May 5, 1964 M. L. ABEL ETAL 3,132,268

MOTION E.M.F. GENERATING TRANSDUCER

Filed March 5, 1962 2 Sheets-Sheet 1

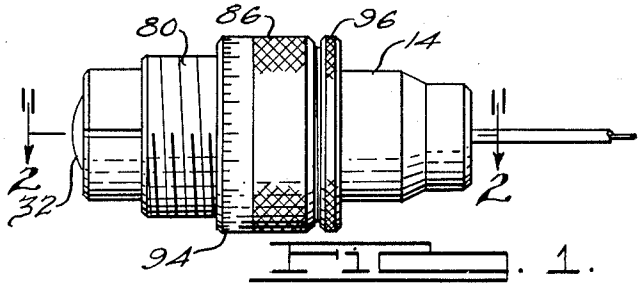


Fig. 1.

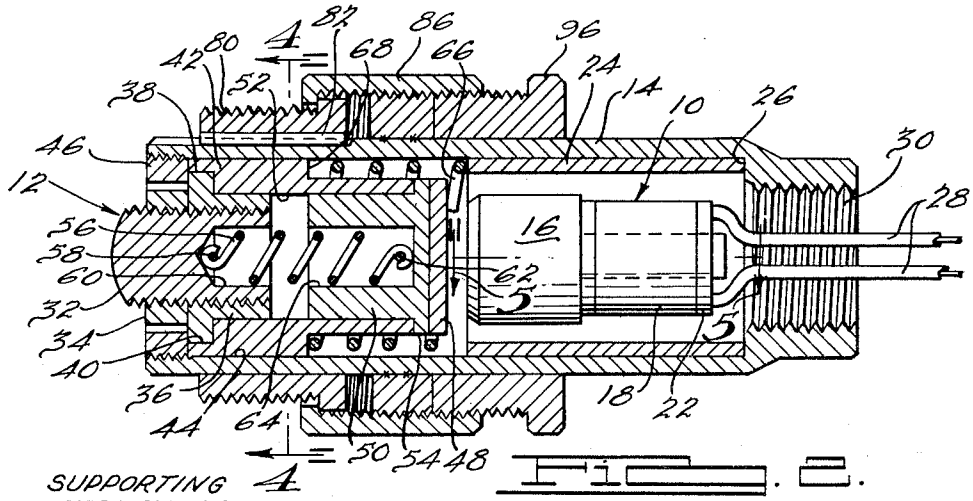


Fig. 2.

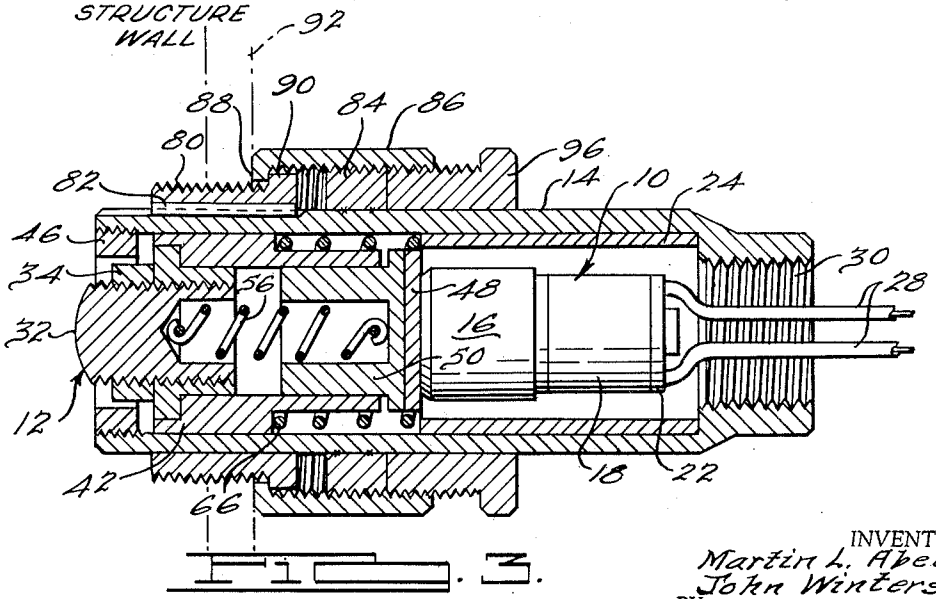


Fig. 3.

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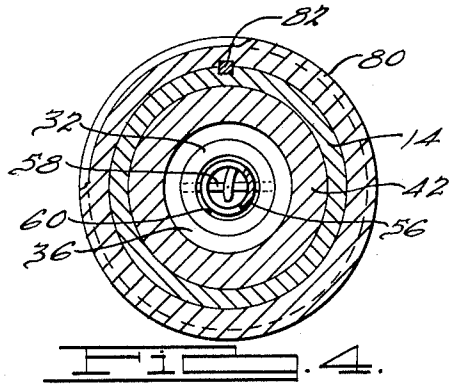


Fig. 4.

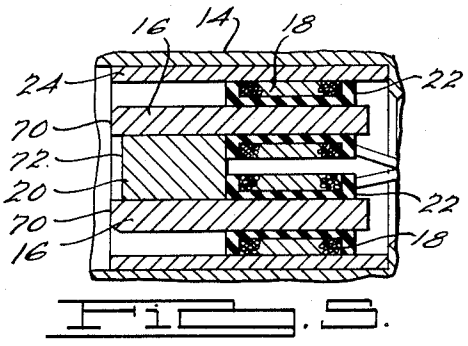


Fig. 5.

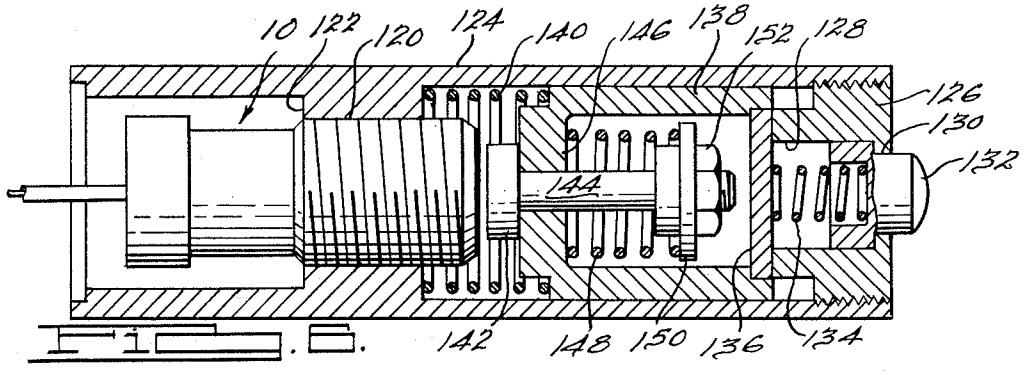


Fig. 6.

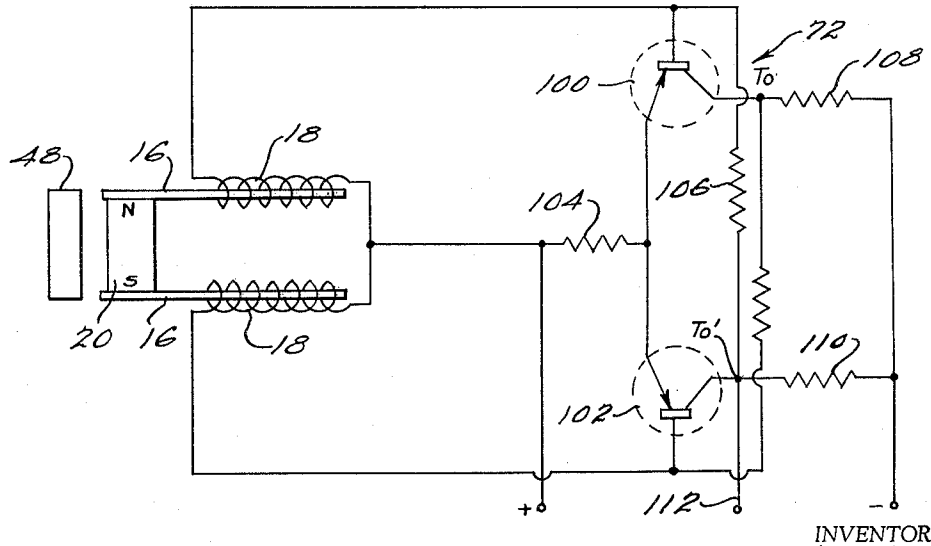


Fig. 7.

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MOTION E.M.F. GENERATING TRANSDUCER

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10 Claims. (Cl. 310—15)

This invention relates to a generator of the type adapted to sense a condition and to operate an electrical circuit in response thereto. More particularly, the invention consists in the provision of a transducer and a triggering device associated therewith for energizing the transducer to operate an electrical control circuit in response to movement of the triggering device. The invention is characterized by the fact that the triggering device includes a movable contact button which will energize the transducer to generate a control signal of constant strength independent of the rate at which the contact button is moved. The point at which the triggering device energizes the transducer is also very accurately controlled so that the control signal is generated at a precise point within extremely small tolerances during each cycle of operation.

A principal object of the invention is to provide a new and improved generator for operating an electrical circuit.

Another object of the invention is to provide a generator comprising a transducer and a triggering device therefor which will energize the transducer to operate a solid state electrical circuit which performs a switching function with extreme accuracy.

Another object of the invention is to provide a triggering device for a transducer which will energize the transducer to cause the latter to emit a control signal of constant strength regardless of the rate of movement of the triggering device.

Other and further objects of the invention will be apparent from the following description and claims and may be understood by reference to the accompanying drawings, of which there are two sheets, which by way of illustration show preferred embodiments of the invention and what we now consider to be the best mode of applying the principles thereof. Other embodiments of the invention may be used without departing from the scope of the present invention as set forth in the appended claims.

In the drawings:

FIG. 1 is an elevational view of a generator according to the present invention;

FIG. 2 is an enlarged sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a view similar to FIG. 2 but showing the parts in a different operative position thereof;

FIG. 4 is a sectional view taken on line 4—4 of FIG. 2;

FIG. 5 is a sectional view taken on line 5—5 of FIG. 2;

FIG. 6 is a sectional view illustrating a modified form of the invention; and

FIG. 7 is a circuit diagram illustrating one type of electrical circuit that may be used in conjunction with the transducer.

The present invention comprises a transducer 10 together with a triggering device 12, both contained within a tubular housing 14. Referring to FIG. 5, the transducer 10 comprises a pair of iron cores or pole pieces 16 each having a coil 18 of fine wire wrapped around one end thereof and a permanent magnet 20 disposed between the other ends of the cores 16. The coils 18 are wound onto insulating spools 22 which are fitted over the ends of the cores 16. The permanent magnet 20 is arranged so that one of its poles faces one of the cores 16 while its opposite pole faces the other core 16. The transducer is encased within an insulating sleeve 24 which is inserted into the housing 14 to abut a shoulder 26 at the inner

end thereof, with the lead wires 28 extending outwardly through a threaded opening 30 in the housing 14.

The triggering device 12 comprises a contact button 32 which is exteriorly threaded to receive a lock nut 34 which engages a collar 36 which is also threaded onto the contact button 32 and is provided with a radial shoulder 38 engaging within a counterbore 40 in a sleeve 42 which is slidable within the bore 44 defining the inner wall of the housing 14. An exteriorly threaded washer 46 is threaded into the outer end of the bore 44 and is engaged by the sleeve 42 and the collar 36 to provide a stop limiting outward movement of such parts.

An armature consisting of a soft iron disc 48 secured to a member 50 is slidable within the central bore 52 of the sleeve 42. A shoulder 54 on the member 50 engages the inner end of the sleeve 42 and is held thereagainst by a spring 56 which is secured at one end to a pin 58 extending across a recess 60 in the contact button 32 and secured at its other end to a pin 62 disposed within a recess 64 in the member 50. Obviously the disc 48 and the member 50 may be made integral is desired. A spring 66 is confined between one end of the sleeve 24 and a radial shoulder 68 on the sleeve 42 and urges the latter against the stop 46.

The contact button 32 is adapted to be engaged by a force transmitting member which will impart movement to the contact button in response to a change in the condition being sensed. The parts are shown in FIG. 2 in the position they occupy when the force applied to the contact button has not yet reached a value sufficient to depress the contact button out of engagement with the stop 46. As the contact button 32 is depressed, the collar 38, sleeve 42 and armature 48 will be depressed as a unit against the force of the spring 66 to move the armature toward the exposed ends 70 of the cores 16 which extend a slight distance beyond the outer end 72 of the permanent magnet 20. When the armature 48 is spaced a certain predetermined distance from the ends 70 of the cores 16, the magnetic force will snap the armature 48 into engagement with the cores 16 against the force of spring 56, thereby moving the lines of flux over the coils 18 to induce an electromotive force which is supplied to a solid state electrical circuit indicated generally at 72 in FIG. 7, which is designed to perform a switching function to control any suitable electrical component such as a solenoid valve.

It will be seen that the strength of the control signal that is generated in the transducer 10 is independent of the rate at which the contact button 32 is depressed because the armature 48 is free to move away from the sleeve 42 into engagement with the cores 16 when the magnetic attraction overcomes the force of the spring 56. The force of spring 56 is of course constant as the armature is moved toward the transducer and the magnetic attraction of the transducer increases rapidly as the armature 48 approaches the cores 16, so that the rapid movement of the armature into engagement with the cores will occur at a precisely controlled point or at a precise spacing of the armature from the cores. The parts are shown in FIG. 3 in the position they occupy after the armature has been pulled into engagement with the pole pieces to generate a control signal. The rate at which the armature is snapped into engagement with the poles will always be the same so that the strength of the signal emitted will be constant and independent of the rate at which the contact button is depressed.

As the contact button is released, another control signal is generated which will also be of constant strength and independent of the rate of movement of the contact button. Upon release of the contact button the spring 66 forces the sleeve 42 toward the stop 46 while the armature 48 remains in engagement with the cores 16 due to

the magnetic attraction thereof. The spring **56** is thereby stretched to exert an increasingly greater pull on the armature and, when the force exerted by the spring **56** exceeds the magnetic force, the armature will be pulled rapidly away from the cores **16** into engagement with the sleeve **42**, thereby inducing another control signal in the coils **18**.

The device may be made to accurately detect the position of an object which engages the contact button by means of a micrometer adjustment which comprises an exteriorly threaded sleeve **80** which is axially slidably but nonrotatably mounted on the exterior of the housing **14** by means of a key **82**. A collar **84** is fixedly secured on the housing **14** and is exteriorly threaded to mesh with a calibrating sleeve **86** provided with an inwardly turned shoulder **88** engaging an outwardly extending shoulder **90** on the sleeve **80**. The sleeve **80** is threaded into a threaded opening in a wall indicated at **92** to engage the contact button **32** with the load or a force transmitting member. The inwardly turned shoulder **88** on the calibrating sleeve **86** abuts against the wall **92** and also is engaged by the shoulder **90** on the sleeve **80**. The sleeve **86** is provided with micrometer markings **94**, and a stationary part such as the wall **92** may be provided with a hairline so that the proper micrometer marking on the sleeve **86** which may be in pounds of force can be aligned therewith. As the micrometer sleeve **86** is rotated, the housing **14** and the threaded collar **84** carried thereby and meshed with the micrometer sleeve will slide axially inwardly or outwardly through the sleeve **80** until the desired reading is obtained. This adjustment of course varies the position of the contact button relative to the force transmitting member so that the device may be made to generate the control signal at any selected value. The micrometer sleeve may be locked by a lock nut **96**.

The transducer may be used in conjunction with any suitable circuit such as the circuit **72** shown in FIG. 7, which is illustrative only. The circuit shown in FIG. 7 may comprise the coils **18** which are wound so that the voltage developed in the coils as the armature is moved toward or away from the ends of the cores **16** will be of opposite polarity. The circuit further includes transistors **100** and **102**, resistances **104**, **106**, **108** and **110**, and an output terminal **112**. The output terminals of the transistors **100** and **102** are indicated at To and To' respectively. When power is supplied to the circuit, one of the transistors will shortly be conducting the current while the other is cut off, which constitutes one of the two stable states of the circuit. If, for example, the transistor **100** is conducting and the armature **48** is moved into engagement with the ends of the cores **16** in the manner described so as to produce a negative voltage exceeding the voltage developed across resistor **104** to be applied to the base of transistor **102** and a positive voltage to be applied to the base of transistor **100**, transistor **102** will then start conducting and reducing the amount that transistor **100** is conducting, which action once begun will continue rapidly until transistor **102** is conducting heavily while transistor **100** is cut off. The output may then by taken from the collector of transistor **102**. This represents the other stable state of the circuit. When armature **48** is moved away from the cores **16**, another voltage is generated which will be negative on the base of transistor **100** and positive on the base of transistor **102**, thereby to return the circuit to its other stable condition. The circuit is therefore a switching circuit and may be used to control any suitable electrically operated device such as a solenoid operated valve, an ignition circuit, or any other electrically actuated device. It will be apparent that other types of switching circuits may be employed and that the circuit illustrated forms no part of the present invention.

In the form of the invention illustrated in FIG. 6, the transducer **10** may be of the same construction previously described and in this case it is contained within a threaded

insulating casing **120** which is threaded into an internal shoulder **122** formed in the housing **124**. At its other end the housing **124** is threaded to receive a stop collar **126** having a recess **128** and a coaxial bore **130** within which the contact button **132** reciprocates. A spring **134** is confined between the contact button **132** and an annular disc **136** which engages an internal shoulder on the sleeve **138**. A spring **140** confined between the internal shoulder **122** on the housing and the sleeve **138** urges the sleeve **138** and the disc **136** into the engagement with the collar **126**.

The armature **142** is secured to a rod **144** which extends slidably through the bottom wall **146** of the housing **138**. A spring **148** is confined between the wall **146** of the sleeve and a washer **150** on the rod **144** which engages a nut **152** threaded onto the outer end of the rod **144**. When the contact button **132** is depressed by a force applied thereto, the spring **134** will be compressed and eventually will force the disc **136** and sleeve **138** inwardly against the spring **140** carrying the armature **142** toward the cores of the transducer. At a predetermined point, the magnetic force will rapidly move the armature **142** into engagement with the cores, thereby compressing spring **148**. When the force applied to the contact button is reduced, the spring **140** will move the sleeve **138** outwardly, further compressing spring **148** until the force of the latter spring exceeds the magnetic force holding the armature in position and at a predetermined point the armature will move rapidly out of engagement with the cores, thereby generating a second control signal. The device shown in FIG. 6 may also be provided with a micrometer adjustment if desired. The spring **134** allows some overtravel of the contact button **132** beyond that necessary to energize the transducer.

Since the rate at which the armature in either form of the invention moves toward the cores of the transducer is independent of the rate of movement of the contact button, the transducer will always generate a sufficiently strong signal of constant value to operate the control circuit. Thus with the present construction it is not possible for the contact button to be moved so slowly as to fail to induce sufficient current in the coils to energize the control circuit as is possible with prior art devices.

While we have illustrated and described preferred embodiments of our invention, it is understood that these are capable of modification, and we therefore do not wish to be limited to the precise details set forth but desire to avail ourselves of such changes and alterations as fall within the purview of the following claims.

We claim:

1. In a device for sensing a condition and operating an electrical circuit in response thereto including a core having a coil wound thereon and a permanent magnet associated therewith, an armature movable into and out of engagement with said core, an actuating member adapted for movement in response to change in the condition being sensed, a motion transmitting connection between said armature and said actuating member so that said armature is movable with said actuating member toward said core until said armature is spaced a predetermined distance from said core whereupon the magnetic attraction causes said armature to snap into engagement with said core thereby to induce a current in said coil independent of the rate of movement of said actuating member, and a spring connecting said actuating member and said armature for urging said armature into engagement with said actuating member but permitting movement of the latter away from said core while said armature remains in engagement therewith until said spring overcomes said magnetic attraction and pulls said armature away from said core and into engagement with said actuating member thereby to induce a second current in said coil independent of the rate of movement of said actuating member.

2. In combination with a transducer device including a core having a coil wound thereon and a permanent

magnet associated therewith, a triggering device for energizing said coil in response to a change in a condition being sensed, comprising an armature movable into and out of engagement with said core, an actuating member adapted for movement in response to change in the condition being sensed, a motion transmitting connection between said armature and said actuating member so that said armature is movable with said actuating member toward said core until said armature is spaced a predetermined distance from said core whereupon the magnetic attraction causes said armature to snap into engagement with said core thereby to induce a current in said coil independent of the rate of movement of said actuating member, and a spring connecting said actuating member and said armature for urging said armature into engagement with said actuating member but permitting movement of the latter away from said core while said armature remains in engagement therewith until said spring pulls said armature away from said core and into engagement with said actuating member thereby to induce a second current in said coil independent of the rate of movement of said actuating member.

3. In a transducer for sensing a condition and operating an electrical circuit in response thereto including a core having a coil wound thereon and a permanent magnet associated therewith, an armature movable into and out of engagement with said core, an actuating member adapted for movement in response to change in the condition being sensed, a motion transmitting connection between said armature and said actuating member so that said armature is movable with said actuating member toward said core until said armature is spaced a predetermined distance from said core whereupon the magnetic attraction causes said armature to snap into engagement with said core thereby to induce a current in said coil independent of the rate of movement of said actuating member.

4. A transducer according to claim 3 including spring means urging said armature into engagement with said actuating member.

5. A transducer according to claim 4 including a spring urging said acuating member away from said core.

6. In a transducer for sensing a condition and operating an electrical circuit in response thereto, a pair of iron cores each having a coil wound thereon at one end thereof and a permanent ceramic magnet between the opposite ends of said cores, a housing, said transducer being mounted in one end of said housing, a triggering device mounted within the other end of said housing comprising an actuating member slidably mounted in said housing for movement toward and away from said transducer, a stop limiting movement of said actuating member away from said transducer, a spring urging said actuating member into engagement with said stop, an armature slidably mounted on said actuating member and opposed to the ends of said cores, said actuating member engaging said armature so that said armature is movable therewith toward said cores as a load is applied to said actuating member until said armature is spaced a predetermined distance from said cores whereupon the magnetic attraction causes said armature to snap into engagement with said cores thereby to induce a current in said coils the value of which is independent of the rate of movement of said actuating member, and a spring connecting said actuating member and said armature permitting movement of said actuating member away from said cores while said armature remains in engagement therewith as the load on said actuating member is decreased until said spring pulls said armature away from said cores and into engagement with said actuating member thereby to again induce a current in said coils the value of which is independent of the rate of movement of said actuating member.

7. In an actuating device for a transducer including a core having a coil wound thereon and a permanent magnet associated therewith, an armature movable into and out of engagement with said core, an actuating member, a motion transmitting connection between said armature and said actuating member so that said armature is movable with said actuating member toward said core until said armature is spaced a predetermined distance from said core whereupon the magnetic attraction causes said armature to snap into engagement with said core thereby to induce a current in said coil independent of the rate of movement of said actuating member.

8. In an actuating device for a transducer including a core having a coil wound thereon and a permanent magnet associated therewith, an armature movable into and out of engagement with said core, an actuating member, a motion transmitting connection between said armature and said actuating member so that said armature is movable with said actuating member toward said core until said armature is spaced a predetermined distance from said core whereupon the magnetic attraction causes said armature to snap into engagement with said core thereby to induce a current in said coil independent of the rate of movement of said actuating member, and a spring urging said armature into engagement with said actuating member but permitting movement of the latter away from said core while said armature remains in engagement therewith until said spring overcomes said magnetic attraction and pulls said armature away from said core and into engagement with said actuating member thereby to induce a second current in said coil independent of the rate of movement of said actuating member.

9. In a device for sensing a condition and operating an electrical circuit in response thereto, a pair of iron cores each having a coil wound thereon at one end thereof and a permanent magnet between the opposite ends of said cores, an actuating member movable in response to a change in the condition being sensed, an armature opposed to the ends of said cores and movable into and out of engagement therewith, a motion transmitting connection between said armature and said actuating member so that said armature is movable with said actuating member toward said cores until said armature is spaced a predetermined distance from said cores whereupon the magnetic attraction causes said armature to snap into engagement with said cores thereby to induce a current in said coils the value of which is independent of the rate of movement of said actuating member, and a spring connected between said actuating member and said armature for urging said armature into engagement with said actuating member but permitting movement of the latter away from said cores while said armature remains in engagement therewith until the force of said spring overcomes said magnetic attraction to pull said armature away from said cores thereby to again induce a current in said coils the value of which is independent of the rate of movement of said actuating member.

10. A device according to claim 9 including a spring urging said actuating member away from said cores.

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