

May 5, 1970

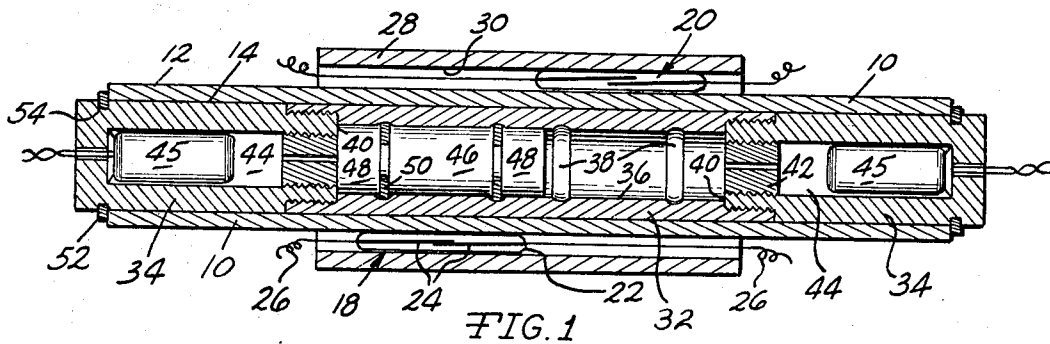
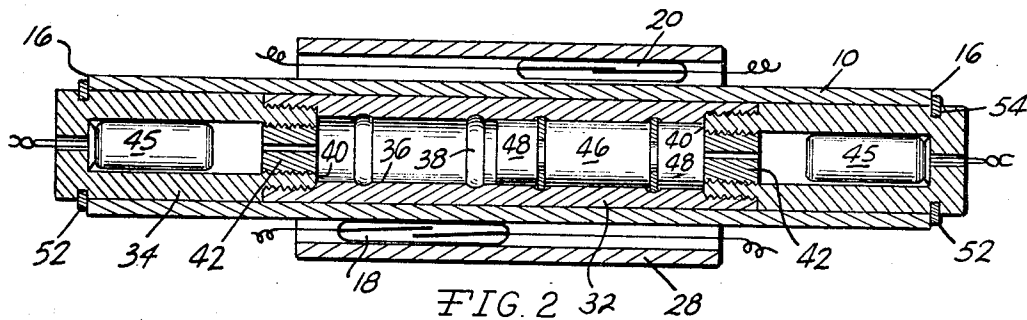
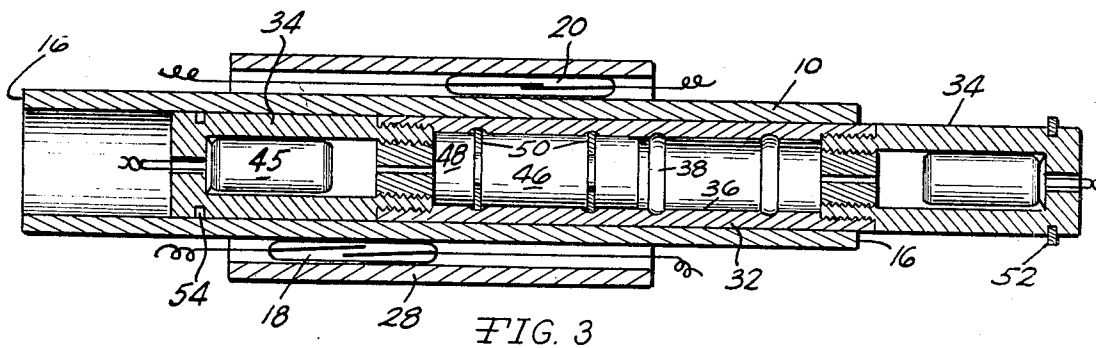
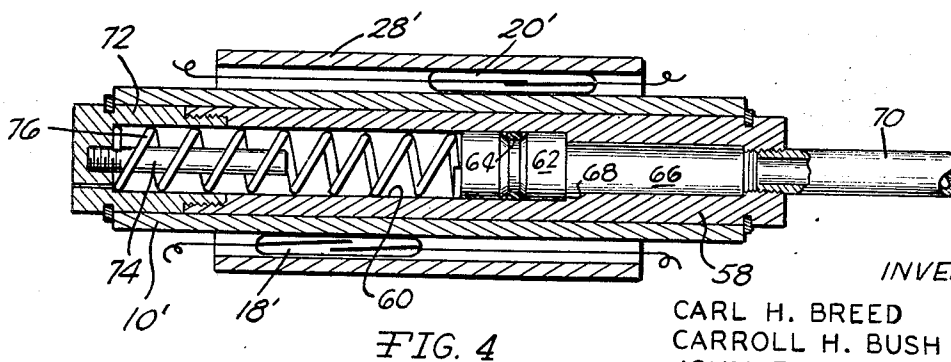
C. H. BREED ET AL

3,510,607

IMPULSE ACTUATED REED SWITCH

Filed Feb. 23, 1967

2 Sheets-Sheet 1



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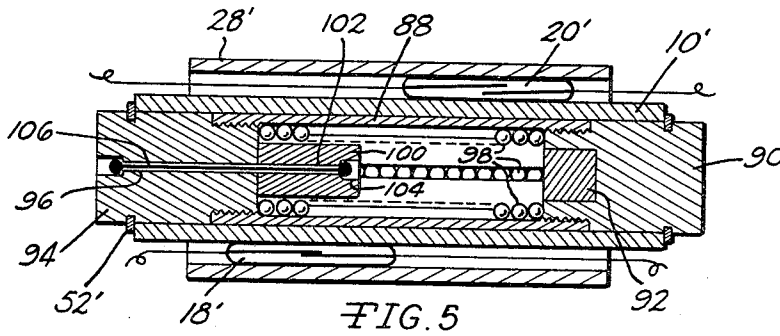
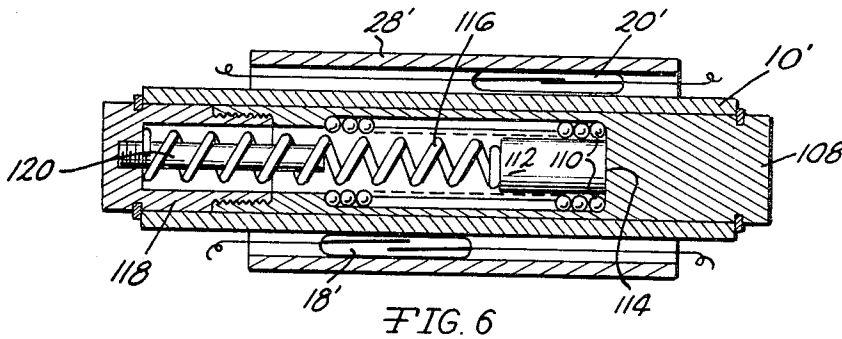
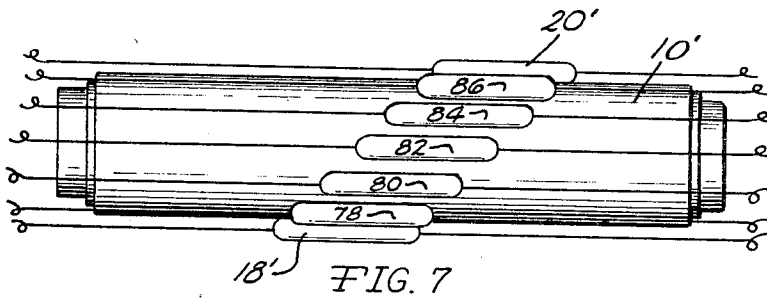
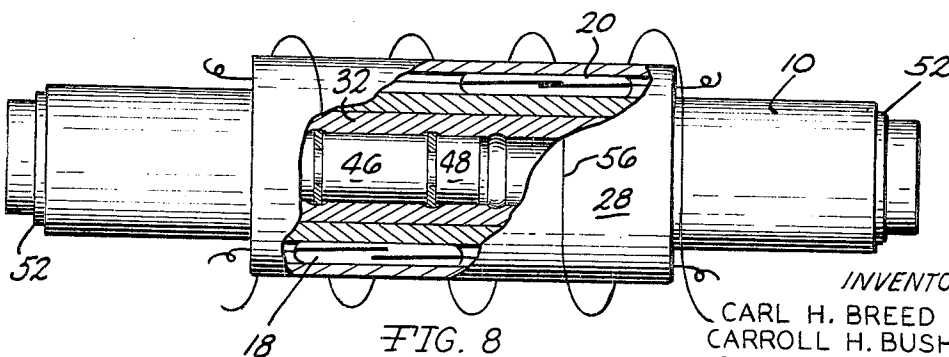
C. H. BREED ET AL

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IMPULSE ACTUATED REED SWITCH

Filed Feb. 23, 1967

2 Sheets-Sheet 2



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3,510,607

IMPULSE ACTUATED REED SWITCH

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U.S. Cl. 200—81

11 Claims

ABSTRACT OF THE DISCLOSURE

An impulse actuated reed switch employing an elongated tubular nonmagnetic member, having a linearly moveable magnet-piston assembly disposed within the tube so as to actuate a reed switch positioned adjacent to the tubular exterior, the magnet movement being caused by pressurized forces applied thereto.

Background of the invention

The invention pertains to reed switch apparatus wherein the reed contacts are caused to function in response to the linear movement of an adjacent magnet, the linear movement caused by pressurized forces. Such forces may be derived from pyrotechnics, acceleration, and applied pressures. Other aspects include hermetically sealed contacts; double-cycle reversible switch; sequential switching; high reliability magnet-piston actuation; manual and remote switch testing; and ease of refurbishing.

Electrical switches utilizing contacts mounted upon or part of small magnetic reeds within a controlled atmosphere, such that the reeds may be attracted or repelled with respect to each other by a magnetic field, are commonly known as reed switches. Reed switches are usually actuated by permanent magnets. Upon a magnet being brought into proximity with the reed switch, the reeds supporting the contacts are actuated by the magnetic field, usually to close the contacts, and when the magnet is removed from the area of the reed switch, the reeds will again actuate to open the switch contacts.

Dry reed switches have become a very common method of switching, particularly where high reliability and sealing is a requirement. A reed switch is comprised of two or more flexible ferromagnetic reed-like arms held in opposite ends, normally positioned in a small glass tube. The free ends, normally spaced apart when no magnetic field is present, are subjected to a magnetic field either by a surrounding current-carrying coil, or alternately by a permanent magnet. The reeds become magnetized by induction and the loose reed-like arms attract each other, thereby establishing electrical contact. When the field is weakened, the reeds spring apart to break the contact. Various forms of reed switch types include biasing coils, some employing multiple magnetic fields which cancel as well as add to establish and/or break contact. Other types include spring biased moveable reeds. Reed switch relays have also been produced which are simply reed switches mounted within a suitable energizing coil, with multiple operation attained by placing related switches within the provided electromagnet. A still further type includes resonant reed relays, such as disclosed in U.S. Pat. 3,209,100.

In U.S. Pat. 3,284,739, assigned to the assignee of the present invention, there is also described a rotary reed switch actuator which is adapted to operate a plurality of sealed reed switches wherein the sequence of switch actuation can be varied widely to provide for a desired logic output. U.S. Pats. 3,057,911 and 2,963,563 disclose

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moveable magnet switches responsive to flow characteristics.

Summary of the invention

It is the purpose of the instant invention to provide for a multi-function high reliability reed switch apparatus wherein the actuating mechanism is provided through an impulse.

The adjacent reed switches positioned exteriorly to the nonmagnetic tubular housing, can be fixed or adjustably positioned about the tubular housing so as to provide for any desired switch sequencing, which offers wide versatility and flexibility of design, yet is readily and economically manufactured.

Another feature of the invention is that the magnetic field induced by the permanent magnet which is linearly moveable within the tubular housing, can be used in both forward and reversed directions, presenting a unique feature for a two cycle and reversible explosive actuated switch mechanism.

The unique structural arrangement also enables pre-testing of the switch circuit without providing the actual actuating force by simply moving the function housing in the direction the magnet moves as if in actual operation. Testing may also be accomplished by utilizing an external magnetic force such as an electromagnet.

It is an object of the invention to provide an electric switch adapted to be operated by an impulse wherein the switch utilizes reed switches and magnet means are employed to cause the reed switches to function.

It is another object of the invention to provide an impulse-operated reed switch wherein the switch structure permits a plurality of reed switches to be utilized and operated by a single magnet.

A further object of the invention is to provide impulse-operated reed switch apparatus wherein, though the impulse may be produced by a "one shot" device, the switch components permit testing of the reed switch without operation of the impulse-producing device.

An additional object of the invention is to provide impulse-actuated reed switch apparatus wherein the reed switch actuating magnet is in the form of a piston translatable within a cylinder, and the impulse for moving the piston may be provided by a pressurized fluid.

Another object of the invention is to provide an impulse-actuated reed switch apparatus wherein biasing means may be employed to impose a force upon the switch operating magnet in opposition to the impulse force, permitting the impulse imposed upon the switch apparatus to be quantitatively determined, and wherein a plurality of reed switches may be used with the apparatus to permit an accurate determination of the magnitude of the impulse imposed upon the switch apparatus.

A further object of the invention is to provide reed switch apparatus which permits testing of the switch, and wherein such testing does not require that the switch function in a normal operating cycle.

A still further object of the invention is to provide for a two cycle and reversible impulse actuated reed switch.

A particular object of the invention is to provide for the remote selection and actuation of a reed switch mechanism.

Brief description of the drawings

These and other objects of the invention arising from the details and relationships of the components of embodiments will be apparent from the following description and accompanying drawings wherein:

FIG. 1 is a diametrical, sectional, elevational view of impulse reed switch apparatus in accord with the invention, wherein the impulse is produced by pyrotechnic

means, the magnet being shown in one position of operation within the sleeve,

FIG. 2 is an elevational, sectional view similar to FIG. 1, illustrating the magnet in the other operative position,

FIG. 3 is an elevational, sectional view of the embodiment of FIGS. 1 and 2, illustrating the relationship of the sleeve to the casing during testing of the reed switches,

FIG. 4 is a diametrical, elevational, sectional view of another embodiment of the invention adapted to be operated by a pressurized fluid medium,

FIG. 5 is an elevational, diametrical, sectional view of another embodiment of reed switch apparatus in accord with the invention for measuring acceleration or deceleration forces,

FIG. 6 is an elevational, diametrical, sectional view of another embodiment of the invention employed to measure various degrees of acceleration or deceleration forces,

FIG. 7 is an elevational view of an arrangement of a plurality of reed switches about the casing, the body protecting the reed switches being removed for purposes of illustration, and

FIG. 8 is an elevational, partly diametrically sectioned view of another embodiment of reed switch testing apparatus in accord with the invention.

The several embodiments of the invention illustrated in the drawings incorporate common structural components and these components will be appreciated in form and detail from the embodiments illustrated in FIGS. 1 through 3. A cylindrical casing 10 is provided of a nonmagnetic material, and is of a tubular form defining an outer surface 12 and an inner bore 14. The ends of the casing are defined by the radially extending surfaces 16.

At least one reed switch is disposed adjacent the casing exterior surface 12 and, in the illustrated embodiments, two reed switches are illustrated in FIGS. 1 through 3. The reed switches 18 and 20 are of a conventional construction incorporating a cylindrical glass envelope 22 containing reeds 24 having contacts formed thereon whereby the reeds may be attracted toward each other to close the contacts as shown in switch 18, FIG. 1, or the reeds may be separated to open the circuit through the switch, as shown in switch 20, FIG. 1, under the influence of magnetic force fields. The reeds are associated with the usual electric conductors 26. To protect the reed switches, a cylindrical body 28 of nonmagnetic material circumscribes the casing 10 at its central region and sufficient radial clearance exists between the bore 30 of the body and the casing outer surface 12 to permit the reed switches to be located therein, as will be apparent from the drawings.

A tubular sleeve 32 is closely received within the casing bore 14, and is of such dimension as to be axially slidable within the casing bore. The sleeve 32 is formed of a nonmagnetic material and, in the embodiment of FIGS. 1 through 3, is threaded at its ends to permit heads 34 to be affixed thereto. The sleeve is provided with a cylindrical bore 36 extending the length of the sleeve which defines a magnet guideway. The inner walls of the sleeve bore are grooved at 38 to cooperate with retaining or friction ring carried by the magnet, as will be later described.

The inner ends 40 of the heads 34 constitute abutment surfaces and the heads are threaded to each receive an orifice plug 42 having an orifice of limited diameter formed therein. Within the chamber 44 of each head 34 is a pyrotechnic squib 45, which upon ignition by means of electrical conductors produces a pressurized gas within the associated chamber which escapes through the associated orifice plug into the sleeve bore 36.

The magnet 46 for operating the reed switches 18 and 20 is of a cylindrical construction and may be formed of any metallic or nonmetallic magnetic material. Resilient shock absorbers 48 are affixed to the magnet at each end

thereof wherein the shock absorbers are positioned between the magnet and the head end surfaces 40. Retaining rings 50, which may be of the split type as to be radially expandable and contractible, are received within grooves formed intermediate the magnet and the shock absorbers, and the spacing between the rings is such that the rings cooperate with a pair of the cylinder grooves 38 when the piston structure is in its two extreme positions, as illustrated in FIGS. 1 and 2. The diameter of the magnet and shock absorber structure is such that the magnet structure functions as a piston within the sleeve bore 36.

The sleeve 32 is axially oriented to the casing 10 by means of snap rings 52 placed in associated grooves 54 formed in the sleeve heads 34. As is apparent from FIGS. 1 and 2, under normal conditions the casing ends 16 will be engaged by the snap rings 52.

In operation, the components of the reed switch apparatus may be related as in FIG. 1. The magnet structure is positioned at the left of the sleeve bore 36 in engagement with the left sleeve head abutment surface 40 and the rings 50 will be received within the left pair of grooves 38. The magnet 46 will be disposed adjacent the reed switch 18 and the magnetic field produced will cause the switch reeds and contacts to close, as illustrated. Upon ignition of the left squib 45, a pressurized gas will occur within the left head chamber 44. This pressurized gas will pass through the associated orifice plug and create a pressure on the magnet structure causing the magnet and associated shock absorbers to very quickly move to the right within the bore 36 against the right head abutment surface 40, as shown in FIG. 2. The force exerted upon the magnet structure by the pressurized gas is sufficient to radially contract the retaining rings 50 and force the rings out of the associated grooves 38. Upon the magnet structure reaching the right position, FIG. 2, the retaining rings 50 will be received within the right pair of grooves 38, and rebound from the right head 34 is prevented. Upon the magnet being moved to the right, as shown in FIG. 2, the reeds and contacts of switch 18 will open and those of switch 20 will close.

If it is desired to return the switch components to the relationship shown in FIG. 1, the right squib 45 is ignited, and the pressurized gas within the right head chamber 44 will force the magnet structure to the left to the position of FIG. 1.

It is usually desired that switch structure be tested for reliability prior to actually being placed in service or when installed in the application with which it is to be used. As it is not desirable to utilize a squib or squibs for such testing, the apparatus of the invention permits testing to be easily accomplished by removing one of the snap rings 52. In FIG. 3, the left snap ring 52 is removed from its groove 54 and the entire sleeve assembly is translated to the right with respect to the casing 10. The sleeve assembly is moved to the right an amount which positions the magnet 46 adjacent the reed switch 20 to permit the reed switches to operate under the conditions which would normally occur after the firing of the left squib, as shown in FIG. 2. If the switches function properly upon the components being positioned as in FIG. 3, the sleeve assembly is moved to the left to return the components to the relationship of FIG. 1, and the left snap ring 52 is reinstalled.

FIG. 8 illustrates another means for permitting testing of the reed switch. In the embodiment of FIG. 8, an electric conductor 56 is spirally wound about the body 28 to form a coil. Upon energization of the conductor 56 the current flowing therethrough will produce a magnetic field which will cause the reed switches to actuate to the position shown in FIG. 8, which is the operative position as shown in FIGS. 2 and 3, and, thus indicate operation under test conditions.

The embodiment of FIG. 4 utilizes many of the identical components of the previously described embodiment

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and similar components are indicated by primes. The sleeve 58 is provided with a smooth guideway or bore 60 in which the cylindrical magnet 62 forms a piston slidably positionable in the bore. The magnet 62 is provided with a central circumferential groove receiving an O-ring 64 whereby the magnet is sealed with respect to the sleeve bore. A passage 66 is axially defined in the sleeve and is of a smaller diameter than the bore 60 whereby an abutment shoulder 68 is formed. A pressurized fluid supply pipe or hose 70 communicates with the passage 66.

The sleeve head 72 includes a compression spring chamber and an abutment pin 74 which is circumscribed by a compression spring 76. The free end of the pin 74 serves as an abutment stop for the magnet 62.

With the components related as in FIG. 4, the switch 20' will be closed and the switch 18' will be opened. Introduction of pressurized fluid, either air or hydraulic liquid, into the passage 66 moves the magnet 62 to the left toward the pin 74. Sufficient movement of the magnet 62 will cause the switch 20' to open and the switch 18' to close, such as when the magnet approaches pin 74.

If it is desired that a reed switch apparatus be provided with the embodiment of FIG. 4 capable of more accurately indicating the pressure within the bore 60 and passage 66 than is possible with two reed switches, a plurality of reed switches may be circumferentially disposed about the casing 10' in a manner as will be apparent from FIG. 7. The reed switches 18', 78, 80, 82, 84, 86 and 20' are axially displaced relative to each other to define a helical or spiral series of switches about the circumference of the casing. Thus, as the magnet 62 is axially translated within the sleeve bore 60, the switches will sequentially operate to permit an accurate indication of the pressure within the sleeve. Of course, by relating the location of the switches to the force imposed upon the magnet by the spring 76, it will be possible to get a direct pressure reading from electrical apparatus controlled by the switches.

FIG. 5 illustrates an embodiment utilizing the inventive concepts whereby acceleration or deceleration forces provide the impulse employed to actuate the magnet. In FIG. 5, components identical to those of FIG. 1 are indicated by primes.

In FIG. 5, the sleeve 88 is closed at one end by a head 90 having a magnet retainer 92 formed therein. The retainer 92 may be of a magnetic material or may be a magnet, itself, of a relatively weak character, as not to energize or actuate the switch 20'.

The left head 94 is provided with a central bore 96 having a concentric recess located at the outer end of the bore.

The sleeve bore or guideway is lined with a plurality of antifriction balls 98 constituting bearing means for supporting the magnet 100. The magnet 100 is provided with an internal bore 102 having a recess 104 wherein a frangible retainer wire 106 may be disposed within the bores 96 and 102 having enlarged ends received within the head recess and the magnet recess 104. The retainer wire 106 is of a calibrated diameter whereby a predetermined tension force within the wire will cause the wire to break.

It will be appreciated that upon sufficient acceleration or deceleration forces to the right in the axial direction of the sleeve being imposed upon the magnet 100, the retainer wire 106 will break, permitting the magnet to move in the sleeve to a position adjacent the magnet retainer 92 and, thereby, close the switch 20' and open the switch 18'. As the retainer wire 106 is frangible, the testing operation possible by removing one of the snap rings 52' is of value, in that it permits the reed switches to be tested without breaking the retainer wire.

The embodiment of FIG. 6 may also be used for indicating acceleration and deceleration forces, and components similar to those of the embodiment of FIG. 1 are indicated by primes.

In FIG. 6, the sleeve 108 is provided with a bore hav-

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ing antifriction bearing means 110 located therein for supporting the magnet 112 for axial movement in the sleeve. The sleeve bore is provided with an abutment end surface 114 and a compression spring 116 maintains the magnet against the abutment surface 114 under normal positions, as represented in FIG. 6. A head 118 is threaded to the sleeve 108 and includes a spring-locating and magnet abutment pin 120 which extends toward the magnet and maintains the spring 116 within the sleeve.

It will be appreciated that acceleration or deceleration forces toward the left imposed on the mass of the magnet 112 will tend to move the magnet from the abutment surface 114 toward the left, FIG. 6. The presence of the antifriction bearings 110 assures that the movement of the magnet under acceleration or deceleration forces will be primarily determined by such forces, as related to the biasing action produced by the spring 116 and, thus, the axial positioning of the magnet within the sleeve will give a true indication of the magnitude of the forces imposed upon the magnet.

In an impulse switch such as in FIG. 6, wherein the forces imposed upon the magnet 112 may be quantitatively analyzed, it is desirable to position a plurality of reed switches about the casing 10', as illustrated in FIG. 7. Thus, limited movement of the magnet may be detected and sensed by the reed switches.

It will be appreciated that the apparatus of the invention permits reed switches to be used in a practical manner for actuation by an impulse. The impulse force may be initiated by pressure means, such as shown in the embodiments of FIGS. 1 through 4, or may be initiated by external forces imposed upon the switch apparatus. Such switch apparatus is of a concise nature and the utilization of reed switches with a positive impulse for movement of the magnet produces a highly reliable device. The testing procedures which may be employed with the switch of the invention are simple, yet effective, and such testing may be provided without depleting "one shot" impulse-producing devices or retainers, as in the embodiments of FIGS. 1 and 5.

While various modifications to the disclosed embodiments may be apparent to those skilled in the art, such modifications as within the spirit of the invention are considered to be within the scope of the inventive concept.

We claim:

1. Reed switch apparatus comprising, in combination, an elongated tubular casing of nonmagnetic material having a longitudinal axis, an elongated magnet guideway defined within said casing having an axis substantially parallel to said casing axis, a magnet within said guideway adapted to selectively move in the direction of the guideway axis, a first reed switch disposed adjacent the exterior of said casing and within the axial length of said guideway, a second reed switch disposed adjacent the exterior of said casing and within the axial length of said guideway, said second reed switch being spaced from said first switch in the axial direction of said guideway, magnet locating means within said guideway releasably locating said magnet at a first predetermined position within said guideway, a second predetermined location within said guideway, movement of said magnet within said guideway from said first to said second locations actuating both of said switches.

2. Reed switch apparatus as in claim 1 wherein an elongated sleeve of nonmagnetic material is mounted within said casing and adapted to be selectively positioned in the axial direction of said casing, said magnet guideway and magnet being located within said sleeve, and releasable means retaining said sleeve in a normal operating position with respect to said casing and first reed switch, releasing of said releasable means permitting said sleeve to be axially shifted with respect to said casing and reed switch to actuate said reed switch for test purposes.

3. Reed switch apparatus comprising, in combination, an elongated tubular casing of nonmagnetic material having a longitudinal axis, an elongated cylindrical magnet guideway defined within said casing having an axis substantially parallel to said casing axis, a magnet within said guideway adapted to selectively move in the direction of the guideway axis, piston structure affixed to said magnet cooperating with said cylindrical guideway, pressurized fluid conducting means communicating with said guideway adjacent an end of said guideway, a first reed switch disposed adjacent the exterior of said casing and within the axial length of said guideway, magnet locating means within said guideway releasably locating said magnet at a first predetermined position within said guideway, said magnet locating means initially locating said magnet within said guideway adjacent said pressurized fluid conducting means whereby introduction of pressurized fluid into said guideway translates said magnet from said first predetermined position and actuates said reed switch.

4. Reed switch apparatus as in claim 3 wherein an ignitable pyrotechnic device is in communication with said pressurized fluid conducting means whereby ignition of said device creates a pressure to translate said magnet from said first predetermined position.

5. Reed switch apparatus as in claim 4 wherein an abutment is defined at each end of said guideway, a separate ignitable pyrotechnic device communicating with each of said guideway and shock absorber means interposed between said magnet and said abutments.

6. Reed switch apparatus as in claim 5 wherein first and second grooves are defined in said guideway in axially spaced relation to each other, a radially expandable and contractible retaining ring fixed to said magnet for movement therewith adapted to be selectively received within a groove upon alignment therewith, said ring being received within a groove upon a shock absorber means engaging an abutment.

7. Reed switch apparatus as in claim 3 wherein a compression spring is mounted in said guideway biasing said magnet toward said pressurized fluid conducting means and said first predetermined position.

8. Reed switch apparatus comprising, in combination, an elongated tubular casing of nonmagnetic material having a longitudinal axis, an elongated magnet guideway defined within said casing having an axis substantially parallel to said casing axis, antifriction bearing means disposed within said guideway substantially parallel to the axis thereof, a magnet within said guideways supported upon said antifriction bearing means adapted to selectively move in the direction of the guideway axis, a first reed switch disposed adjacent the exterior of said casing and within the axial length of said guideway, and magnet locating means within said guideway releasably locating said magnet at a first predetermined position within said guideway whereby movement of said magnet within said

guideway from said first predetermined position actuates said reed switch.

9. Reed switch apparatus as in claim 8 wherein said magnet locating means comprises a frangible element having a portion fixed with respect to said casing and another portion fixed to said magnet adapted to break upon predetermined acceleration or deceleration forces being imposed on said magnet permitting said magnet to be translated in said guideway from said first position.

10. Reed switch apparatus as in claim 8 wherein a spring is located within said guideway having an end fixed with respect to said casing and an end associated with said magnet whereby acceleration or deceleration forces imposed upon said magnet cause said magnet to be translated from said first position a distance proportional to the forces imposed on said magnet.

11. Reed switch apparatus comprising, in combination, an elongated tubular casing of nonmagnetic material having a longitudinal axis, an elongated sleeve of nonmagnetic material mounted within said casing and adapted to be selectively positioned in the axial direction of said casing, an elongated magnet guideway defined within said elongated sleeve having an axis substantially parallel to said casing axis and the length of said sleeve, releasable means retaining said sleeve in a normal operating position with respect to said casing, a magnet within said guideway adapted to selectively move in the direction of the guideway axis, a first reed switch disposed adjacent the exterior of said casing and within the axial length of said guideway, magnet locating means within said guideway releasably locating said magnet at a first predetermined position within said guideway whereby movement of said magnet within said guideway from said first predetermined position actuates said reed switch, releasing of said releasable means retaining said sleeve permitting said sleeve to be axially shifted with respect to said casing and reed switch to actuate said reed switch for test purposes.

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ROBERT K. SCHAEFER, Primary Examiner

U.S. Cl. X.R.

200—142; 335—205

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,510,607 Dated May 13, 1970

Inventor(s) Carl H. Breed, Carroll H. Bush and John E. Getz

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 6, after "49203" add -- assignors to Sparton Corporation, a corporation of Ohio --

Column 8, line 22, delete "elongaed magnett" and substitute -- elongated magnet --

SIGNED AND
SEALED
OCT 27 1970

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents