June 1, 1943. J. E. SHERLOCK ET AL 2,320,895

THERMALLY OPERATED ELECTRIC SWITCH

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Fig. 3

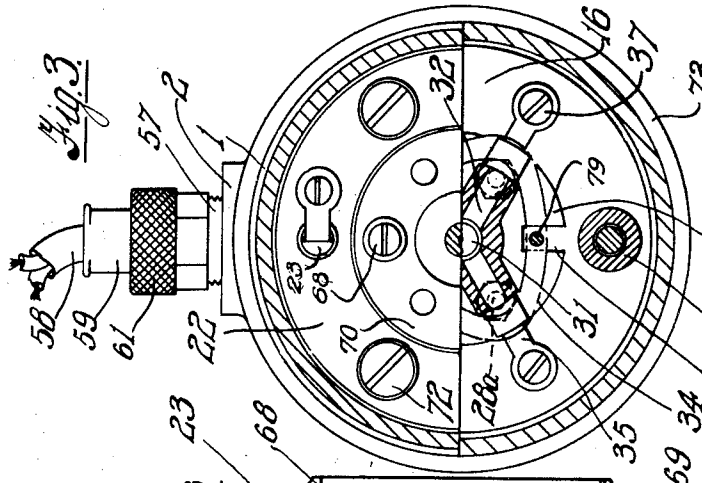
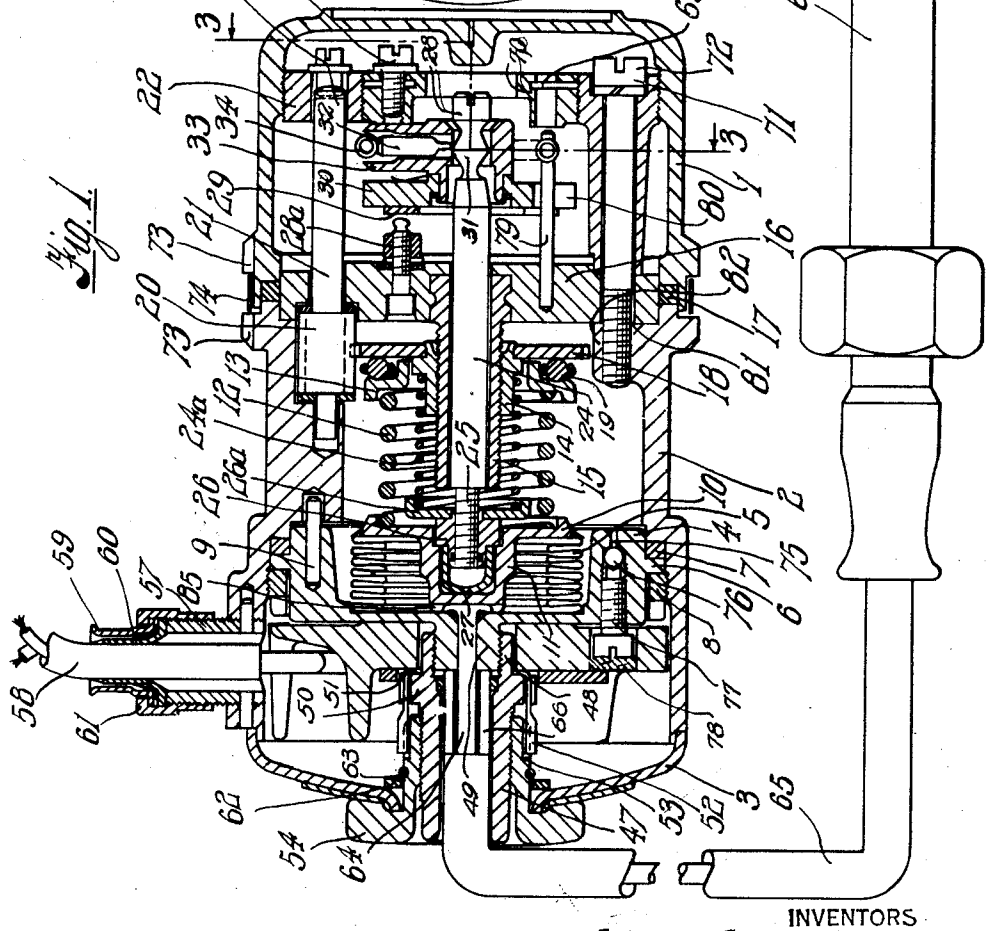


Fig. 1



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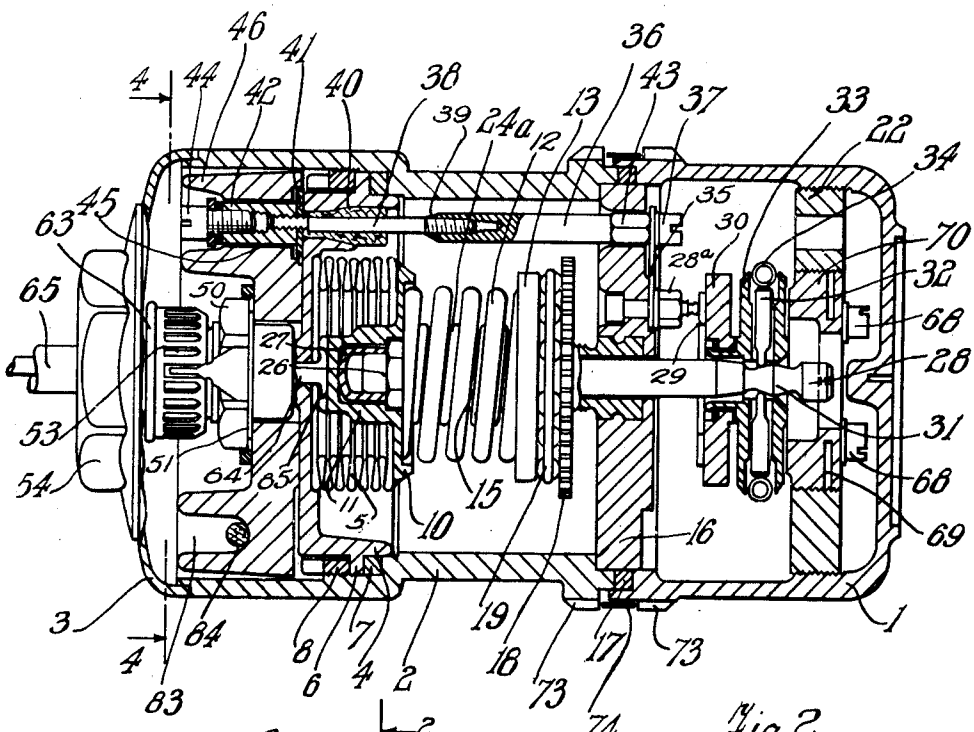


Fig. 2.

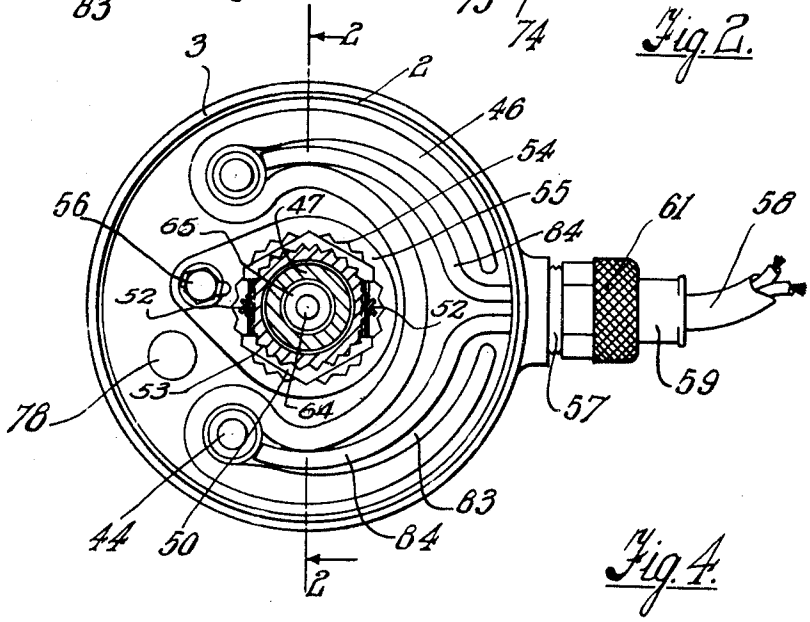


Fig. 4.

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THERMALLY OPERATED ELECTRIC SWITCH

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Application October 25, 1940, Serial No. 362,856
In Great Britain June 7, 1940

12 Claims. (Cl. 200—140)

This invention relates to temperature sensitive control switches and has for its object to provide an improved construction or arrangement of electrical thermostat whose function is to make or break circuit as temperature rises and falls and which is designed so that its operation is unaffected by atmospheric pressure changes and it is screened against interfering with adjacent radio apparatus.

According to the invention a temperature sensitive control switch is provided wherein a thermally sensitive bellows device and a snap action switch mechanism, adapted to be operated by movement of said bellows device are screened against interference with radio apparatus by enclosing them within a metal case whose closure element or elements are sealed to prevent interference with the operation of said bellows by changes of atmospheric pressure.

According to one form of the invention the improved temperature sensitive control switch comprises a snap action switch mechanism mounted adjacent one end of a metallic casing, a thermally sensitive metallic bellows device also disposed within said casing and operatively connected to said switch mechanism a capillary tube sealed into the said casing and electrically screened connecting the said bellows device with means exposed where the temperature is to be controlled and means for sealing said casing against the effects of atmospheric pressure changes.

Reference will now be made to the accompanying drawings which illustrate by way of example a switch constructed according to the invention and in which—

Fig. 1 is a longitudinal section showing the switch open,

Fig. 2 is a section taken on the line 2—2 of Fig. 4 substantially at right angles to Fig. 1 and showing the switch closed,

Fig. 3 is a cross section taken on the line 3—3 of Fig. 1, and

Fig. 4 is a cross section taken on the line 4—4 of Fig. 2.

In the construction illustrated, the switch and its co-operating components are mounted within a casing which is preferably made as an aluminium die casting for lightness and consists of three parts namely: An end element 1, a middle portion 2 and an end cover 3.

Within the middle portion 2 of the casing is mounted a flanged metal plate 4 within which is supported a flexible metallic bellows 5, the plate 4 being formed with an external flange 6 whereby it is retained in position between a jointing ring 7 and a locking ring 8 which has screw threaded engagement with the inner wall of the casing member 2. For convenience in assembly a dowel pin 9 is provided which engages the casing member 2 and the plate 4 to prevent turning of the plate when the locking ring 8 is being rotated into the operative position shown in Fig. 1.

The outer end of the bellows 5 is secured to a plate 10 which has a central boss 11 which is internally of hexagonal shape with a flat base. The bellows is adapted to expand against the pressure of a spring 12 which bears at one end against the plate 10 and at the opposite end against an annular disc 13 disposed around a nut 14 mounted upon a screw threaded sleeve 15 which is fixed at one end in an insulating disc 16 fixed within the casing and registering a joint 17 between the members 1 and 2 thereof. The nut 14 is fixed to a toothed wheel 18 between which and the disc 13 there is interposed a ball thrust race 19 and the toothed wheel is in mesh with a pinion 20 fixed to a spindle 21, one end of which is rotatably mounted in the casing member 2, while the other end passes through a ring 22 suported by legs 71 on to the insulating disc 16 and screw threaded into the outer end of casing member 1 and terminates in a head 23 having a screw driver slot therein for the purpose of enabling the pinion 20 and wheel 18 to be rotated to increase or decrease the compression of spring 12.

Mounted within the sleeve 15 is an operating spindle 24, freely mounted in said sleeve and terminating at one end as a screw threaded portion 25 which carries a lock nut 26 on to which is forced a sleeve 27 having a rounded end which bears on the flat base of the hexagon shaped aperture formed within the boss 11 in the bellows plate 10. The other end of the spindle 24 is provided with a head 28 having a screw driver slot therein which enables its length in relation to the said bellows plate 10 to be adjusted, the spindle being locked in any set position by the lock nut 26. The hexagon formed on this lock nut engages the hexagon shaped recess in the boss 11 and prevents rotation of said nut within the bellows plate and the round ended sleeve 27 allows the spindle 24 to take up a central position within the sleeve 15 without binding therein and for this purpose the hexagon nut 26 is made an easy fit within its seating.

A disc 26a is mounted around the nut 26 and bears against one end of a spring 24a whose opposite end bears against a shoulder on the nut 14, the purpose of this spring being to maintain the spindle 24, nut 26 and sleeve 27 in the positions shown in Fig. 1 relatively to the bellows plate 10 and in particular to cause the spindle 24 and associated parts to follow the movement of the plate as the bellows contracts. In Fig. 2, the springs 12 and 24a and the wheel 18 are shown in full for clearness.

Within the casing section 1 is mounted the snap action switch mechanism which preferably, and as illustrated in Figs. 1 and 2, takes the form described in my prior Patent No. 2,276,885, granted March 17, 1942, in which the switch construction is specifically claimed. This switch is arranged in the present instance as follows:

The insulated disc 16 carries two fixed switch contact elements 28a which, in the position shown in Fig. 1, are out of engagement with a movable contact member 29 carried on a ring 30 which surrounds the spindle 24. This spindle is formed near its outer end with a double ramp 31 consisting of two frusto-conical portions placed base to base and surrounding this double ramp are three radially arranged plungers 32 movably mounted in sockets 33 forming part of the ring 30 and urged into engagement with the said double ramp by a spring or springs 34.

The ring 30 is movable, as hereinafter described, axially of the spindle 24 and is guided by means of a rod 79 fixed in the disc 16. This rod passes through a slot 80 in the disc 30, thereby preventing the disc from turning, and is secured at its outer end to the spring 34 which is thus anchored in operative position relatively to the plungers 32.

Each contact member 28a is linked by a plate 35 to one of a pair of rods 36 internally screw threaded at each end (see Fig. 2). At the contact end the plate 35 and rod 36 are held together by a screw 37 while the other end of the rod is screwed to a terminal rod 38 and soldered thereto as shown at 39. The rod 38 has to pass through the bellows plate 4 without making electrical contact therewith but at the same time a pressure joint has to be made at this point and this is achieved by moulding to the rod a piece of insulating material 40 having a coned portion thereon which is pulled into a conical recess in the said bellows plate by means of an insulating washer 41 and a hexagon terminal pillar 42 both of which are screw threaded onto the end of the rod 38. Rods 36 and 38 are provided with screw threaded connections to enable their combined length to be adjusted so that the hexagon at end 43 on rod 36 lies as level as possible with the plate 35 when the screw 37 is tightened. The plate 35 is flexible and thus within reasonable limits compensates for any assembling or manufacturing errors in the rods 36 and 38. There are two terminal pillars 42, one for each terminal 28 and they are prevented from turning when the terminal screw 44 is being tightened by engaging in a hexagon socket 45 formed in a terminal block 46 which abuts against the bellows base plate 4.

The terminal block 46 consists of a disc of insulating material having channels 83 moulded therein (see Figs. 2 and 4) which serve to receive the electrical conductors 84 attached to the terminal screws 44 situated at the inner ends of the said channels.

The terminal base 46 is held in position by a screw threaded sleeve 47 (Fig. 1) whose inner end has an internally screw threaded portion 48 which engages a boss 49 formed centrally on the outer side of the base plate 4. The sleeve 47 traps between a shoulder 50 formed thereon and the terminal base 45, a spring washer 51 having two upturned ears 52 each formed into a V-section (see Fig. 4) to engage with splines 53 formed in a cap 54 which engages the screw threaded outer portion of the sleeve 47 and closes the outer end of the portion 3 of the casing. The sleeve 47 is prevented from slacking off by a tab washer 55 (Fig. 4) which is secured in place by a hexagon nut and tab washer 56.

The electric cable consisting of the conductors 84 enters the casing through a conduit 57, the metallic braiding 58 which is required for screening being held between sleeves 59 and 60 and held in position by a cap nut 61 engaging the exterior of the conduit 57. The electrical screening is completed by the casing portion 3 which is retained in position on the cap 54 by spring rings 62—63. The capillary tube 64 which is soldered into the central opening in the bellows plate 4 is protected by a flexible steel conduit 65 and as this conduit must be threaded on to the capillary tube 64 assembly prior to soldering the said capillary to the bellows plate, a U-section distance piece 66 is employed to make up the length between the end of the conduit and the boss 49 of the bellows plate. The outer end of the capillary tube and its protective sheathing are connected to the phial 67.

In order to ensure that the capillary tube 64 is in communication with the interior of the bellows 5 under all conditions, the end of the boss 11 is formed with spaced projections 85 which, when the bellows is in its contracted position (shown in Fig. 1), prevent the boss 11 from closing the end of the said capillary tube.

The ring 22 is formed integral with the three hollow legs 71 whose inner ends bear against the outer face of the disc 16 which is formed with passages 81 co-axial with the legs 71. Through the legs 71 and passages 81 pass screws 72 whose inner screw threaded ends engage screw threaded sockets formed in an inwardly directed flange 82 integral with the casing portion 2 thereby holding the ring 22 in fixed relationship with the disc 16. The inner portion of the ring 22 is screw threaded and is engaged by a screw threaded ring 70 which constitutes an abutment for the ring 30 on its outward movements. In order to vary the differential between cutting in and cutting-out of the switch, the position of the ring 70 is made variable and it is locked in the desired position of adjustment by three screws 68 which, due to an annular groove 69 turned in the periphery of the ring 70, can throw a portion of this ring out of pitch and thereby prevent rotational movement thereof until the screws 68 are slackened. This operation is possible because the entry portions of the screw sockets on the outer side of the groove 69 are not threaded.

The mechanism above described is completely enclosed by the casing which is made air tight by the trapped joints 7, 17 and 40. The first of these joints is completed after the bellows 5 and its associated parts have been operatively assembled, the completion of the joint being made by screwing home the ring 8. The second joint 17 is completed as the casing portion 1 is screwed onto the periphery of the ring 22, its inner end being guided by a portion of reduced section on the casing portion 1 fitting over the jointing

member 17. To facilitate this operation the casing portions 1 and 2 are formed externally with serrations 73 by means of which these components can be tightened relatively the one to the other and the exterior of the joint between them is sealed by a band 74.

When the assembly is complete and the parts adjusted to the positions required, a pressure test is applied to ensure that there are no leaks in the casing and its joints. For the purpose of this test a passage 75 is provided in the bellows plate 4 and when the test has been satisfactorily completed a steel ball 76 is introduced to close the passage 75 and is held in position by a screw 77 (Fig. 1) which is passed through an aperture in the terminal block 46 and enters a screw-threaded socket co-axial with the passage 75. The screw 77 is sealed and locked in position by composition 78 pressed and moulded into the aperture in the terminal block 46. After this sealing operation, the casing end 3 is positioned and locked in place by means of the cap 54, both of said elements having been loosely passed over the conduit 65 before fixture of the capillary tube 64 to the bellows plate 4.

In the operation of the device above described, the bellows 5 expands as the temperature of the element to which the phial 67 is exposed increases. The bellows expansion is transmitted through the plate 10 which, when the pressure within the bellows is sufficiently high, overcomes the resistance of spring 12 and forces the spindle 24 to move towards the right (Fig. 1). This action causes the plungers 32 to be moved radially outwards by one portion of the double ramp device 31 until the second coned surface comes into contact with the plungers, when the spring 34 comes into operation to force the plungers inwardly and impart a rapid movement to the ring 30 whereby the switch contact member 29 is brought into engagement with the members 28 to close an electrical alarm or contact circuit. This position of the spindle 24, plungers 32, ring 30 and switch contact members 28 and 29 is shown in Fig. 2. When the bellows 5 contracts, the spindle 24 is moved towards the left (Figs. 1 and 2) until by another snap action movement caused by the spring 34 as the plungers 32 ride over the line of intersection of the two ramps constituting the device 31, the switch contact members 29 are moved out of engagement with the members 28 and return to the position shown in Fig. 1. The sealing of the casing in the manner above described ensures that the bellows 5 is unaffected by atmospheric pressure changes which may take place externally of the casing so that the device when once accurately set will continue to function at the predetermined temperature communicated from the phial 67.

The construction of the thermostatic switch above described and the screening of the cable 84 prevents the switch from causing any interference with adjacent radio equipment and especially with the radio equipment of aircraft to which the compactness and lightness of the device renders the invention particularly applicable.

We claim:

1. A temperature sensitive control switch, comprising a metallic casing formed in a number of jointed sections, a snap action switch device disposed within said casing and screened electrically thereby, an expansible metallic bellows also disposed within said casing, an axially movable spindle adapted to transmit the movement of said bellows to said switch device, means for varying the temperature at which the switch device will operate, means for sealing the joints between the said casing sections to prevent interference with the bellows operation by changes of atmospheric pressure, electrical conductors connected to said switch device and having means for electrically screening them, and a capillary tube connecting the bellows with a phial exposed where the temperature is to be controlled.

2. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a complete electrical screening element, a control spring acting against said bellows device and reacting against a rotatable abutment member mounted in said casing and operable to vary the stress of the spring when it is rotated, said member being externally toothed and meshing with a pinion rotatably mounted in said casing, and means for rotating said pinion.

3. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a complete electrical screening element, said snap action switch mechanism comprising a pair of fixed switch contacts, a terminal block at one end of said casing and having switch terminals mounted therein, adjustable connecting rods sealed into said casing and interconnecting said switch contacts and terminals, electrical conductors connected to said terminals and having means for screening them externally against electrical interference, and a clamping sleeve through which said conductors are led into the casing.

4. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a complete electrical screening element, said switch mechanism comprising a spindle having means for adjusting its length relatively to said bellows, guiding means for said spindle, and means for locking said spindle in adjusted position, said means engaging said bellows to prevent rotation of the spindle and locking means and permitting movement of the spindle freely in an axial direction within said guiding means and without binding therein.

5. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a

complete electrical screening element, a fixed base plate in said casing supporting said bellows device, a terminal block, a locking sleeve for holding said block against said base plate, the inner end of said sleeve engaging said base plate, a cap mounted around said sleeve and retaining one end section of said casing in position, and locking elements held in position by said sleeve and engaging said cap for holding it against rotation.

6. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a complete electrical screening element, said casing being made in detachably interconnected sections, one of which encloses said switch mechanism and is rotatable into close engagement with an adjacent casing section which encloses said bellows device, and a sealing element interposed between the abutting edges of said sections, and a second sealing element surrounding the plane of contact between said edges.

7. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a complete electrical screening element, one of said casing sections enclosing said switch mechanism and an adjacent casing section enclosing said bellows device and having an end wall forming a base plate for the bellows device, a sealing element interposed between said adjacent casing section and said base plate, said base plate having an aperture formed therein to enable the same casing sections to be pressure tested after assembly, and a plastic composition seal for subsequently closing and sealing said aperture to ensure operation of said bellows and switch mechanism free from atmospheric pressure changes.

8. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a complete electrical screening element, said switch mechanism including electrical connections and terminals enclosed by one of said casing sections, and locking means connecting centrally through said casing section to said bellows device for securing said one casing section in position.

9. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a thermally sensitive bellows device and a snap action switch mechanism adapted to be operated by said bellows device both disposed within said casing, means for sealing the joints of said casing sections to prevent interference with the operation of the bellows by changes of atmospheric pressure and to form a complete electrical screening element, said switch mechanism including a mobile switch member, and an outer screw threaded ring mounted within one of said casing sections, and a screw threaded ring mounted within said outer ring and against which said switch member bears when the switch is in open condition, and adjustable in said outer ring to vary the extent of movement of said switch member.

10. A temperature sensitive control switch comprising a casing formed of a plurality of sections composed of electrical screening material, a thermally sensitive bellows device disposed within said casing, electrical switch mechanism also disposed within said casing and electrically screened thereby, and coacting with said bellows device, said switch mechanism being accessible while said casing sections are relatively separated, and means for joining and sealing together the assembled casing sections to protect said bellows device from the influence of atmospheric pressure changes and to complete the electrical screening of said switch mechanism.

11. A temperature sensitive control switch comprising a casing formed of a plurality of sections composed of electrical screening material, a thermally sensitive bellows device enveloped by said casing, electrical switch mechanism enveloped by said casing and electrically screened thereby, and coacting with said bellows device, adjusting means for said switch mechanism enveloped by the casing but accessible while said casing sections are relatively separated, means for joining and sealing together the assembled casing sections to complete the envelopment of and protect said bellows device from the influence of atmospheric pressure changes and to complete the electrical screening of said switch mechanism, and electrical conductors leading into said casing and connected to said switch mechanism, and having means for electrically screening them.

12. A temperature sensitive control switch comprising a metallic outer casing formed in a number of sections, a snap action switch mechanism disposed within said casing adjacent to one end thereof, electrical conductors leading to said switch mechanism, a thermally sensitive metallic bellows device also disposed within said casing, a spindle arranged to be actuated by said bellows device and communicating with said switch mechanism, adjusting means for determining the temperature at which said switch mechanism will operate, a capillary tube sealed into said casing to connect said bellows device with means exposed where the temperature is to be controlled, means for protecting said capillary tube, means for electrically screening said electrical conductors, and means for sealing the joints between the casing sections and the casing as a whole after assembly against the effects of atmospheric pressure changes.

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