April 30, 1957 R. G. TOWLE 2,790,863

DEFORMATION SWITCH MECHANISM

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Fig. 1.

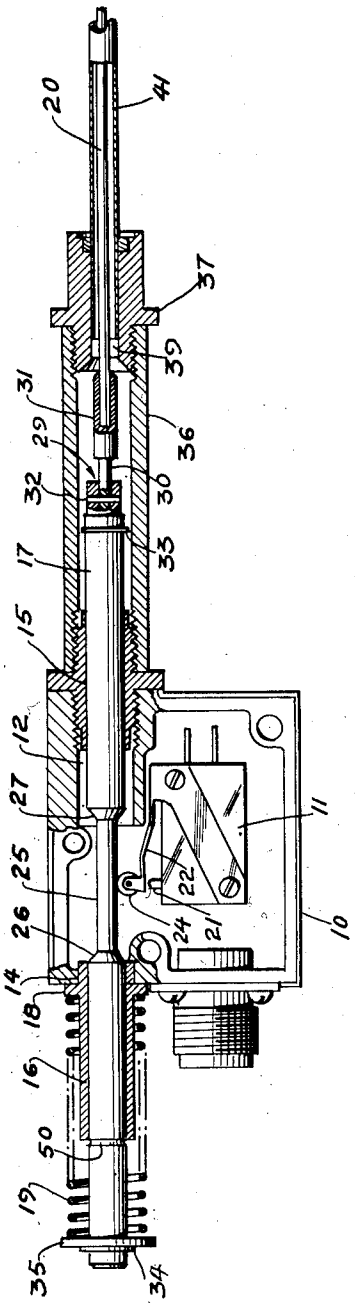
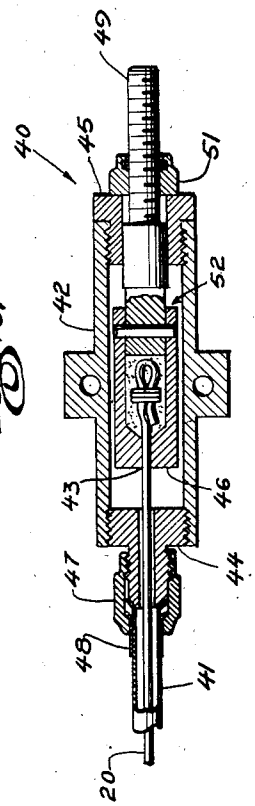


Fig. 2.



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Fig. 3.

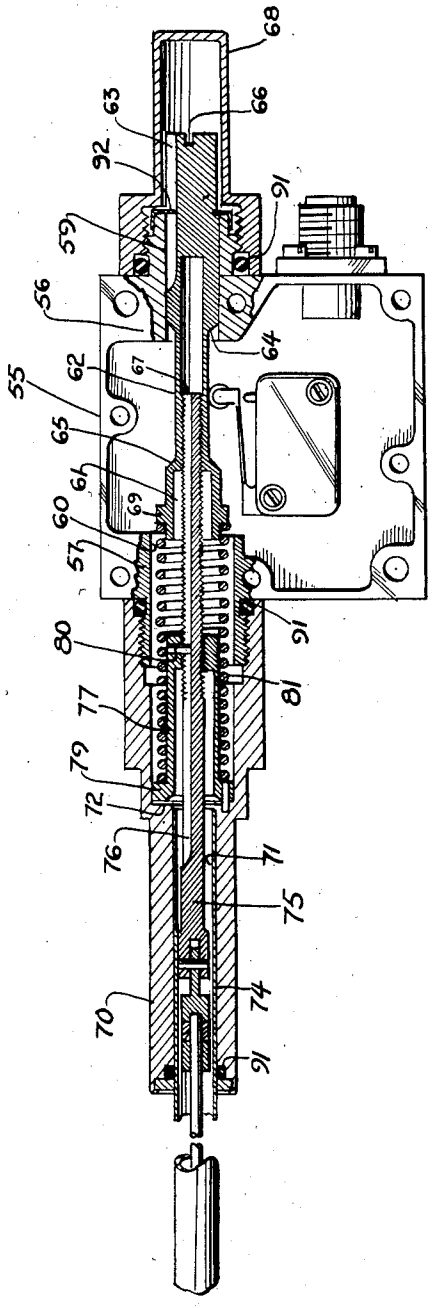
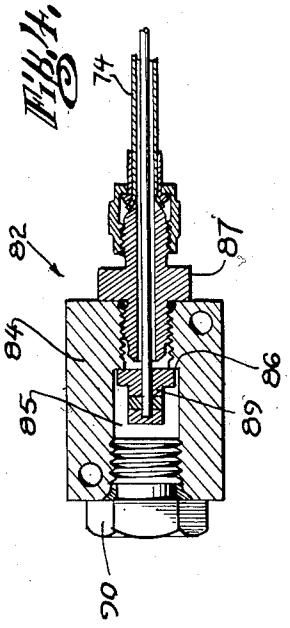


Fig. 4.



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DEFORMATION SWITCH MECHANISM

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7 Claims. (Cl. 200—61.08)

This invention relates to electrical circuit makers, and, more particularly, to switches which are operable by the deformation or severance of an elongate structural member.

Heretofore, it has been proposed to provide aircraft, for example, with systems which are automatically operable in the event of a crash to prevent explosions or breaking out of fire. In the provision of such systems, it is necessary that initiating means be able to sense a crash as distinguished from other less violent occurrences such as storms and the like, as well as from malfunction of components of the system itself. Such systems are therefore operated by the actuation of a plurality of switches simultaneously, each of which responds to a different condition which has been found to occur during a crash.

Careful study of crashes reveals that explosion or fire is often caused by gasoline, oil, or other combustibles, which are usually carried in the wings, escaping from damaged containers or conduits and coming into contact with hot engine parts.

Accordingly, it is an object of the present invention to provide a switch mechanism which is adapted to close an electrical circuit in the event of the deformation, beyond a predetermined limit, or breaking off of a wing or other structure of considerable length.

It is another object to provide such apparatus including an initiating cable extending lengthwise along the length of the structure subject to deformation or breaking off in the event of a crash.

It is another object to provide such apparatus wherein the cable will be released from the other switch components when deformation of the cable occurs which is great enough to damage such other components.

It is a further object of the present invention to provide such apparatus which is reliable and efficient in operation, easily installed in an aircraft, light in weight, requires very little maintenance, is free from damage by the elements and has a long shelf life.

Other and further objects of the invention will be obvious upon an understanding of the illustrative embodiment about to be described, or will be indicated in the appended claims, and various advantages not referred to herein will occur to one skilled in the art upon employment of the invention in practice.

In accordance with the present invention the foregoing objects are accomplished by providing craft having a structure of considerable length subject to being deformed or breaking off upon crash of the craft with switch apparatus comprising a pull cable extending lengthwise along the structure having one end secured to the structure adjacent one end thereof, spring means adjacent the other end of the structure for exerting a force on the pull cable at the other end thereof to tension the same, actuating means, and an element movable with the pull cable for effecting operation of the actuating means upon a change in the tensioning of the pull cable.

A preferred embodiment of the invention has been chosen for purposes of illustration and description, and is shown in the accompanying drawing, forming a part of the specification, wherein:

Fig. 1 is a longitudinal fragmentary view partly in section, of apparatus in accordance with the present invention connected to one end of the cable;

Fig. 2 is a longitudinal view, partly in section, of apparatus connected to the other end of the cable;

Fig. 3 is a view similar to Fig. 1 but shows another embodiment of the invention; and

Fig. 4 is a view similar to Fig. 2 but shows another embodiment of the apparatus illustrated therein.

Referring to the drawings in detail, there is shown in Fig. 1 a frame or casing **10** supporting a conventional switch **11** and being formed with a pair of opposite apertures **12** and **14** in the ends thereof. Slide bearings **15** and **16** are mounted in the respective apertures **12** and **14**, a rod **17** is slidably mounted in the bearings for operating the switch, a helical compression spring **19** is arranged for urging the rod in one direction, and a pull cable **20** is connected at one end to the rod for effecting movement thereof in opposition to the spring.

The switch **11** is provided with an actuating plunger **21** and an operating arm **22**, formed preferably of spring steel, secured at one end to the switch body and positioned over the plunger at its other end. A roller **24** is mounted at the free end of the arm and is normally urged by the spring action thereof in a direction away from the plunger **21**.

The ends of the rod **17** extend outwardly through the bearings **15** and **16**, and the portion of the rod which is normally disposed within the casing is formed with a section **25** of reduced diameter having frusto-conical cam faces **26** and **27** at the respective ends for actuating the switch as described hereinafter.

The end of the rod to which the cable **20** is connected is provided with an axial slot and a radial bore adapted to serve as a clevis joint **29** for the reception of a flat tongue **30** of a swage element **31** for retaining the end of the pull cable **20**. The clevis pin **32** is adapted to shear when the cable is placed under a predetermined tension. An annular snap ring **33** is seated in a groove in the rod adjacent the clevis joint for a purpose to be described.

The opposite or free end of the rod is formed with an annular groove for seating a snap ring **34** which serves as a backing for a washer **35** and the spring **19** fits over the rod **20** and the tubular slide bearings **16** and bears against an annular flange **18** of the bearings at one end and against the washer **35** at the other end to urge the rod **20** to the left, as viewed in Fig. 1.

A tubular sleeve member **36** is screw threadedly secured to the slide bearing **15** at one end and to a fitting **37** formed with a longitudinal bore **39** at the other end and serves to protect the clevis joint **29** and the swage element **31** against damage from external sources.

As shown in Fig. 2, the other end of the cable **20** is anchored in a mount **40** which may be located any desired distance from the actuating mechanism described heretofore. In order to protect the cable against injury or wear by contact with structural members of the craft, a tube **41** surrounds the cable and is fitted into the bore **39** at one end, in sliding engagement with the fitting **37**, while the other end of the tube is secured in the mount **40** substantially at the other end of the cable so that no portion of the cable is exposed.

The mount **40** includes a tubular member **42** formed with apertured flanges for securement to the craft, a fitting **44** formed with an axial bore secured in one end thereof, a second fitting **45** formed with an axial bore

secured in the other end thereof and a hollow cable retaining block **46** open at one end and provided with an aperture **43** at the other end slidably and adjustably disposed within the member **42** between the end fittings.

The cable **20** passes through the bore in the fitting **44** and the aperture in the block **46** in which it is secured and the tube **41** is flared at its end and abuts the fitting **44** to which it is secured by a conventional tube nut **47** and sleeve clamp **48**.

A stud **49** threaded at one end extends through the bore of the fitting **45** and is secured at its other end to the open end of the block by a clevis joint **52**. A nut **51** screw threaded on the stud serves to adjust the cable in a manner to be described.

To mount the apparatus to actuate the switch upon deformation or breaking off of a wing of an aircraft, for example, the casing **10** may be mounted adjacent the inboard end of a wing, say in the wheel well, and the mount **40** may be secured to a structural member of the wing at its outboard end in such a manner that the cable **20** extends substantially adjacent and parallel to the leading edge of the wing. The position of the rod **17** is then adjusted by means of the stud **49** in the adjusting mount **40** so that the roller **24** abuts the section **25** of the rod at its center. In order to determine when center contact is established without removing the cover of the casing, indicia, such as an annular groove **50** may be provided on the rod so that it lines up with the end of the slide bearing **16** when the proper adjustment is effected.

In operation, normal deflection of the wing, due to vibration, wind currents and the like, will not actuate the switch **11** due to the predetermined length of the section **25** of the rod **17** which will merely move back and forth over the roller **24**. However, if abnormal deflection occurs, due to a collision or crash, for example, the cable will be deformed so as to pull the rod in a direction towards the mount **40** to such an extent that the cam face **26** will bear against the roller **24** and cause the arm **22** to depress the switch plunger **21** to close an electrical circuit.

If the cable is deformed to a point such that the shear load on the clevis pin **32** is greater than that for which it is designed, the pin will shear disconnecting the cable from the rod to protect the casing and switch from being damaged. On the other hand, in the event that a portion of the wing and consequently the cable, is sheared off by a relatively sharp object, say, for example, a wire, the spring **19** will urge the rod in a direction away from the mount **40** until the cam face **27** bears against the roller **24** causing actuation of the switch in the manner described. The annular ring **33** will engage the end of the slide bearing **15** to prevent the rod from being moved completely out of the casing by the spring.

In Fig. 3, an embodiment of the present invention is illustrated wherein adjustment is made at the switch end of the cable and a moisture proof casing **55** is provided to prevent corrosion of the parts whereby a long shelf and operating life is assured.

The casing **55** is essentially the same as that described heretofore except that slide bearings **56** and **57** are formed integral with the casing and project outwardly away from the end walls thereof while surrounding apertures **59** and **60**, respectively. The casing cover plate (not shown) is provided with a moisture proof gasket and the switch and its actuating lever and roller are disposed in the casing in the manner described hereinbefore.

A rod **61** extends through the casing and is in slidable engagement at one end thereof with the bearing **56**. This rod is formed with a section of reduced diameter **62** having cam faces **64** and **65**. The end portion of the rod extending out of the casing through the aperture **59** is formed with an end slot **66** and a groove **63**. The other end of the rod **61** is provided with an internally threaded axial bore **67** and an external flange **69**. The

rod **61** is considerably shorter than the rod **17** discussed heretofore and does not extend through the bearing **57** when in its normal position, as viewed.

To assist in preventing moisture from entering the casing, a cap **68** is in screw threaded engagement with the outer surface of the projecting portion of the bearing **56** and covers the slotted end of the rod **61**, allowing sufficient clearance for the rod to move to the right, as viewed, to enable the cam face **65** to effect actuation of the switch. At the other side of the casing, the projecting portion of the bearing **57** is externally screw threaded to receive an elongate sleeve member **70** formed with a longitudinal bore **71** therethrough providing an internal shoulder **72**.

One end of a tube **74** for protecting the cable extends into the end of the bore **71** in the sleeve member and is slidably disposed therein.

An adjuster rod **75** provided with a longitudinal slot **76** is slidably mounted at one end in the tube **74** and extends into the bore **67** of the rod **61** with which it is in screw threaded engagement. The end of the adjuster rod which is mounted in the tube is provided with a clevis joint, including a clevis pin adapted to shear under a predetermined load, by which a swage element is secured in the manner described heretofore. One end of the cable is retained by the swage element and the cable and tube extend any desired distance to an end mount **82**, as shown in Fig. 4.

A tubular spring retainer **77** surrounds the adjuster rod and is formed with an end flange **79** abutting the shoulder **72** of the sleeve member **70**. The other end of the retainer has a radial bore from which a pin **80**, secured therein, extends into the groove **76** of the adjuster rod to prevent the rod from rotating.

A helical spring **81** extends between the flange **79** of the spring retainer and the flange **69** of the rod **61** and tends to urge the rod in a direction away from the retainer.

As shown in Fig. 4, the end mount **82** includes a block **84** formed with a bore **85** having an internal shoulder **86** extending therethrough. A standard fitting **87** is threaded into one end of the bore and the cable passes through the fitting and is soldered to an anchor member **89** provided with a flange which abuts the shoulder **86** to anchor the end of the cable in the block. The other end of the fitting **87** is secured to a conventional tube nut and sleeve clamp for securing the end of the tube **74** in the manner described with respect to Fig. 2 and the open end of the bore **85** is sealed by a plug **90** fitted with a conventional gasket.

In this embodiment of the invention, conventional O-rings **91** are employed as seals against moisture at the threaded end of the cap **68**, at both ends of the sleeve member **70** and between the fitting **87** and the block **84**.

In order to adjust the position of the rod **61**, the cap **68** is removed and, by means of a screw driver applied to the slot **66**, the rod may be rotated until an annular groove lines up with the end of the projecting portion of the bearing **56** in the manner described heretofore. The rod may be locked in this position by sliding a locking ring **92** having an internal tab and a pair of opposite external tabs over the rod so that the internal tab fits into the groove **63** and the external tabs are then bent into longitudinal external grooves in the projecting portion of the bearing.

As the rod **61** is rotated, the adjuster rod **75** is moved into or out of the bore **67** since the pin **80** mounted in the spring retainer **77** and extending into the groove **76** of the adjuster rod prevents that rod from rotating.

The apparatus illustrated in Figs. 3 and 4 is similar in operation to that described heretofore. Deflection of the cable beyond a predetermined limit will cause the rod to move against the action of the spring **81** until the

cam face 64 effects operation of the switch. Severance of the cable will cause the spring to urge the rod in a direction whereby the cam face 65 will effect operation of the switch. The cap 68 serves to prevent the rod from being ejected out of the casing entirely in the event that the clevis pin is sheared by excessive tension applied to the cable.

From the foregoing description, it will be seen that the present invention provides a switch mechanism for closing an electrical circuit in the event of deformation, beyond a predetermined limit, or breaking off of a wing or other structure of considerable length, which mechanism is reliable and efficient in operation, easily installed, light in weight, requires little maintenance, is free from damage by the elements and has a long shelf life. It will also be seen that the apparatus includes a cable extending the length of the structure subject to deformation or breaking off which cable will be released from the other components of the apparatus before deformation of the cable occurs which is great enough to damage the other components thereof.

As various changes may be made in the form, construction and arrangement of the parts herein, without departing from the spirit and scope of the invention and without sacrificing any of its advantages, it is to be understood that all matter herein is to be interpreted as illustrative and not in any limiting sense.

I claim:

1. In combination with craft of the class described having structure of considerable length subject to being deformed or breaking off upon crash of the craft, a pull cable extending lengthwise along the structure having one end secured to the structure adjacent one end thereof, actuating means adjacent the other end of the structure, an element having the other end of said pull cable connected to one end thereof, a spring connected to the structure and to the other end of said element for tensioning said pull cable, and means on said element for effecting operation of said actuating means upon an increase in the tensioning of said pull cable, and upon failure of said cable said pull cable and said element being connected by a pin adapted to rupture when an excessive force is exerted on said pull cable.

2. In combination with craft of the class described having structure of considerable length subject to being deformed or breaking off upon crash of the craft, a pull cable extending lengthwise along the structure having one end secured to the structure adjacent one end thereof, a switch adjacent the other end of the structure having an operating arm, a slidably mounted element adjacent said switch and connected to the other end of said pull cable at one end thereof, and a spring connected to the other end of said element for tensioning said pull cable, said element being constructed and arranged for movement in a direction towards said cable upon an increase in the tension thereof and for movement in the opposite direction under the influence of said spring upon failure of said cable and having means for engaging said arm upon movement thereof upon an increase in the tension of said cable and having means for engaging said arm upon failure of said pull cable and movement of said element under the influence of said spring.

3. In combination with craft of the class described having structure of considerable length subject to being deformed or breaking off upon crash of the craft, a pull cable extending lengthwise along the structure having one end secured to the structure adjacent one end thereof, a switch adjacent the other end of the structure having an operating arm, a slidably mounted element adjacent said switch and connected to the other end of said pull cable at one end thereof, and a spring connected to the other end of said element for tensioning said pull cable, said element having means for engaging said arm upon pulling of said cable and having means for engaging said arm upon failure of said pull cable and movement of said element under the influence of said spring, said element and said pull cable being connected by a pin adapted to rupture when said pull cable is tensioned beyond a predetermined value, whereby said element is free to move under the influence of said spring.

4. A control head of the class described comprising a frame for means to be actuated, said frame having aligned slide bearing means at opposite sides thereof, an element slidably mounted in said bearing means and extending through said frame, said element having a pair of spaced apart portions for actuating the first mentioned means, a spring for urging said element in one direction, a pull cable connected at one end to said element for effecting movement thereof in opposition to said spring and being fixed at its other end, and stop means for limiting the movement of said element under the influence of said spring, said element and said pull cable being connected by a pin adapted to rupture when said pull cable is tensioned beyond a predetermined value, whereby said element is free to move under the influence of said spring.

5. A control head of the class described comprising a frame for means to be actuated, said frame having aligned bearings at opposite sides thereof and having stop means adjacent one of said bearings, a rod slidably mounted in said bearings and extending through said frame, said rod having a reduced intermediate section providing a pair of opposed faces for actuating the first mentioned means, a pull cable fixed at one end thereof, means including a rupturable element for connecting the other end of said pull cable to one end of said rod, a spring retainer on said rod adjacent the other end thereof, a cylindrical helical spring surrounding said rod and compressed between said retainer and said frame to urge said rod in a direction to tension said pull cable, and means for varying the effective length of said pull cable to arrange said rod faces in a neutral position with respect to the first mentioned means.

6. A control head of the class described comprising a frame for means to be actuated, said frame having aligned bearings at opposite sides thereof and having stop means adjacent one of said bearings a rod slidably mounted in said bearings and extending through said frame, said rod having a reduced intermediate section providing a pair of opposed faces for actuating the first mentioned means, a pull cable fixed at one end thereof, means including a rupturable element for connecting the other end of said pull cable to one end of said rod, a spring retainer on said rod adjacent the other end thereof, a cylindrical helical spring surrounding said rod and compressed between said retainer and said frame to urge said rod in a direction to tension said pull cable, means for varying the effective length of said pull cable to arrange said rod faces in a neutral position with respect to the first mentioned means, and means for adjusting the position of said spring retainer to vary the force of said spring acting to tension said pull cable.

7. A control head of the class described comprising a casing for means to be actuated, said casing having aligned slide bearing means at opposite sides thereof, an element slidably mounted in said bearing means and extending through said casing, said element having a pair of spaced apart portions for actuating the first mentioned means, a spring for urging said element in one direction, a pull cable releasably connected at one end to said element for effecting movement thereof in opposition to said spring and being fixed at its other end in a mount sealed from the ambient atmosphere, tube means substantially coextensive with said cable and surrounding the same, sleeve means abutting said casing and sur-

rounding and slidably engaging one end of said tube means, said tube having its other end in sealed fixed engagement with said mount, a cap for one of said bearing means constructed to receive and cover the other end of said element and means for sealing said casing from the ambient atmosphere.

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