature by reason of the foreshortening of the lateral parts of the pole 28 also contributes to the prompt release of the armature.

The shading coil 59 is particularly effective by its split phase action to maintain the armature in contact with the pole during the reversals of flux in the normal alternating current operation, so that hum or chattering of the armature is avoided.

Thus the parts making up the relay are readily assembled as two sub-assemblies, the main yoke assembly and the armature and contact assembly, and the latter is readily mounted upon the former as set forth. The spring arm 43 need do no mechanical work other than to carry its contact 30 to open circuit position when rod 47 recedes therefrom. The retraction of the armature from the yoke is effected by the pressure of spring 52 independently of the spring arm 43. Thus contact closure is reliably maintained with a low resistance contact, and this would not be disturbed even if in operation the fiber plate 42 were to warp under distortion due to heat or other strain.

The intervening brass arm 20 magnetically separating the main yoke 10—15 from the auxiliary yoke 26, the operation of the relay is not affected to any appreciable degree by the presence of the main yoke, except of course to require the desired larger voltage across coil 21 for effective attraction of the armature.

The electro-magnet and yoke structure as such

is the subject of divisional application Serial No. 527,409 filed March 21, 1944.

As many changes could be made in the above apparatus and many apparently widely different embodiments of this invention could be made without departing from the scope of the claims, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a relay of the type that comprises a magnetic yoke having a fixed air gap, an electro-magnetic coil about one arm of said yoke and an auxiliary yoke through said coil having a pair of poles straddling said coil and an armature and contact assembly associated with said latter yoke; the combination in which said assembly comprises a non-magnetic sheet metal bracket including a plate and a wing, said plate being removably affixed in face to face engagement with one of said poles, an armature extending through a slot in said bracket plate and having lateral notches straddling the ends of said slot, said armature bridging across said poles, and the extremity thereof protruding beyond said bracket, an insulating plate affixed to said bracket plate, a pair of contact arms riveted to said insulating plate, one of said contact arms being resilient and biased to open contact position, the wing of said bracket having an armature stop near its lower end, a leaf spring riveted to said wing and extending upward therefrom, and an insulating rod carried by and extending transversely through the protruding end of said armature and engaging and serving as a thrust transmitter between said spring and said resilient contact arm.

2. In a relay structure of the type that comprises a magnetic yoke, an electro-magnetic coil encircling one portion thereof, an auxiliary yoke through said coil having a pair of poles straddling the same and an armature and contact assembly associated with the latter yoke; the combination in which said assembly comprises a non-magnetic metal plate superposed over one of said poles, an armature accommodated in a corresponding slot in said plate and having notches straddling a portion of said slot, said armature bridging across the ends of the two poles, a fiber plate riveted to said metal plate, a pair of co-acting contact members affixed to said fiber plate, and a pair of apertures through said fiber and metal plates, to coact with corresponding apertures of smaller diameter in the pole adjacent said metal plate and screws affixing said metal and fiber plates to said pole, the apertures through the latter plates being somewhat larger than those through the pole to permit minor adjustment for correct registry of the armature with respect to the poles in the tightening of said screws.

3. An armature and contact assembly for a relay, said assembly comprising a non-magnetic sheet metal hinge plate, an armature having lateral notches extending through a corresponding aperture in said plate for hinging mount thereon, an insulating carrier plate affixed to one face of said hinge plate and extending substantially at right angles to said armature, a pair of parallel arms, each having a contact near one end thereof, the widths of said arms extending at right angles to said carrier plate, said arms each having an outturned base lug near the end thereof remote from the contact carrying end, said lugs resting upon and being affixed to said insulating carrier plate, and transmission means between said armature and one of said contact arms.

4. An armature and contact assembly for a relay, said assembly comprising a non-magnetic angle shaped sheet metal piece, an armature plate having notches straddling the edges of a corresponding aperture in said piece for hinge mount thereat, an insulating carrier plate affixed to one face of said angle shaped piece and extending substantially at right angles to said armature, a contact maker including a resilient contact carrying arm fixed to said insulating carrier plate, a leaf spring riveted to one arm of said angle shaped piece and extending substantially at right angles to the insulating carrier plate, an insulating rod carried by the free extremity of said armature near the hinge thereof and resiliently engaged at the opposite ends thereof respectively by said leaf spring and said resilient contact carrying arm.

5. An armature and contact assembly for a relay, said assembly comprising a bracket of non-magnetic sheet metal including a plate and a wing element, an armature plate extending through a corresponding generally rectangular opening in the plate portion of said bracket and having lateral notches straddling the edges of said opening, said armature having an extension beyond said hinge and protruding from said bracket, an insulating rod carried by said armature end, an insulating plate carried by the plate portion of said bracket, a pair of contact members carried by said insulating plate, one of said members comprising a resilient contact carrying arm engaging one end of said insulating rod and biased to contact opening position, and a leaf spring riveted to the wing part of said bracket and resiliently engaging the opposite end of said rod, the wing of said bracket having an armature stop.

6. In a relay of the type set forth the combination of an electro-magnetic coil, a U-shaped yoke therethrough having poles straddling said coil, an armature plate having lateral hinging notches, a non-magnetic metal armature holding plate superposed over one of said poles, a stepped slot through said holding plate, said slot having a portion of width to accommodate said armature, a somewhat narrower slot portion the ends of which are straddled by the lateral notches of said armature, said plate having a still narrower slot portion affording stop shoulders for the width of the armature between said notches, the end of said pole engaging the rear face of said armature adjacent said holding plate.

ADOLPH WARSHER.