

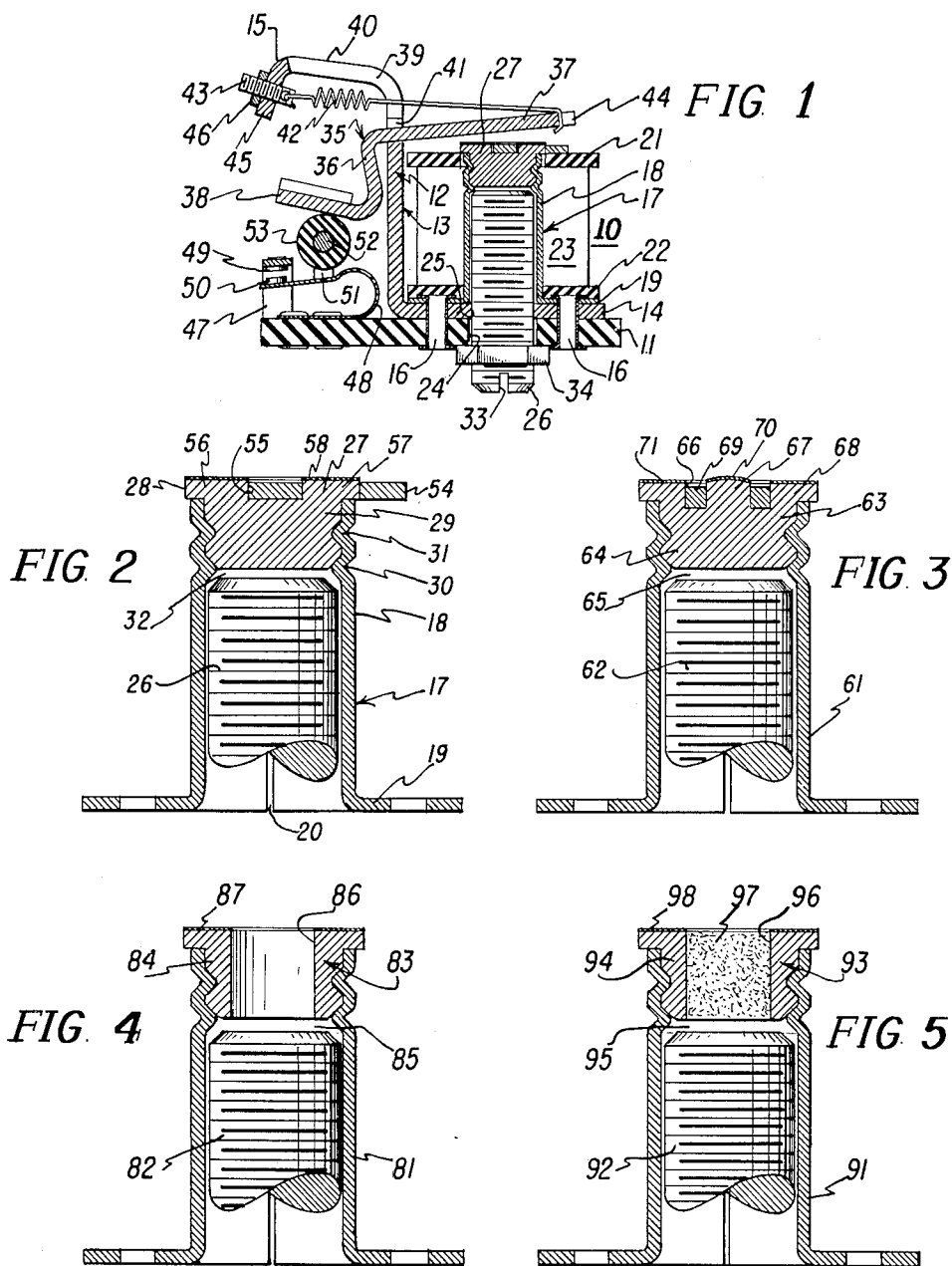
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ELECTROMAGNETIC RELAYS

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ELECTROMAGNETIC RELAYS

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The present invention relates to electromagnetic relays and more particularly to such relays of the current response or marginal type of the character disclosed in U. S. Patent No. 2,547,131, granted on April 3, 1951, to Alexander J. Lewus, that are especially suited for use in the control circuits of single phase induction motors of the split phase or capacitor type.

It is a general object of the present invention to provide an electromagnetic relay of the current responsive or marginal type that embodies an improved and simplified arrangement for adjusting the magnetic reluctance of the magnetic circuit thereof so as to accommodate ready adjustment of the characteristics of the relay to match the characteristics of a wide range of induction motors of the split phase or capacitor type.

Another object of the invention is to provide in an electromagnetic relay of the type noted, an improved arrangement for preventing chatter of the armature with respect to the cooperating pole piece when the associated winding is energized with an alternating current.

A further object of the invention is to provide in an electromagnetic relay of the type noted, an improved arrangement for preventing sticking of the armature to the cooperating pole piece as a result of residual magnetism therebetween when the alternating current traversing the associated winding is reduced to a value at which restoration of the armature is desired.

Further features of the invention pertain to the particular arrangement of the elements of the electromagnetic relay, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification, taken in connection with the accompanying drawing, in which Figure 1 is a vertical sectional view of an electromagnetic relay embodying the present invention; Fig. 2 is an enlarged fragmentary vertical sectional view of the central portion of the relay shown in Fig. 1, illustrating the arrangement for adjusting the magnetic reluctance of the magnetic circuit thereof; Fig. 3 is an enlarged fragmentary vertical sectional view of the central portion of a modified form of the relay, illustrating the arrangement for adjusting the magnetic reluctance of the magnetic circuit thereof; Fig. 4 is an enlarged fragmentary vertical sectional view of the central portion of another modified form of the relay, illustrating the arrangement for adjusting the magnetic reluctance of the magnetic circuit thereof; and Fig. 5 is an enlarged fragmentary vertical sectional view of the central portion of a further modified form of the relay, illustrating the arrangement for adjusting the magnetic reluctance of the magnetic circuit thereof.

Referring to Figs. 1 and 2 of the drawing, the electromagnetic relay 10 there illustrated and embodying the features of the present invention comprises a supporting plate 11 formed of insulating material, such, for example, as "Bakelite," and a substantially Z-shaped field element

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12 formed of magnetic material and provided with a body 13 terminating in two oppositely directed arms 14 and 15. In the arrangement, the arm 14 extends forwardly with respect to the adjacent lower end of the body 13, and the arm 15 extends rearwardly with respect to the adjacent upper end of the body 13. The arm 14 is suitably secured to the adjacent upper surface of the supporting plate 11 by an arrangement including a plurality of rivet eyelets 16 extending through aligned openings respectively provided in the plate 11 and in the arm 14. Also a tubular winding spool carrying member 17 formed of non-magnetic material, such, for example, as brass, is carried by the adjacent upper surface of the arm 14 and secured in place by the eyelet 16 extending through aligned openings provided therein. The member 17 comprises an upstanding substantially cylindrical barrel 18 disposed forwardly with respect to the body 13 of the field element 12 and a lower substantially annular flange 19, the flange 19 being directly secured to the adjacent upper surface of the arm 14, as previously noted. Preferably the barrel 18, as well as the flange 19, of the member 17, has a longitudinally extending slit 20 formed therein in order to interrupt the electrical circuit path therearound so as to minimize eddy currents in the member 17 that are induced therein when the winding provided on the associated winding spool is energized with an alternating current. Also the relay 10 comprises a unitary winding spool and supported winding that is removably carried by the member 17, the heads of the winding spool being indicated at 21 and 22, and the winding being indicated at 23. The heads 21 and 22 of the winding spool are formed of insulating material, such, for example, as "Bakelite," and the composite winding 23 is formed of suitable conducting wire, such, for example, as copper, or the like, individual terminals of the composite winding 23, not shown, being suitably insulated from each other.

Aligned openings 24 and 25 are respectively formed in the plate 11 and in the arm 14, the openings 24 and 25 being arranged in alignment with the inner end of the hollow barrel 18, and the opening 25 being threaded and engaging the threaded exterior surface provided on the inner end of a core element 26 projecting through the openings 24 and 25 and arranged within the barrel 18. The core element 26 is formed of magnetic material and the outer end thereof comprises a pole end terminating adjacent to the outer end of the barrel 18. Arranged in the outer end of the barrel 18 is a pole piece 27 formed of magnetic material, the pole piece 27 being provided with an outwardly directed annular flange 28 engaging the extreme outer end of the barrel 18, for the purpose of locating the pole piece 27. Also the pole piece 27 includes a body 29 arranged within the outer end of the barrel 18 and having a pair of laterally spaced-apart annular recesses formed therein that receive a cooperating pair of inwardly directed annular ribs 30 and 31 carried by the outer end of the barrel 18. More particularly, the preformed pole piece 27 may be placed in the outer end of the barrel 18, the annular flange 28 engaging the extreme outer end of the barrel 18; and the pair of ribs 30 and 31 may be rolled into the barrel 18 down into the pair of recesses provided in the body 29, whereby the pole piece 27 is securely fastened in place and properly located. It will be understood that the pole end of the core element 26 may be adjusted with respect to the adjacent end of the pole piece 27 to accommodate adjustment of an air gap 32 provided therebetween by virtue of the arrangement of the engaging threads provided in the opening 25 and upon the outer surface of the inner end of the core element 26, thereby to adjust the magnetic reluctance of the composite core of the relay 10. The inner end of the core element 26 has a slot 33 formed therein that is adapted to receive a screwdriver, or the

like, to facilitate the adjustment noted; and the inner end of the core element 26 also carries a lock nut 34 so that the adjusted position thereof within the barrel 18 may be retained by virtue of the cooperation between the lock nut 34 and the adjacent lower surface of the plate 11.

Further, the relay 10 comprises an armature 35 having a substantially Z-shape and including a body 36 terminating in two oppositely directed arms 37 and 38. The arm 37 projects forwardly with respect to the associated upper end of the body 36 and cooperates with the adjacent outer end of the pole piece 27, while the arm 38 projects rearwardly from the associated lower end of the body 36 and constituting a work lever. The armature 35 is formed of magnetic material and is pivotally mounted upon the upper portion of the body 13 of the field element 12 somewhat above the upper end of the barrel 18 and between the arms 14 and 15 of the field element 12. Specifically a substantially centrally disposed opening 39 is formed in the upper portion of the field element 12 at the junction between the upper end of the body 13 and the arm 15, whereby two laterally spaced-apart sides 40 extend between the upper end of the body 13 and the rear extremity of the arm 15. Further, two laterally spaced-apart side notches 41 are provided in the sides 40 that respectively receive two laterally spaced-apart tabs, not shown, provided on the opposite sides of the armature 35 adjacent to the junction between the body 36 and the arm 37 thereof. Thus it will be understood that the arrangement, comprising the side notches 41 respectively provided in the lower portions of the sides 40 and merging into the opening 39 and respectively receiving the tabs, not shown, provided on the armature 35, mounts the armature 35 upon the field element 12 for pivotal movements, the arm 37 of the armature 35 being selectively movable toward and away from the pole face of the pole piece 27 about the tabs, not shown, riding in the side notches 41.

The armature 35 is normally biased in its released position illustrated by an arrangement comprising a tension element or spring 42 projecting through the opening 39 and cooperating between the front end of the arm 37 and a screw 43. More particularly, a substantially centrally disposed notch 44 is provided in the front end of the arm 37 that receives the front end of the spring 42, the front end of the spring 42 being arranged in the notch 44 and hooked over the lower surface of the outer end of the arm 37. The rear end of the arm 15 is curved both rearwardly and downwardly and terminates in a tab 45 having an opening therein in which the screw 43 is located, the front end of the screw having a hole therein that receives the rear end of the spring 42, and the rear of the screw 43 carrying an associated adjusting nut 46. As described above, the front end of the tension element 42 is pivotally connected to the front end of the arm 37 in the notch 44, while the rear end of the tension element 42 is connected to the screw 43. Thus it will be understood that when the nut 46 is rotated, the screw 43 is moved in the associated opening provided in the tab 45, whereby the position of the front end of the screw 43 is adjusted both in the horizontal and vertical directions effecting corresponding movements of the rear end of the tension element 42. Accordingly, the tension element 42 normally biases the armature 35 in the counterclockwise direction about its pivotal mounting; and the moment of this bias exerted by the tension element 42 upon the front end of the arm 37 may be selectively varied or adjusted depending upon the position of the screw 43 in the associated opening provided in the tab 45. The moment of the bias is adjusted, both by the vibration of the tension in the spring 42 and by the variation in the elevation of the front end of the screw 43 with respect to the front end of the arm 37.

Further, the relay 10 comprises a stationary switch spring 47 and a movable switch spring 48, both suitably mounted upon the plate 11 and insulated from each other.

The switch springs 47 and 48 are formed of suitable electrical conducting material, and the movable switch spring 48 possesses considerable resiliency. The switch springs 47 and 48 respectively carry stationary and movable contacts 49 and 50 that may be formed of precious metal for the purpose of making and breaking the electrical circuit between the switch springs 47 and 48. Also the movable switch spring 48 carries a pair of laterally spaced-apart upstanding arms 51 carrying a laterally extending pin 52 therebetween upon which an insulating roller 53 is mounted. The roller 53 may be formed of glass, porcelain, or the like, and is readily rotatable upon the pin 52 in order to eliminate friction therebetween. The outer surface of the roller 53 is urged by the resiliency of the movable contact spring 48 into engagement with the adjacent lower surface of the work lever 38 of the armature 35. When the armature 35 occupies its normal release position illustrated, the work lever 38 engaging the outer surface of the roller 53 retains the movable switch spring 48 in its lower position so that the contacts 49 and 50 are disengaged. When the armature 35 is moved into its attracted position with respect to the pole piece 27, it being pivoted in the clockwise direction, as illustrated in Fig. 1, the work lever 38 is effectively moved away from the pin 52 so that the outer surface of the roller 53 rolls upon the adjacent surface of the work lever 38 as the roller 53 follows the work lever 38 due to the resiliency of the movable switch spring 48, whereby the contact 50 is moved into engagement with the contact 49, closing the electric circuit between the switch springs 47 and 48. When the armature 35 is moved into its fully attracted positions, the work lever 38 disengages the adjacent surface of the roller 53, so as positively to prevent chatter of the contacts 50 and 49. Subsequently, when the armature 35 is returned to its normal released position, as illustrated in Fig. 1, the work lever 38 engaging the adjacent surface of the roller 53 forces the roller 53, as well as the pin 52 and the movable switch spring 48, downwardly so that the outer surface of the roller 53 rolling upon the adjacent lower surface of the work lever 38 moves the movable switch spring 48 in order again to disengage the movable contact 50 from the stationary contact 49 so as to again interrupt the electric circuit between the switch springs 47 and 48.

Further, an arrangement is provided for preventing chatter of the arm 37 of the armature 35 upon the cooperating pole face of the pole piece 27, which arrangement includes a shading coil 54 formed of copper, or the like. More particularly, a cross slot 55 is provided in the pole face of the pole piece 27 in order to divide the pole piece 27 to provide two pole projections 56 and 57 thereon, the shading coil 54 surrounding only the pole projection 57, one side of the shading coil 54 being disposed in the cross slot 55. Of course, this arrangement provides a phase shift between the magnetic fluxes traversing the pole projections 56 and 57 in order to eliminate chatter of the arm 37 of the armature 35 with respect to the pole piece 27 when the winding 23 is energized with an alternating current. Finally, the upper pole face surface of the pole piece 27 is provided with a thin layer of non-magnetic material 58 for the purpose of preventing sticking of the arm 37 of the armature 35 to the pole face of the pole piece 27 as a result of residual magnetism therebetween when the alternating current traversing the winding 23 is reduced to a value at which restoration of the armature 35 is desired. This thin layer of non-magnetic material 58 carried upon the pole face of the pole piece 27 preferably comprises a plating of copper thereon having a thickness within the range 0.001" to 0.005". The provision of the thin layer of non-magnetic material 58 breaks the magnetic circuit between the pole piece 27 and the arm 37 when the armature 35 occupies its attracted position, thereby preventing the sticking mentioned. For example, in one embodiment of a marginal relay 10 of the character described, the adjustments mentioned were made to effect operation of the

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armature 35 when the alternating current traversing the winding 23 was increased to 16.0 amperes and restoration of the armature 35 when the alternating current traversing the winding 23 was reduced to 15.0 amperes; whereby the pick-up current was found to be substantially constant at 16.0 amperes, while the drop-out current was found to vary within the range 15.1 to 14.9 amperes, over a wide range of temperature and other operating conditions, whereby the approximate value of 15 amperes was closely held.

In view of the foregoing description of the construction and arrangement of the relay 10, it will be appreciated that the characteristics thereof may be adjusted over a wide range in order to match the characteristics of a wide range of induction motors of the split phase or capacitor type. Specifically, the magnetic reluctance of the magnetic circuit of the relay 10 may be readily adjusted by adjustment of the longitudinal position of the core element 26 within the barrel 18 so as correspondingly to adjust the gap 32 between the pole end of the core element 26 and the adjacent surface of the pole piece 27. Moreover the moment that is exerted by the spring 42 upon the armature 35 may be readily adjusted by appropriate manipulation of the nut 46 upon the screw 43. Between these two adjustments, the alternating currents traversing the winding 23 that bring about respective operation and release of the armature 35 may be selectively adjusted.

Referring now to Fig. 3 of the drawing, a modified form of the relay is illustrated that comprises the tubular winding spool carrying member 61, receiving the adjustable core element 62, and having the pole piece 63 secured in place in the outer end of the member 61; all in the manner previously described. In this form of the relay, the pole piece 63 comprises the body 64 arranged in spaced-apart relation with respect to the pole end of the core element 62 to provide the air gap 65 therebetween; and the pole face of the pole piece 63 is divided by an annular recess 66 formed therein to provide a central pole projection 67 and a surrounding annular pole projection 68, a shading coil 69 being arranged in the recess 66 and surrounding the pole projection 67 for the purpose of shifting the phase of the fluxes respectively traversing the pole projections 67 and 68, to achieve anti-chatter of the associated armature. Also in this arrangement, the central pole projection 67 extends above the annular pole projection 68 so that it is directly engaged by the cooperating armature, not shown, thereby separating the armature by a small gap from the annular pole projection 68 so as to prevent sticking of the armature as a result of the residual magnetism therebetween. Finally, the pole faces of the pole projections 67 and 68 respectively carry thin non-metallic coatings 70 and 71, formed of a plating of copper, or the like, in order further to minimize sticking of the armature with respect to the pole piece 67.

Referring now to Fig. 4 of the drawing, another modified form of the relay is illustrated that comprises the tubular winding spool carrying member 81, receiving the adjustable core element 82, and having the pole piece 83 secured in place in the outer end of the member 81; all in the manner previously described. In this form of the relay, the pole piece 83 comprises the body 84 arranged in spaced-apart relation with respect to the pole end of the core element 82 to provide the air gap 85 therebetween; and a longitudinally extending centrally disposed opening 86 is formed through the pole piece 83, for the purpose of providing the phase shift in the magnetic fluxes respectively traversing the body 84 and the opening 86 in order to prevent chatter of the cooperating armature. In this connection, it will be understood that the hysteresis loop of the magnetic material of which the body 84 is formed will be different from that of the air in the opening 86 to provide the phase shift of the fluxes, as noted above. Specifically, the body 84 of the pole piece 83 may be formed of a suitable non-retentive material, such for

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example, as ordinary silicon steel. Finally, the pole face of the pole piece 83 is provided with a thin layer of non-magnetic material 87 that may take the form of the thin plating of copper to prevent sticking of the cooperating armature, in the manner previously explained.

Referring now to Fig. 5 of the drawing, the further modified form of the relay is illustrated that comprises the tubular winding spool carrying member 91, receiving the adjustable core element 92, and having the pole piece 93 secured in place in the outer end of the member 91; all in the manner previously described. In this form of the relay, the pole piece 93 comprises the body 94 arranged in spaced-apart relation with respect to the pole end of the core element 92 to provide the air gap 95 therebetween; and a longitudinally extending centrally disposed opening 96 is formed through the pole piece 93 and receives a core piece 97 therein. The body 94 of the pole piece 93 is formed of a non-retentive magnetic material having a low hysteresis loss, such, for example, as ordinary silicon steel; while the core piece 97 is formed of a non-retentive magnetic material having a very low hysteresis loss, such, for example, as "Hypemik," an alloy consisting essentially of about 50% nickel and 50% iron. The arrangement noted provides the phase shift between the fluxes respectively traversing the body 94 and the core piece 97 in order to prevent chatter of the cooperating armature. In the arrangement, the core piece 97 may take the form of a highly compacted mass of finely divided magnetic material of the character mentioned disposed in the opening 96, or it may be of integral one-piece construction. Finally, the pole faces of the body 94 and the core piece 97 are provided with a thin layer of non-magnetic material 98 that may take the form of the thin plating of copper to prevent sticking of the cooperating armature, in the manner previously explained.

In view of the foregoing, it is apparent that there has been provided an electromagnetic relay incorporating improved structure for varying the current responses or marginal characteristics thereof over a wide range, thereby lending flexibility to the relay for use in the control circuits of a wide variety of single phase induction motors of the split phase or capacitor type.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. An electromagnetic relay comprising a magnetic field element, a longitudinally extending tubular non-magnetic metal member secured at its inner end to said field element, a longitudinally extending winding carried by said tubular member in surrounding relation therewith, a substantially plug-like magnetic pole piece secured in the outer end of said tubular member in fixed relation thereto, a magnetic armature, a pivotal connection between said armature and said field element, said armature having a free end cooperating with said pole piece and movable toward and away from said pole piece, means biasing the free end of said armature away from said pole piece, said field element having an opening formed therein in longitudinal alignment with said tubular member and communicating with the inner end thereof, a longitudinally extending magnetic core element carried by said field element within said opening and projecting longitudinally into said tubular member and having an outer pole end disposed adjacent to said pole piece and spaced longitudinally therefrom by a gap positioned within said tubular member and intermediate the ends thereof, and means for selectively adjusting the longitudinal position of said core element in said tubular member so as selectively to adjust the length of the gap between the pole end of said core element and said pole piece.

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2. The electromagnetic relay set forth in claim 1, wherein said adjusting means comprises cooperating threads respectively carried by said field element within said opening and by the inner end of said core element.

3. An electromagnetic relay comprising a magnetic field element, a longitudinally extending tubular non-magnetic metal member secured at its inner end to said field element, a longitudinally extending winding carried by said tubular member in surrounding relation therewith and adapted to be energized with an alternating current, said tubular member being split longitudinally to interrupt the eddy current path therearound, a substantially plug-like magnetic pole piece secured in the outer end of said tubular member in fixed relation thereto, a magnetic armature, a pivotal connection between said armature and said field element, said armature having a free end cooperating with said pole piece and movable toward and away from said pole piece, means biasing the free end of said armature away from said pole piece, said field element having an opening formed therein in longitudinal alignment with said tubular member and communicating with the inner end thereof, a longitudinally extending magnetic core element carried by said field element within said opening and projecting longitudinally into said tubular member and having an outer pole end disposed adjacent to said pole piece and spaced longitudinally therefrom by a gap positioned within said tubular member and intermediate the ends thereof, and means for selectively adjusting the longitudinal position of said core element in said tubular member so as selectively to adjust the length of the gap between the pole end of said core element and said pole piece.

4. An electromagnetic relay comprising a magnetic field element, a longitudinally extending tubular non-magnetic metal member secured at its inner end to said field element, a longitudinally extending winding carried by said tubular member in surrounding relation therewith and adapted to be energized with an alternating current, a magnetic armature, a pivotal connection between said armature and said field element, said armature having a free end movable toward and away from the outer end of said tubular member, means biasing the free end of said armature away from the outer end of said tubular member, a substantially plug-like magnetic pole piece secured in the outer end of said tubular member in fixed relation thereto and divided to provide two pole projections extending longitudinally into cooperating relation with the free end of said armature, a shading coil surrounding one of said pole projections in order to produce a phase shift between the magnetic fluxes in said pole projections when said winding is energized so as to prevent chatter of said armature, said field element having an opening formed therein in longitudinal alignment with said tubular member and communicating with the inner end thereof, a longitudinally extending magnetic core element carried by said field element within said opening and projecting longitudinally into said tubular member and having an outer pole end disposed adjacent to said pole piece and spaced longitudinally therefrom by a gap positioned within said tubular member and intermediate the ends thereof, and means for selectively adjusting the longitudinal position of said core element in said tubular member so as selectively to adjust the length of the gap between the pole end of said core element and said pole piece.

5. The electromagnetic relay set forth in claim 4, and further comprising a thin layer of non-magnetic material carried by the outer end of said pole piece and engaged by the free end of said armature so as to prevent the free end of said armature from sticking to said pole piece by residual magnetism therebetween when the alternating current traversing said winding is reduced to a value at which the release of said armature is desired.

6. The electromagnetic relay set forth in claim 5, wherein one of said pole projections is longer than the

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other in order that only said one pole projection is engaged by the free end of said armature so as to prevent the free end of said armature from sticking to said pole piece by residual magnetism therebetween when the alternating current traversing said winding is reduced to a value at which the release of said armature is desired.

7. An electromagnetic relay comprising a magnetic field element, a longitudinally extending tubular non-magnetic metal member secured at its inner end to said field element, a longitudinally extending winding carried by said tubular member in surrounding relation therewith and adapted to be energized with an alternating current, a magnetic armature, a pivotal connection between said armature and said field element, said armature having a free end movable toward and away from the outer end of said tubular member, means biasing the free end of said armature away from the outer end of said tubular member, a substantially plug-like magnetic pole piece secured in the outer end of said tubular member in fixed relation thereto and having an outer end provided with a pole face cooperating with the free end of said armature, the outer end of said pole piece projecting longitudinally beyond the outer end of said tubular member and carrying a laterally extending locating flange engaging the outer end of said tubular member and the inner end of said pole piece terminating within said tubular member, said pole piece including a body having a hole extending longitudinally therethrough between the inner and outer ends thereof in order to produce a phase shift between the magnetic fluxes in said hole and in the surrounding portion of said body when said winding is energized so as to prevent chatter of said armature, said field element having an opening formed therein in longitudinal alignment with said tubular member and communicating with the inner end thereof, a longitudinally extending magnetic core element carried by said field element within said opening and projecting longitudinally into said tubular member and having an outer pole end disposed in longitudinal alignment with said hole and arranged adjacent to the inner end of said pole piece and spaced longitudinally therefrom by a gap positioned within said tubular member and intermediate the ends thereof, and means for selectively adjusting the longitudinal position of said core element in said tubular member so as selectively to adjust the length of the gap between the pole end of said core element and the inner end of said pole piece.

8. An electromagnetic relay comprising a magnetic field element, a longitudinally extending tubular non-magnetic metal member secured at its inner end to said field element, a longitudinally extending winding carried by said tubular member in surrounding relation therewith and adapted to be energized with an alternating current, a magnetic armature, a pivotal connection between said armature and said field element, said armature having a free end movable toward and away from the outer end of said tubular member, means biasing the free end of said armature away from the outer end of said tubular member, a substantially plug-like pole piece secured in the outer end of said tubular member in fixed relation thereto and having an outer end projecting longitudinally beyond the outer end of said tubular member and provided with a pole face cooperating with the free end of said armature and having an inner end terminating within said tubular member, said pole piece including a body having a hole extending longitudinally therethrough between the inner and outer ends thereof, a longitudinally extending pole core secured in place in said hole, said pole piece and said pole core being formed of magnetic materials having different magnetic hysteresis loss characteristics in order to produce a phase shift between the magnetic fluxes therein when said winding is energized so as to prevent chatter of said armature, said field element having an opening formed therein in longitudinal alignment with said tubular member and communicating with the inner end thereof, a longitudinally extending

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magnetic core element carried by said field element within said opening and projecting longitudinally into said tubular member and having an outer pole end arranged adjacent to the inner ends of said pole piece and said pole core and spaced longitudinally therefrom by a gap positioned within said tubular member and intermediate the ends thereof, and means for selectively adjusting the longitudinal position of said core element in said tubular member so as selectively to adjust the length of the gap between the pole end of said core element and the inner ends of said pole piece and said pole core.

9. The electromagnetic relay set forth in claim 8, wherein said pole piece is of integral construction of a material having a low magnetic hysteresis loss, and said pole core is of composite construction of a compressed mass of magnetic particles having a very low magnetic hysteresis loss.

10. The electromagnetic relay set forth in claim 8, wherein the outer end of said pole core is disposed substantially flush with the outer end of said pole piece and is also provided with a pole face cooperating with the free end of said armature, and further comprising a thin

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layer of copper carried by the pole faces of said pole piece and said pole core and engaged by the free end of said armature so as to prevent the free end of said armature from sticking to said pole faces by residual magnetism therebetween when the alternating current traversing said winding is reduced to a value at which the release of said armature is desired.

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