Sept. 2, 1958 F. A. HOOVER ET AL 2,850,593

HIGH SENSITIVITY ELECTRICAL RELAY

Filed Aug. 25, 1955

Fig. 1.

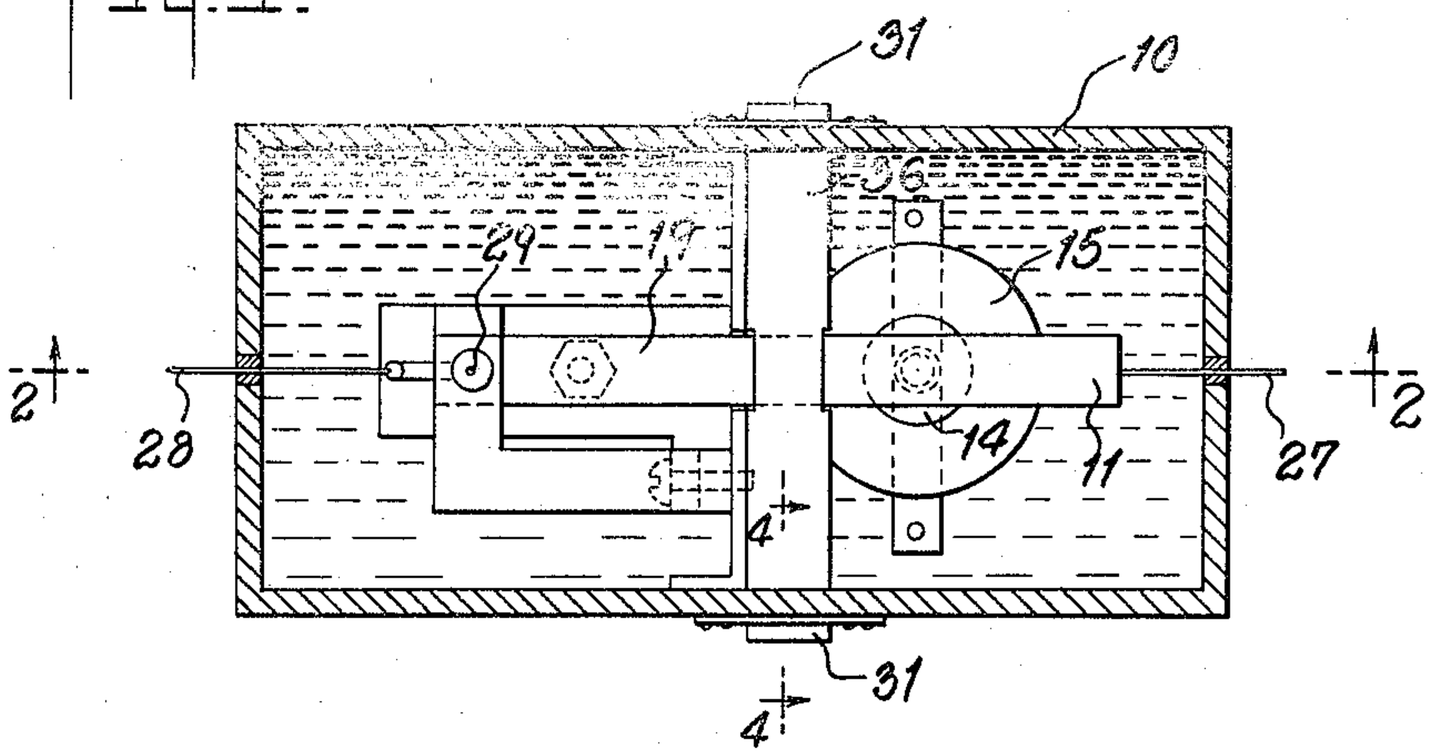


Fig. 2.

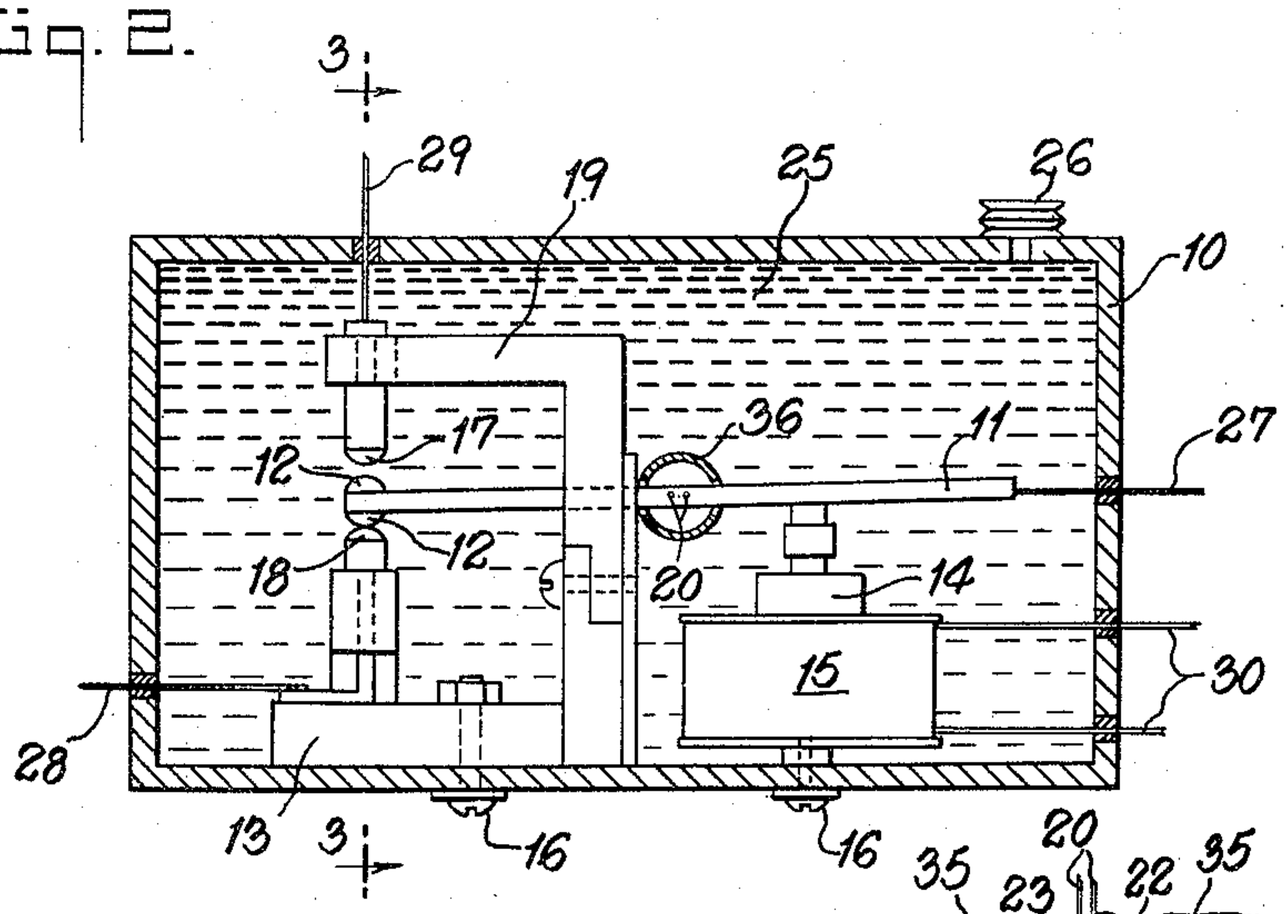


Fig. 3.

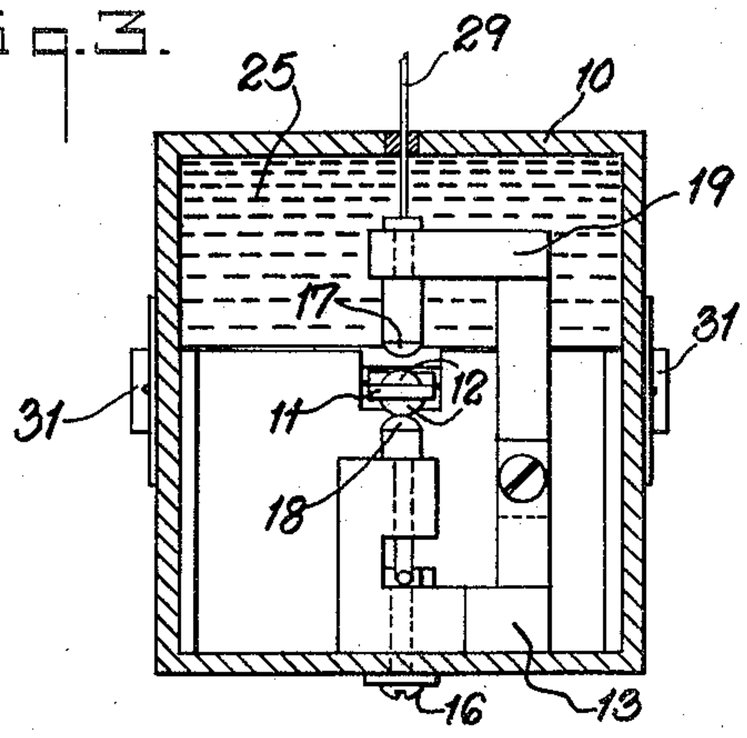
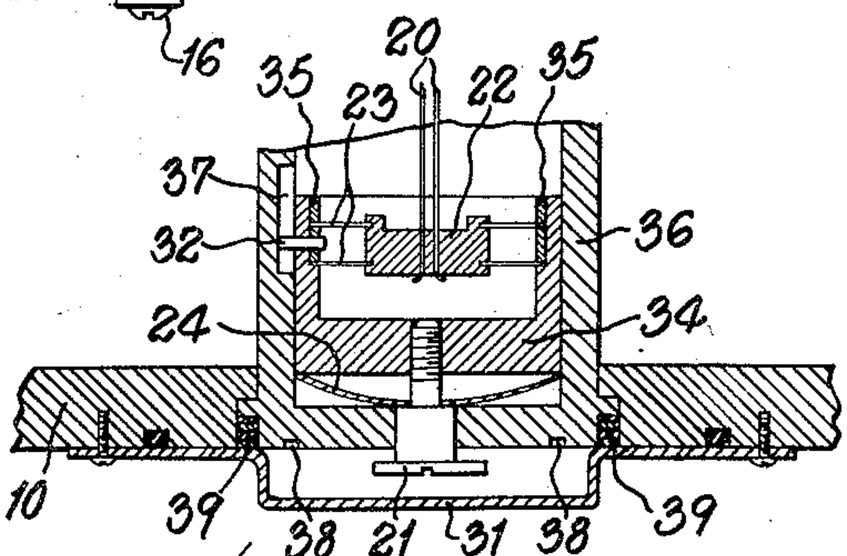


Fig. 4.



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HIGH SENSITIVITY ELECTRICAL RELAY

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Application August 25, 1955, Serial No. 530,580

8 Claims. (Cl. 200—87)

Our invention relates to high sensitivity relays and in particular to those types of relays which utilize torsion mounted arms.

An important object of our invention is to provide a sensitive electrical relay which is not affected by external shock and vibration.

A further object of our invention is to provide an electrical relay whose sensitivity may be adjusted.

Other objects and advantages of our invention will be apparent during the course of the following description.

In the accompanying drawings, forming a part of this application, and in which like numerals are employed to designate like parts throughout the same.

Figure 1 is a horizontal plan view, partly in section, of an embodiment of our invention,

Figure 2 is a side, elevation, partly in section, of the embodiment of Figure 1,

Figure 3 is an end elevation, partly in section, of the embodiment of Figure 1, and

Figure 4 is a section along the line 4—4 of Figure 1.

In the drawings, wherein for the purpose of illustration, is shown a preferred embodiment of our invention, the numeral **10** designates the relay case, the numeral **11** designates the relay arm, the numeral **12** designates the relay contacts, and the numeral **13** designates the relay base. The numeral **14** designates the solenoid armature, the numeral **15** designates the solenoid coil, the numeral **16** designates the mounting screws, and the numeral **17** designates the upper fixed contact.

The numeral **18** designates the lower fixed contact, the numeral **19** designates the relay frame, the numeral **20** designates the relay arm suspension, and the numeral **21** designates the tension adjustment screws. The numeral **22** designates the relay arm suspension anchor, the numeral **23** designates the double spiral cantilever springs, the numeral **24** designates the retaining springs, the numeral **25** designates the degassed liquid, and the numeral **26** designates the pressure relief valve. The numeral **27** designates the relay arm lead wire, the numeral **28** designates the lower fixed contact lead wire, the numeral **29** designates the upper fixed contact lead wire, the numeral **30** designates the solenoid lead wires, and the numeral **31** designates the sealing strips. The numeral **32** designates the mounting key, the numeral **34** designates the mounting block, the numeral **35** designates the retaining rings, and the numeral **36** designates the mounting shell. The numeral **37** designates the slot in which mounting key **32** is seated. Holes **38** are provided so as to permit armature **14** to be properly centered and lock ring **39** holds mounting shell **36** in position.

In the preferred embodiment of our invention, shown in the figures, the relay base **13** is mounted to the outer case **10** by means of mounting screws **16** and rigidly affixed thereto. Outer case **10** is filled with a degassed liquid **25** such as carbon tetrachloride or the like, under pressure, and is hermetically sealed. Pressure relief valve **26** is provided to act as a pressure release in the event

that the pressure within the case **10** becomes excessive. Relay arm **11** is constructed so that its average density is substantially equal to the density of liquid **25**. For example, this may be accomplished by constructing relay arm **11** of light weight plastic with a sealed hollow interior chamber containing air. A thin light weight metallic conductor may then be bonded along the length of arm **11** to electrically connect arm lead **27** to arm contacts **12**. Arm lead **27** is brought out through a seal in case **10**. This additional metallic conductor is not required if arm **11** is constructed of conductive material. Lower fixed contact **18** is affixed to base **13** and may be insulated therefrom or electrically connected thereto depending upon the application in which the relay is to be used. Lower fixed contact lead **28** is electrically connected to lower fixed contact **18** and brought out through a seal in outer case **10**.

Upper fixed contact **17** is insulated from frame **19** and electrically connected to upper fixed contact lead **29** which is brought out through a seal in outer case **10**. Solenoid armature **14** is fixedly attached to relay arm **11** and is acted upon by solenoid coil **15** whose electrical leads **30** are brought out through seals in outer case **10**. When current flows in the external electrical circuit associated with leads **30**, solenoid armature **14** is pulled down and contact is made between **12** and **17** and the associated external electrical circuit is closed. At the same time contact is broken between **12** and **18** and the associated external electrical circuit is opened. When no current flows in solenoid coil **15**, solenoid armature **14** is moved upwards by the action of the relay arm suspension **20** and the contact between **12** and **18** is closed and that between **12** and **17** is opened.

Relay arm **11** is center supported by relay arm suspension **20**. This suspension is of the torsion type and may be constructed of the bifilar wires illustrated in the figures or a flat strip or a single torsion wire on each side of armature **11**. The sensitivity of the relay is adjusted by adjusting the tension of the relay arm suspension **20**. This is accomplished by adjusting tension adjustment screws **21** which are threaded differentially where they enter the rotatable housings **36** and at their ends where they enter the suspension anchor mounts **34**. Tension adjustment screws **21** are made so that they cannot fall inside housings **36** in their most extreme clockwise positions. The embodiment of our invention illustrates two tension adjustment screws **21** used in conjunction with the associated units described but relays embodying our invention may be constructed utilizing only a single such adjustment. Relay arm suspension anchor **22** is held in position by a pair of double spiral cantilever springs **23** which are suitably held by mounting keys **32** and retaining rings **35**. Retaining spring **24** serves to eliminate any play due to looseness of fit in the assembly. Pin **32** fits into a keyway or slot **37** to prevent rotation of mount **34** with respect to housing **36** so rotation of **21** moves the associated relay suspension anchor mount **34** toward or away from case **10** and thus increases or decreases the tension on assocaited relay arm suspension **20** through springs **23**. Housing **36** may be rotated within case **10** by means of a spanner wrench or similar tool inserted in holes **38** to provide a means of adjusting the normal static position of relay armature **11**. Locking ring **39** can be tightened to secure this adjustment. Sealing caps **31** serve to seal the case **10** and to protect tension adjustment screws **21** and position of housing **36** from accidental movement or misadjustment.

The tension of the relay arm suspensions **20** may be balanced by suitable adjustment of **21**. The center support suspension provides dynamic balancing of the relay arm **11** enabling it to resist rotational motion caused by linear acceleration in any of the three coordinate axes.

The torsion suspension reduces friction and breakage and hysteresis common in bearing mounted armatures.

The liquid **25** provides motional damping thus materially reducing or eliminating relay chatter due to both mechanical vibration and high frequency interfering currents in the solenoid coil **15**. **25** also provides better electrical resistance between the contacts and improves the arc suppression when the contacts are opened. Liquid **25** impregnates solenoid coil **15** and by conducting heat away from **15**, lessens the chance of the coil's burning out due to current overloads.

The pressure relief plug **26** serves as a pressure relief mechanism to prevent blowout at elevated temperatures. The average density of relay arm **11** is made equal to the density of liquid **25** so that there is no effect on the relay assembly due to external shock or vibration.

Because of the increase in resistance between the contacts, the employment of the torsion suspension, and the utilization of the degassed ffuid within a hermetically sealed case, it is feasible and practical to manufacture electrical relays, in accordance with our invention, which are smaller in size, capable of higher current carrying capacity, and less affected by external shock and vibration than relays which are now being manufactured and used.

While we have shown only one embodiment of our invention, it will be recognized that this is only by way of illustration of general principles and that our invention is not limited to the particular means illustrated, but various changes, modifications and alterations may be made without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described our invention, we claim:

1. An electrical relay comprising an arm mounted on a pair of bifilar torsion suspensions; each said suspension being formed of thin resilient material; each said suspension being fixedly attached to one side of said arm and substantially at right angles thereto; said arm having at least one electrical contact affixed thereto; enclosing means isolating said relay from the surrounding medium; the end of one of said bifilar torsion suspensions opposite said arm being affixed to tension adjusting means; the end of the other of said bifilar suspensions being affixed to said enclosing means; fluid means contained within said enclosing means; the average density of said arm being substantially equal to the density of said fluid means; said tension adjusting means comprising a first cup-shaped housing within said enclosing means, a second cup-shaped housing mounted within said first housing and movable with respect thereto, said first housing being keyed whereby the relative movement of said second housing with respect to said first housing is limited, a retaining ring affixed to the inner surface of said second housing, said retaining ring supporting a pair of cantilever springs to which is attached an anchor, said bifilar torsion being affixed to said anchor, and means for adjusting the position of said second housing with respect to said first housing.

2. An electrical relay as described in claim 1 wherein said means for adjusting the position of said second housing with respect to said first housing is a differentially threaded screw.

3. An electrical relay as described in claim 1 wherein said first housing is movable with respect to said enclosing means.

4. An electrical relay comprising an arm mounted on a pair of bifilar torsion suspensions; each of said bifilar suspensions being formed of thin resilient material; each said bifilar suspension being affixed to one side of said arm and substantially at right angles thereto; said arm having at least one electrical contact affixed thereto; enclosing means isolating said relay from the surrounding medium, the ends of both of said bifilar suspensions opposite said arm being affixed to tension adjusting means; fluid means contained within said enclosing means; the average density of said arm being substantially equal to the density of said fluid means.

5. An electrical relay comprising in combination an elongated arm having at least one contact fixed near one end thereof, a thin reslient torsion suspension element fixedly attached substantially at right angles to said arm at a position spaced from said contact to provide a pivot point about which said arm is disposed to move, magnetic actuating means to cause said arm to move disposed on the other side of said pivot point from said contact, an envelope for isolating said arm and said actuating means from the surrounding medium, one end of said torsion suspension element being fixed with respect to said envelope, and tension and torsion adjusting means connected to the other end of said torsion suspension element constructed for manipulation externally of said envelope thereby to obtain a fine degree of control over the operation of said relay.

6. An electrical relay as described in claim 5 wherein a fluid is contained within said envelope, said fluid having a density substantially equal to the density of said arm.

7. An electrical relay as described in claim 5 wherein a fluid is contained within said envelope, said fluid having a density substantially equal to the density of said arm.

8. An electrical relay comprising in combination an elongated arm having at least one contact connected thereto, a pair of bifilar torsion suspension elements each formed of a thin resilient material, fixedly attached substantially at right angles to said arm to serve as a pivot for the motion of said arm, means for magnetically actuating said arm, said actuating means and said contact being disposed on opposite sides of said pivot, enclosing means for isolating said relay from the surrounding medium, wherein the end of at least one of the bifilar suspension elements of said pair is fixed to tension and torsion adjusting means, and the end of the other element of said pair is fixed with respect to said enclosing means, and a fluid contained within said enclosing means, the average density of said arm and of said fluid being substantially equal.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,850,593 September 2, 1958

Frank A. Hoover et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 3, line 19, for "ffuid" read -- fluid --; column 4, lines 32 to 35, strike out "a fluid is contained within said envolope, said fluid having a density substantially equal to the density of said arm." and insert instead -- said resilient torsion suspension element is of a bifilar type. --.

Signed and sealed this 18th day of November 1958.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents