July 9, 1963 H. SAUER 3,097,328

ELECTROMAGNETIC RELAY

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FIG. 1.

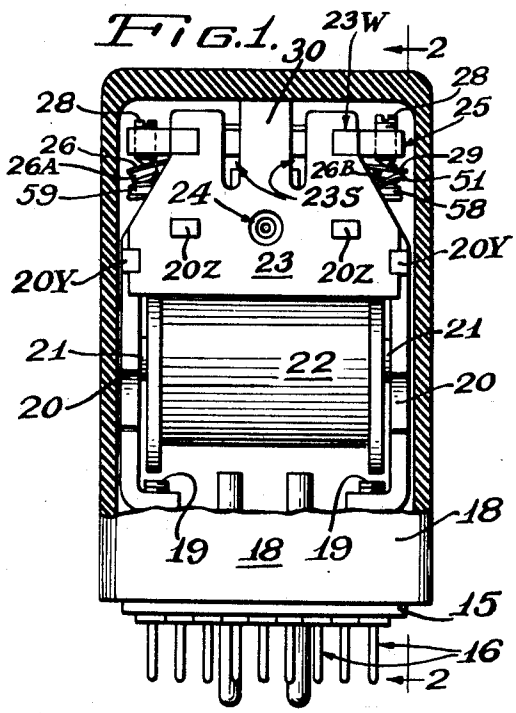


FIG. 2.

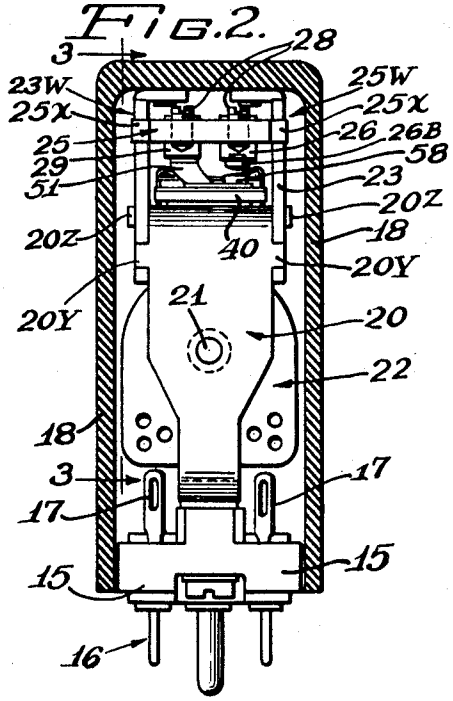


FIG. 3.

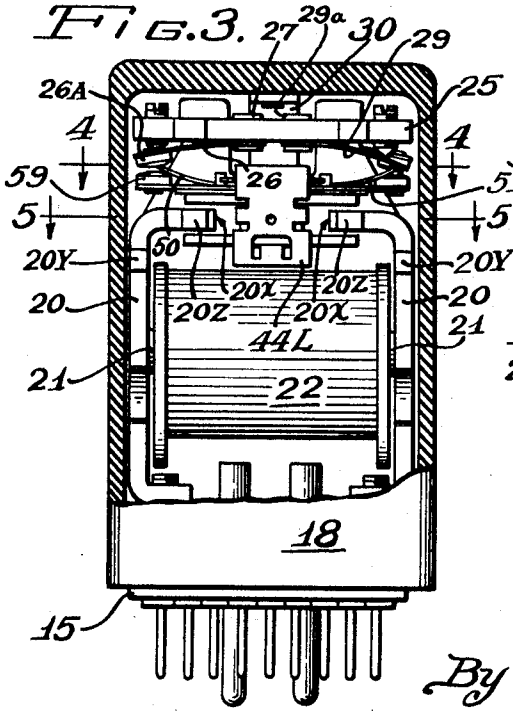


FIG. 4.

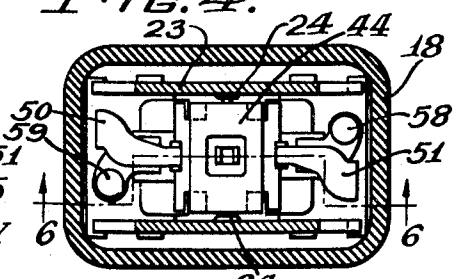
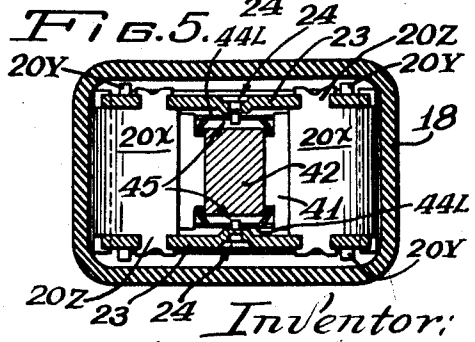


FIG. 5.



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FIG. 6.

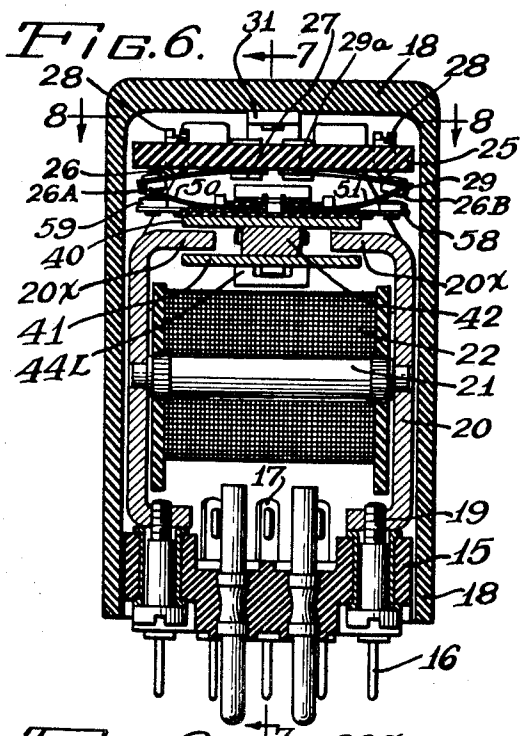


FIG. 7.

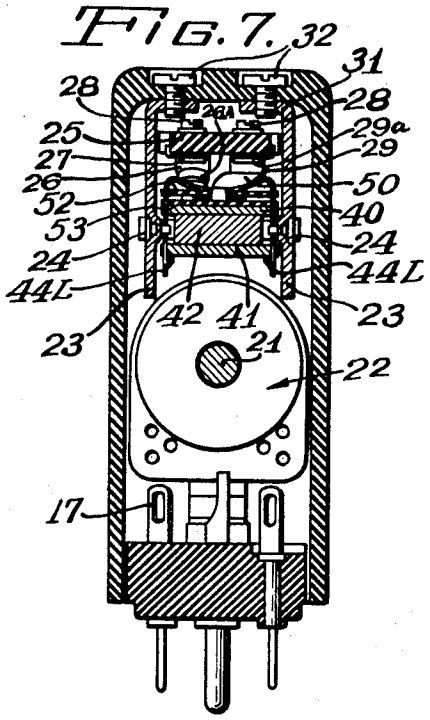


FIG. 8.

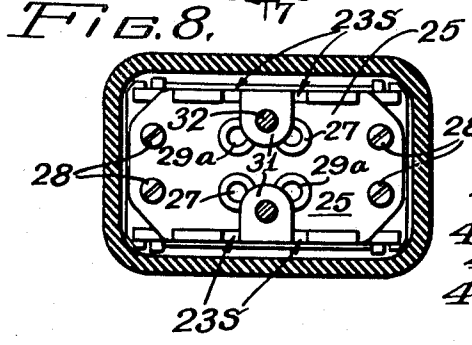


FIG. 9.

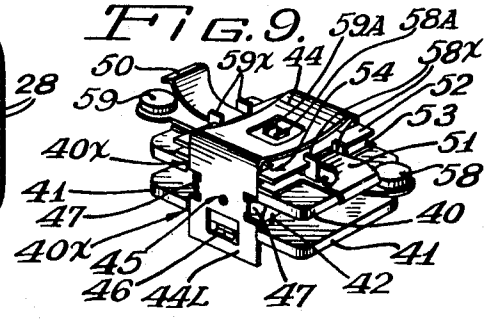


FIG. 10.

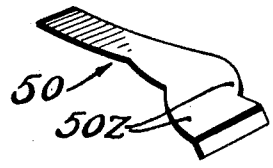
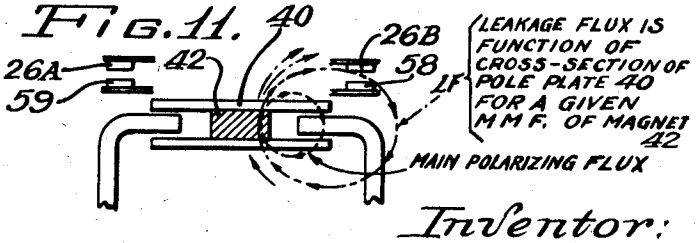


FIG. 11.



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United States Patent Office 3,097,328 Patented July 9, 1963

3,097,328
ELECTROMAGNETIC RELAY

Hans Sauer, Chicago, Ill., assignor, by mesne assignments, to Comar Electric Company, Chicago, Ill., a corporation of Illinois

Original application July 18, 1955, Ser. No. 522,538, now Patent No. 2,825,783, dated Mar. 4, 1958. Divided and this application Feb. 12, 1957, Ser. No. 640,061
6 Claims. (Cl. 317—199)

This application is a division of a copending application Serial No. 522,538, now Patent No. 2,825,783, the disclosed improvements relating to electromagnetic relays, particularly the polarized variety, and has as its principal object the provision of a polarized relay characterized by an exceptional sensitivity which is achieved by certain constructions pertaining especially to the form, mounting, and spring loading of the moving elements, and the particular arrangement of parts constituting the magnetic circuit for both the permanent and induced magnetic fluxes.

Additional objects relate to the provision of a polarized relay which is rugged and highly shock resistant, has fast pull-in and release response with suppressed contact flutter and arcing, and which can be economically manufactured for all applications requiring extreme sensitivity, stability, and reliability, as will more fully appear hereinafter.

Still more detailed objects pertain to the provision, in a device of the class described, of a novel subassembly constituting the main moving system of the relay and comprising a novel carrier unit including bearing, spring-loading, polarizing, and contact means, all comprising a compact, dynamically balanced, easily integrated and adjusted subassembly, making possible the manufacture of an exceptionally sensitive precision instrument on a production basis at a moderate cost.

Additional aspects of novelty and utility relate to details of the construction and operation of the device described hereinafter in view of the annexed drawings, in which:

FIG. 1 is a front elevation of the new relay with portions of the casing cut away and relay parts shown in elevation;

FIG. 2 is a vertical section through the casing along lines 2—2 of FIG. 1 with relay elements shown in elevation;

FIG. 3 is a sectional view partly in elevation similar to FIG. 1 but taken at lines 3—3 of FIG. 2;

FIG. 4 is a horizontal section taken in the direction of lines 4—4 of FIG. 3;

FIG. 5 is another horizontal section taken at lines 5—5 of FIG. 3;

FIG. 6 is a full vertical median section;

FIG. 7 is a full vertical cross section taken along jogged lines 7—7 of FIG. 6;

FIG. 8 is a horizontal top section through the housing shell taken along lines 8—8 of FIG. 6 and looking down in plan upon the moving system or carrier subassembly;

FIG. 9 is a perspective detail of the moving system or carrier subassembly;

FIG. 10 is a perspective of one of the variable characteristic springs;

FIG. 11 is a diagram of the arc supressing action.

Referring to FIG. 1, the relay consists of a molded base member **15** of suitable insulating properties and into which are embedded terminal prongs **16**, having internal lugs **17**, as required (FIG. 2).

Fitted onto the base is a suitable housing, canister, or shell **18** which may be sealed onto the base hermetically, or as required.

Secured to the base, as at **19**, are a pair of ferromagnetic pole pieces **20**, the upper ends of which (FIG. 3)

are offset toward each other to provide spaced pole faces **20X** (see FIG. 5 also).

A coil core **21** (FIGS. 1–3) is staked into the two pole pieces and carries the coil bobbin or winding **22** (see FIG. 6 also) from which suitable energizing leads (not shown) are carried to the lugs **17** in the usual way.

One each of a pair of bridge and bearing plates **23** (FIG. 1) is secured on the opposite sides of the pole pieces by means of lugs **20Z** (FIGS. 1 to 5) which are staked into said plates to rigidify the entire frame structure and afford both a bearing means and support for a contact carrier, as will appear, it being noted that additional lug means **20Y** are provided on pole pieces **20** to interfit with said bridge plates; and the latter are extruded inwardly to provide aligned bearing means or pivots **24** for the movable system hereinafter described.

The frame structure is completed by application of a contact carrier in the form of an insulated plate **25** (FIGS. 6, 7, 8) carrying a pair of divergent spring contact arms **26** riveted to the plate as at **27**, and a pair of opposite upper blade springs **29** likewise riveted to the plate as at **29a**, FIG. 8.

As viewed best in FIG. 8, the contact plate is provided with four adjustment screws **28** each overlying one of the blades **26** or **29** for adjustment to tension each of the same more or less for the purpose of regulating the contact gap as well as response characteristics of the moving system.

The contact plate **25** is rigidly seated between, and secured by, the pair of bridge plates **23** in the manner shown in FIGS. 1 and 2 by means of cut-outs **25X** on the plate interfitting with complementary cut-outs **23W** on said plates so that when the latter are staked home the contact plate is rigidly secured in position.

As viewed especially in FIGS. 1 and 8, each of the two bridge plates **23** has a pair of slots **23S** defining a tongue **30** which is upset to provide a lug **31** (FIG. 8); and these lugs are tapped to receive cover screws **32** (FIG. 7) in the embodiment shown.

A very important feature of the new construction is the so-called moving system by which is meant a pivoted armature element to be displaced by the two magnetic working forces acting from time to time (i.e. the permanent and applied forces), this moving system being constructed as a very compact subassembly such as depicted in FIG. 9.

The moving system comprises a pair of spaced-apart pole plates **40, 41** having clamped therebetween a permanent magnet **42** (FIGS. 5 to 7 also) by means of a combination bearing and retainer clamp **44** in the form of a U-shaped piece of Phosphor bronze or like spring metal having its opposite vertical legs **44L** pierced to provide bearings **45** respectively receiving the pivot pins **24** on the bridge plates, as in FIGS. 5 and 7.

The U-shaped bearing and retaining strap **44** is punched to provide a plurality of offset tongues **46, 47** (FIG. 9), the former being set beneath the lower pole plate **41** (both front and rear) and the latter being set in on opposite sides of the permanent magnet at the two ends thereof, it being observed that both pole plates **40, 41** are notched as at **40X, 41X**, respectively, to interfit snugly with this combination bearing and clamp strap **44**.

Also a part of the subassembly are a pair of spring-blade contacts **58, 59** and a pair of armature springs **50, 51**, all of the same being clamped between a pair of insulating wafers **52, 53** which are notched, as at **54**, to interfit or key with the bearing strap **44**, and as at **55** to key into a pair of upstanding ears **58X, 59X** respectively struck up from contact springs **58** and **59** carried between the set of insulating wafers.

The two blade contacts **58, 59** each have a tail portion

58A, 59A (FIG. 9) struck up and fitted through a slot formed near the center of the uppermost insulating wafer 52, the U-shaped bearing strap having a square clearance hole punched through its bight to clear these tail projections, which serve as soldering lugs.

The springs 50, 51 are especially shaped (e.g., as in FIG. 10) to produce a variable or dynamic characteristic which is predetermined to match the dynamic response curve for the armature system in question, in accordance with principles analogous to those disclosed in my copending application, Serial No. 492,451, filed March 7, 1955.

From the shape of the spring 50 depicted in FIG. 10, it will be observed that the blade is not of uniform width throughout its length, but on the contrary is peculiarly shaped and widened in a graduated manner toward its free end 50Z with a certain increment calculated to produce an increasing tension which is proportionate to the rate of increase of the magnetic pull on the armature as the air-gap reluctance diminishes when the armature moves from a normal or rest position toward a fully attracted position, taking into account the magnitude of the initial and final air gaps and the magnitudes and directions of the magnetomotive forces acting on the armature in the energized and deenergized states of the winding.

Another feature of the invention relates to the arrangement of the contact means in relation to the source of permanent magnetic flux to diminish arcing, reference being had to the diagrammatic showing of FIG. 11, wherein the normal low-reluctance magnetic circuit for the flux of the permanent magnet 42 is shown in dotted lines to be substantially through and confined to the mass of the two pole plates 40, 41, with a designated "leakage flux" shown in dash-dot lines as cutting across the zone occupied by the relay contacts.

Since the sets of contacts (e.g. 26A, 59) are disposed close to the upper pole plate 40 and the direction of the polarizing-leakage flux acts in a path cutting transversely through the contact gap, a magnetic field exists in the latter region which can oppose ionization in the contact gap in accordance with the magnitude of the stray flux available or caused to traverse the contact zone, more specifically the contact "meeting" and "parting" line, by which is meant that imaginary line at which the contacts 26B, 58, for instance, normally would meet and separate.

Assuming a given coercive or magnetomotive force for the permanent magnet 42, the amount of leakage flux LF in a given construction of the subassembly is a function of the cross-sectional areas of the pole plates, particularly the upper plate 40, such that if the latter is saturated by a suitably strong polarizing flux, there will be a considerable leakage flux through the air path in the region adjoining the upper side of the upper pole plate, and this leakage flux will have an important spark-suppressing effect on the relay contacts disposed in its path in the manner illustrated.

While it is known in the art to utilize a magnetic field to influence arcing, the presently disclosed constructions are considered novel with respect to the support and location of the contact assembly and a polarizing magnet in relation to spaced pole plates with intermediate pole faces in such manner as to provide a predictable and in a certain sense adjustable, leakage flux and circuit therefor largely confined to the contacting zone for the purpose of diminishing arcing.

The exceptional sensitivity and efficiency of the new relay is in large measure due to the construction and arrangement of parts constituting the polarized subassembly or "moving system," so-called herein because it comprises all of the essential moving parts of the relay including the contact elements which are positively moved relative to a stationary contact means.

In this connection, the importance of the combination retaining strap and bearing piece 44 must be emphasized as to the dual functions suggested, in addition to the fact

that it makes unnecessary adhesives or like expediencies for holding the polarizing magnet in position, and thereby increases the permeability of the magnetic circuit.

I claim:

1. In a relay: electromagnetic actuating means having a given electromagnetic-force-displacement characteristic; rockable armature means adapted to be displaced by said actuating means; biasing spring means for said armature means and comprising at least one leaf spring carried thereby with one end region freely projected and having a tapered configuration providing portions of greater lateral width than other portions thereof in the region of said end region; whereby to provide a predetermined spring characteristic corresponding approximately to said given characteristic for said armature means; and means providing a bearing point engageable with said end region of the leaf spring for biasing the latter and said armature means to a desired normal position.

2. In a magnetic device, in combination, a movable member including a magnetically-attractable element; means including a magnetic device for attracting said element across an air gap diminished progressively by displacement of said member from a desired normal position, said magnetic device having a predetermined magnetic-force-displacement curve which is a function of the displacement of said movable member under the urgence of the magnetic force exerted across said gap by said magnetic device; and spring means having a dynamic characteristic approximating said predetermined curve and normally biasing said movable member to said desired normal position relative to the magnetic device, said spring means comprising a leaf spring of elongated character fixed at one end and having its opposite end projecting into space and laterally widened predetermined amounts relative to said one fixed end for the purpose aforesaid; together with adjustable means providing a fulcrum point engaged by said opposite projecting end of the spring and causing the latter to change its characteristic progressively in accordance with said curve responsive to flexure thereof with movement of said movable members by said magnetic device as said air gap is diminished.

3. Spring means having a dynamic characteristic and comprising: an elongated thin blade of springy material tapering from a predetermined width at one end to a widened width in the region of the opposite end; mounting means supporting the narrower end of the blade against movement with said widened end projecting into space for flexure laterally of the plane of the blade; and relatively stationary fulcrum means engaging said widened end region of the blade in a predetermined normal position of the latter such that flexure of the latter from said normal position in a direction against said fulcrum will result in a varying characteristic spring resistance extending over a predetermined range the characteristic of which for a blade of given length, thickness, and stock, will be determined by the tapered shape of said blade.

4. The armature-biasing spring 50 of dynamic change-rate characteristic in the form of an elongated strip of initially flat spring stock having one fixed end of predetermined narrow width and an opposite free end region 50Z offset from the longitudinal axis of the strip and of substantially greater width at said free end and the region immediately adjacent thereto, said free end having a form providing a gliding surface thereat, said strip being bowed transversely of said axis; and the fixed end thereof being adapted to be secured on a rocking armature and the gliding surface form of the free end being adapted to work on a relatively stationary surface responsive to rocking of the armature to produce a changing spring rate proportioned in predetedmined degree to the armature displacements.

5. In a relay having a rockable armature and an electromagnet positioned to attract said armature from a normal position across an air gap diminished as the arma-

ture moves under attraction as aforesaid, improvements comprising, namely: a blade spring having a dynamic characteristic to increase its tension at a predetermined rate approximating the rate of increase in pull on said armature when attracted to move from said normal position toward said electromagnet, said blade spring being characterized in that one end thereof is of a predetermined narrower width than the other end and is fixed in position relative to the rocking fulcrum of the armature, and said other end thereof is increasingly widened and free to engage a bearing surface at a point remote from said fulcrum responsive to rocking of the armature, said spring acting to bias the armature into said normal position and resisting the movement thereof increasingly as the displacement of the armature increases from said position at a rate which is a function of the rate of widening of the blade toward said free end.

6. A relay having electromagnetic armature actuating means and a spring-loaded armature operatively displaced thereby in accordance with a given electromagnetic force-displacement-characteristic, together with spring means loading said armature and having a dynamically variable characteristic predetermined to match said force-displacement-characteristic of the armature by reason of the shape and operative coaction of said spring means within

the armature characterized in that said spring means comprises an elongated leaf spring body tapered lengthwise from a narrower end region toward a widened end region and operatively associated with said armature in a relation in which said narrower end is fixed to move with the armature, while said widened end region works slidably against a surface relatively stationary with respect to the armature in a direction to increase its resistance in unison with the operative displacement of the armature from a normal position of rest at a rate substantially matching the rate of increase of magnetic pull on the armature as the determinant parameter of the electromagnetic-force-displacement-characteristic aforesaid.

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