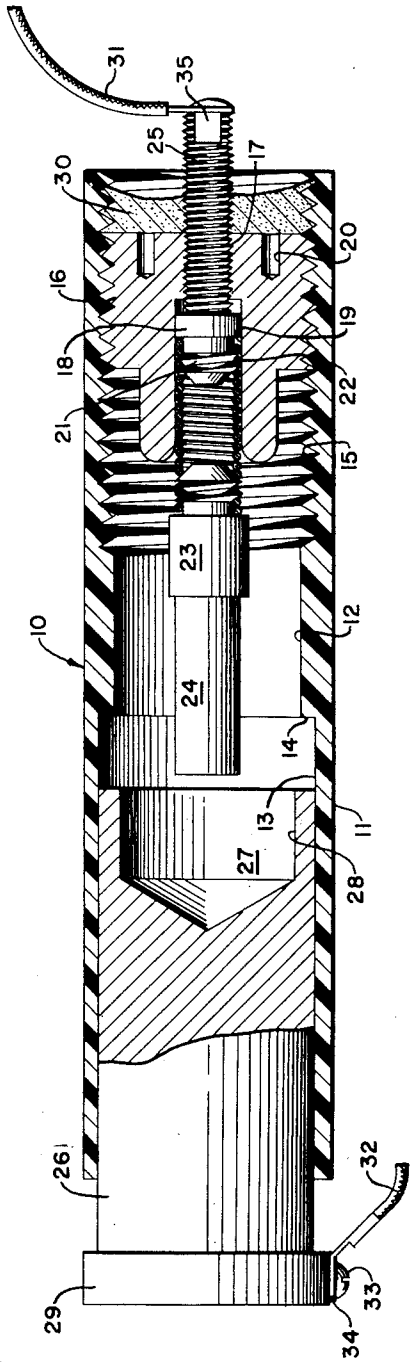
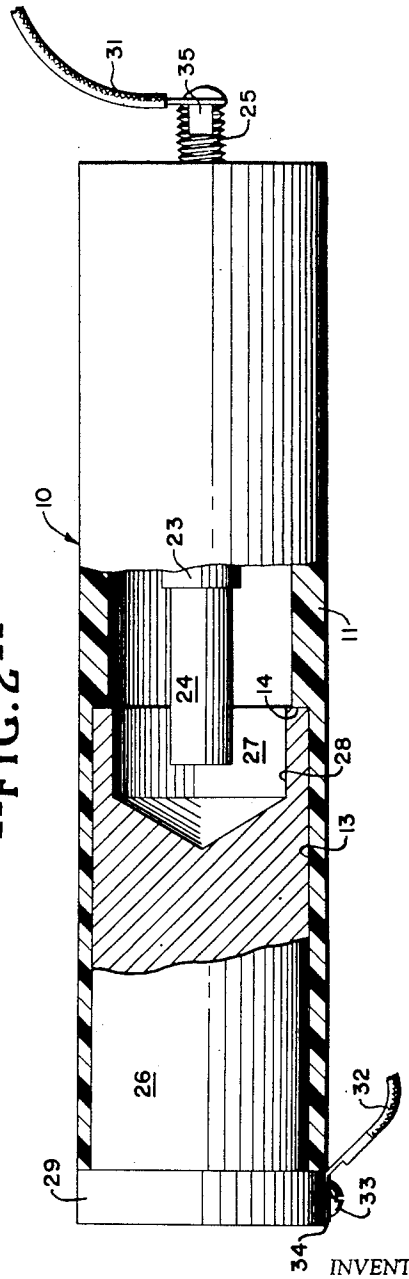
May 7, 1957 E. R. HABERLAND 2,791,653

SENSITIVE IMPACT SWITCH WITH MAGNETIC HOLD

Filed July 12, 1955



--FIG.1--



--FIG.2--

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United States Patent Office 2,791,653
Patented May 7, 1957

2,791,653

SENSITIVE IMPACT SWITCH WITH MAGNETIC HOLD

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Application July 12, 1955, Serial No. 521,650

5 Claims. (Cl. 200—61.51)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to an impact switch and more particularly to a normally open impact switch having magnetic contact elements, one of which is permanently magnetized thereby to retain the switch in closed position after the switch has operated.

In devices of this character heretofore devised it has been the usual practice to provide a mass at one end of a spring in a cantilever type arrangement in which the mass is brought into momentary closure with the switch contact in response to an impact received by the switch.

In accordance with the present invention the switch is provided with a pair of contact elements composed of magnetic material, one of which elements is permanently magnetized and movable into contact engagement with the other element in response to a force received thereby having a component normal to the axis of the switch and regardless of the direction of such force. The switch is maintained closed by magnetic attraction between the contact elements, and is provided with means for preventing closure of the contacts until a movable element thereof has been moved from an initial safe position to a moved or armed position.

The device of the instant invention also provides means for preventing movement of the movable contact element in response to minute forces applied thereto whereby the switch contacts are closed only in response to a shock or impulse applied thereto of predetermined magnitude.

One of the objects of the present invention is to provide an impulse switch having an inertial contact member movable into contact engagement with an annular contact member in response to a sudden force applied thereto of predetermined magnitude in which new and improved means are provided for preventing movement of the movable contact element in response to forces of lesser magnitude.

Another object is the provision of an impact switch having a magnetic element normally maintained in fixed spaced relation with respect to a second complementary magnetic contact element while minute forces are received thereby and movable into engagement with the second contact element only when the forces have reached a predetermined degree of strength and in which new and improved means are provided for preventing disengagement of the contacts after the force has subsided.

A still further object is to provide an impulse switch having an inertial element composed of magnetic material and adapted for movement into engagement with a complementary magnetic element in which new and improved means are provided for preventing movement of the inertial element with respect to the complementary contact element until the force applied thereto has reached a predetermined degree of strength and in which means are provided for controlling the sensitivity of the switch.

A still further object resides in an impulse actuated switch having an inertial member constructed and arranged to be moved from an initial fixed position only when a shock of predetermined strength is applied thereto and in which new and improved means are provided for rendering such movement ineffective to close the switch contacts until the switch has been armed.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a view partially in section of the device of the present invention according to a preferred embodiment thereof and with the switch in an unarmed position; and

Fig. 2 is a view partially in section and partially broken away showing the switch in the armed position.

Referring now to the drawing for a more complete understanding of the invention on which like numerals of reference are employed to designate like parts throughout the several views and more particularly to Fig. 1, thereof, there is shown thereon an impulse switch indicated generally by the reference numeral **10** comprising a cylindrical casing **11** composed of insulating material suitable for the purpose such for example, as a material known in the art as mica base phenolic. The casing is provided with a bore **12** and a bore **13** of greater diameter than the bore **12** and disposed coaxially therewith thereby forming a shoulder **14**, the purpose of which will become more clearly apparent as the description proceeds. The casing is also threaded as at **15** to receive a base member **16** threadedly engaged therein and composed of metal suitable for the purpose such, for example, as brass. The base member **16** is threaded into the casing **11** by a tool, for example, a spanner, adapted to engage the bores **20** therein.

The base member is also threaded as at **17** to receive a sensitivity adjusting rod **25** threaded therein and having an end portion thereof comprising a cylindrical bearing member **18** disposed within a bore **19** formed within the base member coaxially with the threaded portion **17** thereof. The rod **25** is also threaded as at **21** to receive and grip a spring **22** whereby the spring **22** may be moved to a selected position within the bore **19** by the adjusting rod such that a predetermined free length thereof projects beyond the end of the bore **19** selectively in accordance with the instant setting of the rod.

The other end of spring **22** is secured to a cup-shaped member **23** as in the manner illustrated whereby the cup-shaped member is carried by the spring **22** and movable from an initial fixed position as the spring **22** is flexed. Secured within the cup-shaped member at one end thereof is a cylindrical bar magnet **24** composed of magnetic material suitable for the purpose such, for example, as a material known in the art is "Alnico II."

The spring **22** is composed of spring material such, for example, as stainless steel, a wire diameter of .012 inch having been found suitable for the purpose The turns of the spring are tightly wound and are initially tensioned together with a force such, for example, as 30 grams between turns whereby the spring maintains an original rigid condition and supports the mass carried thereby in an initial fixed position until a force has been applied suddenly and laterally thereto by the base member **16** sufficient to disengage adjacent turns of the spring.

The adjusting rod **25** is provided with any suitable means such, for example, as the pair of flat surfaces **35** illustrated whereby the rod may be turned to a predetermined adjusted position by a suitable tool connected thereto. An arrangement is thus provided in which the effective free length of the spring **22** projecting beyond

the end of the bore **19** within the base member **16** is changed to control the response of the inertial element **24** to different degrees of force applied thereto. It should now be clearly apparent that the greater the free length of the spring **22** projecting beyond the bore **19**, the less force will be required to move the inertial magnetic member **24** from an initial fixed position within the casing **11**. The adjusted position of the rod **25** is maintained in any suitable manner as by a coating of cement **30** such as a thermosetting cement applied thereto in sufficient quantity to lock the rod to the base member **16** and casing **11**.

A cylindrical contact member **26** is fitted for sliding movement within bore **13** of the casing **11** and provided with a bore **27** therein having a contact surface **28** preferably cylindrical in configuration. The contact member **26** is composed of magnetic material such, for example, as soft iron and provided with a head **29** formed thereon by means of which the contact member **26** is moved from the safe or initial position, Fig. 1, in which the contact member is not engageable by inertial contact member **24** as the contact member **24** moves laterally in response to an impulse to the position herein referred to as an armed position, Fig. 2, in which the contact surface **27** of the contact member or keeper **26** is disposed within the path of movement of an end portion of the bar magnet **24**. When the bar magnet engages the keeper **26** it remains in contact therewith by reason of the force of magnetic attraction therebetween.

The contact member **26** is preferably provided with a coating of silver or other precious metal suitable for the purpose to improve the electrical contact of the contact element **24** therewith. It has also been found advantageous to provide a coating of silver between the bar magnet **24** and the cup formed in member **23** to provide good electrical connection therebetween. External electrical connections to the switch are provided by conductors **31** and **32**, the conductor **31** being secured to the end of the adjusting rod as by soldering the parts together and the conductor **32** being secured to the contact member **26** in any suitable manner as by the screw **33** threaded into the head **29** and the washer **34**.

The device is useful with many forms of ordnance devices in which a circuit is to be closed in response to an impulse of predetermined strength received thereby. It is particularly suitable, for example, for use in a moored mine in which the mine is secured y a mooring line beneath the surface of the water. In such an application, the contact member **26** remains in the initial safe position until the mine has been planted. When this occurs, the contact member **26** may be moved to the armed position, Fig. 2, by any suitable means, such, for example, as by a hydrostat. The conductors **31** and **32** may be placed in series with a source of low potential of the order of one and one half volts and a detonator suitable for operation at this voltage, an electrically fired blasting cap having been found to be suitable for use with this circuit arrangement. After the contact member **26** has been moved to the armed position, movement of the inertial magnetic member **24** with respect thereto in response to tide, wave action and the like, is prevented by reason of the rigidity of the tightly wound spring **22**. When the mine is struck by a moving vessel, however, the shock of the impact is sufficient to move the inertial contact member **24** into engagement with contact surface **28** of the member **26** and thereby close the firing circuit. When this occurs, contact element **24** remains in continuous contact with contact surface **28** by reason of the force of magnetic attraction therebetween and thus the firing circuit remains closed for a period of time sufficient to fire the detonator and explode the mine.

Whereas in the embodiment disclosed and described with particular reference to Figs. 1 and 2 of the drawings, the inertial member **24** comprises a permanent magnet and the contact member **26** is composed of magnetic material such as soft iron, it will be understood that this is by way of example only and that, if desired, the inertial member **24** may be composed of soft iron and the contact member **26** may be a permanent magnet. With this latter arrangement electrical contact between the contact elements will be improved by applying a coating of silver to the soft iron inertial member.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In an impact switch of the character disclosed, in combination, a cylindrical magnetic inertial contact member, a non-conducting tubular casing, means threaded within an end portion of said casing and having an axially disposed bore therein for supporting said inertial element in an initial position within said casing and coaxial therewith, said supporting means comprising a tightly wound pretensioned spring by which the inertial element is carried, said spring having a portion confined by said bore and a free portion exterior of the bore to which inertial element is secured, means for adjusting the effective length of said free portion of the spring, an annular contact member slideably disposed within said casing and having an interior contact surface of greater diameter than the diameter of said inertial member, and means for slideably moving said annular contact member from an initial position not engageable by said inertial contact member to a position encircling said inertial contact member and coaxial therewith whereby the inertial contact member is moved into engagement with said annular contact surface in response to an impact force applied to the switch, at least one of said contact members being permanently magnetized whereby electrical contact between the inertial member and the annular contact member is maintained after the force of impact has subsided.

2. In an impulse switch of the character disclosed, in combination, a tubular casing of non-conductive material, a base threaded within one end of said casing, said base having a threaded bore and an unthreaded larger bore coaxial therewith, an adjusting rod threaded within said base and having a shoulder thereon movably fitted within said larger bore and an end portion thereon extending within the larger bore, a pretensioned closely wound helical spring secured to said adjusting rod at the end portion thereof and closely fitted within the larger bore for rotative and sliding movement therein, said spring having a free end portion thereof extending beyond said larger bore, a rod-like bar magnet, means for securing one end of said bar magnet to sail free end of the spring and coaxial with said casing, a magnetic keeper having an annular contact surface formed therein slideably fitted within said casing, said contact surface being greater in diameter than said bar magnet, and means for moving said contact surface from a position beyond the end of said magnet to a position encircling the magnet whereby the magnet is moved into electrical and magnetic engagement with said annular contact surface in response to an impact of predetermined strength applied to the switch, said electric and magnetic engagement being maintained by the force of magnetic attraction between said magnet and said annular surface.

3. A switch according to claim 2 in which the adjusting rod is locked in a predetermined adjusted position by a coating of cement applied thereto.

4. An impulse switch of the character disclosed for use with a moored mine, comprising, in combination, an inertial magnetic contact element, a complementary annular magnetic contact element encircling said inertial element and disposed concentric therewith in spaced relation with respect thereto, a tightly wound pretensioned helical spring

supporting said inertial contact element in fixed position with respect to said complementary element while forces of predetermined character are applied to the switch and for allowing movement of the contact element into engagement with said complementary contact element in response to an impact of a character corresponding to the impact of a moving vessel against the mine, said contact elements remaining mutually engaged by the force of magnetic attraction therebetween, means on said switch forming a bore within which a fractional portion of the length of said spring is disposed and closely confined

thereby, and means settable at will for varying the length of said confined portion of the spring.

5. A switch according to claim 4 in which said bore terminates in an outwardly flaring surface contiguous therewith within which the spring is disposed.

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