

Aug. 22, 1939.

M. W. EATON

2,170,748

SNAP SWITCH

Filed Dec. 4, 1935

3 Sheets-Sheet 2

Fig. 9.

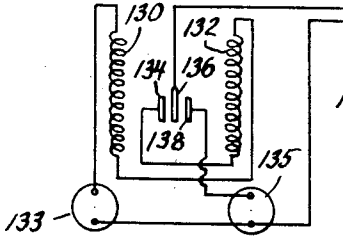


Fig. 10.

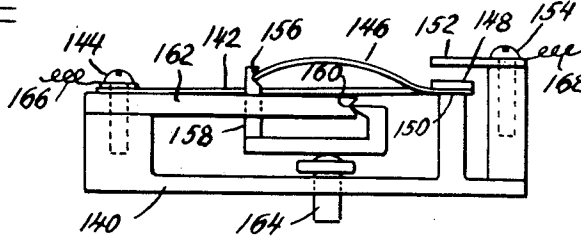


Fig. 11.

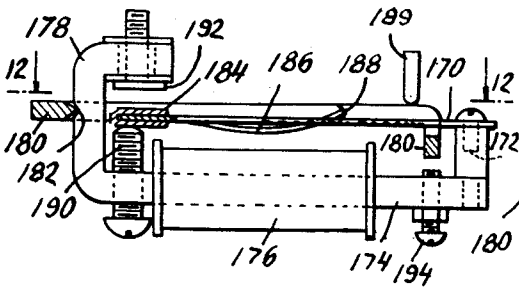


Fig. 12.

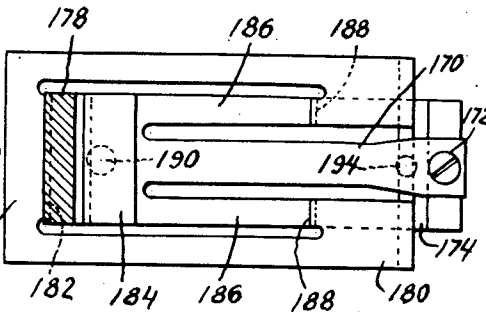


Fig. 13.

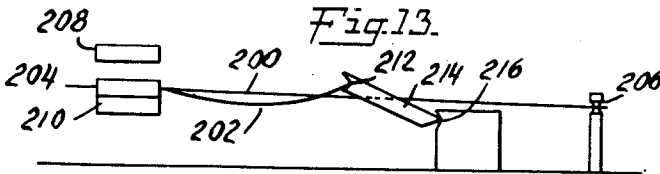


Fig. 14.

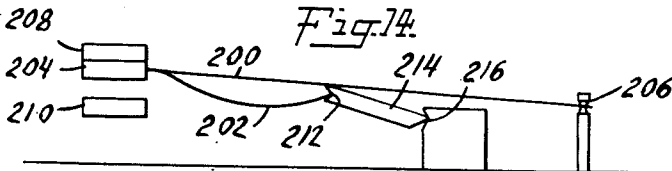
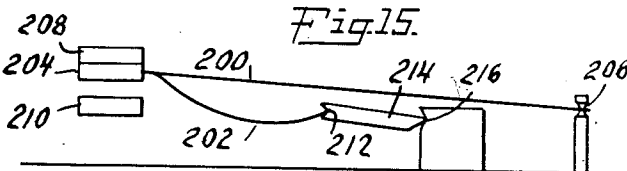


Fig. 15.



INVENTOR
M. W. Eaton
BY

Pearce, Davis, Martin & Edwards
ATTORNEYS

Aug. 22, 1939.

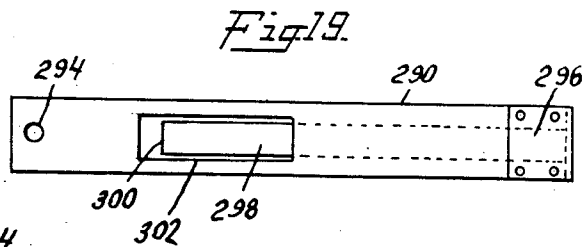
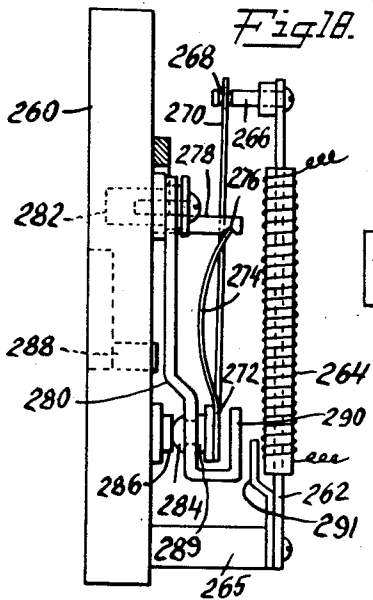
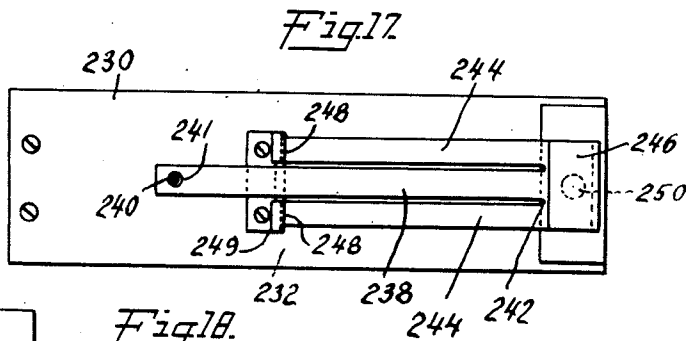
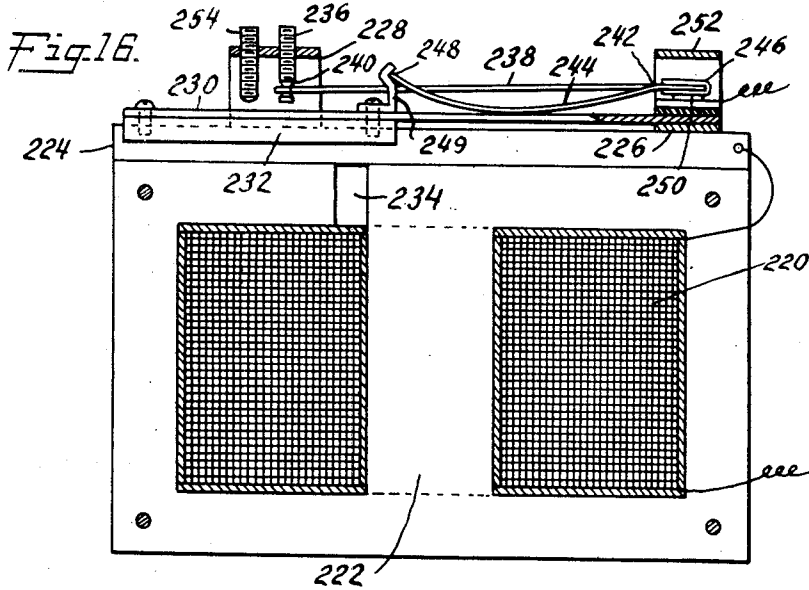
M. W. EATON

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SNAP SWITCH

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3 Sheets-Sheet 3



INVENTOR
M. W. Eaton
BY
Pence, Davis, Marvin & Edmonds
ATTORNEYS

UNITED STATES PATENT OFFICE

2,170,748

SNAP SWITCH

Malcolm Webster Eaton, Freeport, Ill., assignor,
by mesne assignments, to Micro Switch Cor-
poration, Freeport, Ill., a corporation of Illi-
nois

Application December 4, 1935, Serial No. 52,771

21 Claims. (Cl. 200—138)

This invention relates to snap switches, and more particularly to improvements in the type of snap switch which is described in the McGall Patent No. 1,960,020, issued May 22, 1934.

Among the objects of this invention are to provide a switch that requires a minimum of power for its operation; that provides a means when used in thermostatic devices by which both the operating differential and operating temperature thereof may be adjusted readily; that when used in conjunction with low wattage loads such as thermostats has appreciable contact pressure at the point of instability thereby providing a clean break of the contacts without practically any tendency to flicker or sizzle on low wattage loads; and that makes it possible to construct a temperature regulating device in which the thermostatic elements, such as thermostatic metal, are substantially unrestrained at all temperatures.

The specification is to be read in conjunction with the drawings which disclose specific embodiments of my invention.

In the drawings:

Fig. 1 is a cross sectional elevation of a bimetallic temperature regulator employing my improved snap switch as it appears within a particular temperature range;

Fig. 2 is a plan view of the general arrangement of the connected tension and compression members of the switch of Fig. 1;

Fig. 3 is a side elevation of another form of the invention;

Fig. 4 shows a special form of contact;

Fig. 5 is a side elevation of another thermostat structure embodying my invention;

Fig. 6 is a detail of the supported end of the tension member of Fig. 5;

Fig. 7 is a section along line 7—7 of Fig. 5;

Fig. 8 is a plan view of the base portion of Fig. 5;

Fig. 9 is a wiring diagram for an alternate flasher device;

Fig. 10 is a side elevation in partial section of a switch in which a tension toggle member is incorporated;

Fig. 11 is a side elevation in partial section of a relay incorporating my switch;

Fig. 12 is a plan view along line 12—12 of Fig. 11;

Figs. 13, 14 and 15 show diagrammatically a further modification of my invention in three different operating positions;

Fig. 16 is a cross sectional elevation of a further modification of my switch in conjunction

with an electromagnet to provide an intermittent flow of electric current thereto;

Fig. 17 shows the general arrangement of the movable elements of the switch as employed in Fig. 16;

Fig. 18 shows a specific type of switch incorporating my invention; and

Fig. 19 illustrates a further variation in the design and assembly of the tension and compression elements of Fig. 2.

One form of my modified and improved switch is shown in Fig. 1 in which a multi-layered thermostatic metal member is used in combination with the switch of my invention to form a thermostatic control device which is compact and serviceable.

A strip of suitable thermostatic metal, which may be made of any desirable combination of two or more superimposed layers of metals is formed into the shape of a U with one longer leg 10 and a shorter leg 12. Leg 12 has an end portion 14 thereof turned inwardly toward leg 10. A tension strip 16 is mounted at the end of longer leg 10 by means of threaded adjustable post 18. Post 18 may be electrically insulated from leg 10 as shown. This strip 16 has a hole 19 in it which fits over a necked portion 20 of post 18 whereby strip 16 is supported and its position is fixed when it is put under tension. Strip 16 is put in tension by means of adjacent compression spring strip 22 which is fastened to the free end of tension strip 16 as shown at 24. The opposite end of spring strip 22 is pivoted in a notch 26 formed in the inturned portion 14 of the U-shaped thermostatic metal device. Inturned part 14 has its central part cut away as shown so that it will not interfere with the vertical movement of tension member 16. The spring strip 22 is sufficiently long so that it is bowed in compression when so mounted. An electrical contact block 28 is secured to the strips 16 and 22 and makes and breaks the electric circuit operated by the switch. It is made of silver to minimize sparking and terminal corrosion. As shown it operates between suitable stops, contacts or terminals 30 and 32. The stops or contacts 30 and 32 are mounted to limit the movement of the free end 24 of the tension member to the amount necessary to make and break the electrical circuits to be controlled thereby. These stops or contacts preferably are adjustable vertically. For heavy currents a magnetic blowout may be used in conjunction with the switch to minimize injury to the contacts.

The tension member 16 and compression arm

22 may be formed out of one sheet of spring metal. Although one compression arm is all that is necessary it is advisable in commercial production to use two compression arms laterally adjacent the tension strip. Any number of tension strips or compression springs may be used.

The construction shown involves a second U-shaped member 34 mounted interiorly of the bi-metal U-shaped member, these two structures being fastened together firmly and to a suitable mounting base 36 by rivets, welding or other fastening means to provide a rigid construction. Terminals 38 and 40 may be electrically connected to contacts 30 and 32 and insulated from thermostatic metal 10, 12 as shown. In the construction shown in Fig. 1, terminal 42 is connected to post 18 and is insulated from the thermostatic metal and contact 28 is electrically connected to the thermostatic metal through compression member 22. If contact 28 is to be electrically insulated from the thermostatic metal this may be accomplished by substituting a non-conducting material for intumed portion 14 of leg 12 or by otherwise insulating the notch at pivot 26 from the leg.

Elongated tension strip 16 may be made of a spring strip or it may be a stiff unyielding strip. The support at 20 may be that shown or any suitable hinged type. It also may be constructed by turning upwardly the end portion of leg 10 similar to portion 14 of leg 12 and forming a necked portion thereon to support tension strip 16 at opening 19 thereof. If the tension strip 16 is flexible, for example, if it is a spring strip, then it may be mounted in non-pivotal fashion at 20, (as illustrated in McGall Patent 1,960,020) instead of being pivoted or hinged as shown.

The average temperature (average of the "on" and "off" temperatures) at which the switch operates may be controlled by raising and lowering support point 20 by means of stud 16. The average operating temperature also may be controlled by a similar arrangement on leg 12 whereby the pivot point 26 is raised or lowered. The same effect also may be secured by subjecting either or both legs 10 and 12 to controlled vertical mechanical pressure preferably near the base portion to thereby cause them to bend the desired amount and change the position of either or both support 20 and pivot 26.

When contact 28 touches the lower terminal 30 as shown pivot point 26 is above the tension center line of tension strip 16, that is, a line connecting the point of junction 24 with point of support 20. The tension center line is not necessarily the physical center line of the tension member. As the temperature of thermostatic metal strip 10, 12 is changed so that legs 10 and 12 thereof bow inwardly toward each other, the pivot point 26 approaches the tension center line of tension strip 16. When pivot point 26 passes downwardly through the tension center line, tension strip 16 snaps upwardly so that junction 24 or contact 28 reaches stop or contact 32. It is apparent that for different temperature ranges the normal position of pivot point 26 is either below or above the tension center line of strip 16, the tension center line practically coinciding with strip 16 if said strip is substantially straight. For the range of temperature in which pivot point 26 is below the tension center line of strip 16, legs 10 and 12 move outwardly during the necessary temperature change which causes contact 28 to snap from stop or contact 32 to stop or contact 30. Upon return of pivot point 26 to above the tension

center line of tension strip 16, said tension strip will snap back into the position shown. In the thermostatic device of Fig. 1 the temperature differential thereof, i. e., the difference between the "on" and "off" temperatures is controllable over a wide range by the width of gap or the movement of the contact end 28.

It is obvious that the switch as described and shown in Fig. 1 is operable by the simultaneous movement of legs 10 and 12 to thereby shift pivot point 26 and support 20 in a generally vertical direction. Tension strip 16 or the tension center line thereof and pivot point 26 move or pass with respect to each other, that is, their relative positions change with respect to each other. It therefore is not necessary to have both pivot point 26 and support 20 move in order to secure the necessary relative movement of pivot point 26 and tension member 16. Either or both legs may move and may be made of thermostatic metal or one of the legs may be made of non-thermostatic material. Either or both legs or either or both pivot point 26 and support 20 may be actuated by other devices such as fluid filled bellows, pistons, etc. that are used in the field of automatic temperature control. However, if other temperature-responsive devices or other means operate either or both legs they may be made of non-thermostatic material such as hard rubber, non-thermostatic metal, asbestos board, etc., provided the operative leg is suitably mounted as on a hinge, to allow necessary movement thereof, as, for example in Fig. 10.

If, for example, the operative leg is made of flexible material other than thermostatic metal such as a strip of ordinary spring brass mounted in cantilever fashion as in Fig. 3, the switch operates when the spring is deformed sufficiently by any suitable force, such as temperature responsive means, manual or any mechanical or other means. Upon release of the operative force on the spring the switch snaps back to its original position if the pivot point of the compression member returns to its original position with respect to the tension center line of the tension member. If pivot point 26 or support 20 do not return to their original positions the switch does not return to its original position. In any case either or both pivot point 26 and support 20 are so mounted that pivot point 26 is moved relative to the tension center line of the tension member thereby causing the switch to operate.

Fig. 3 shows a specific embodiment of one of the types of switches referred to in the preceding paragraph, this type being applicable especially to switches used for starting and stopping small shop motors. The usual snapswitch construction is used including a base 40, a combination (of the type of Fig. 2) spring strip tension member 42 and spring strip compression member 48, and a double contact 50 of the type shown in Fig. 4. Tension member 42 is mounted on necked portion 44 of stud 46 carried by the base. Compression member 48 is connected to the free end of the tension member by contact 50 which cooperates with two contacts 52. Contacts 52 are insulated from each other and mounted on base 40 and are connected with the circuit to be controlled. The other end of compression spring strip 48 is pivotally mounted at 54 in a notch or angle in the down-turned end of a spring strip 56. Strip 56 is mounted in cantilever fashion on base 40 and operated by push-button 58 attached thereto. When spring 56 is depressed sufficiently by pushing on button 58 to force pivot point 54 below

the tension center line of tension spring 42 the connected end with contacts 50 snaps upwardly thereby breaking the circuit connected to stationary contacts 52. Cantilever spring 56 is spaced sufficiently above the contact position of the tension member as illustrated so that when connected end 50 snaps upwardly and cantilever spring 56 acts as a stop to prevent further upward travel, the tension center line of tension member 42 remains above pivot point 54 after cantilever spring 56 returns to its normal position, that is, the circuit remains open when the pressure on button 58 is released. A second cantilever spring strip 60, operated by push-button 62, is mounted on base 40 at an end thereof opposite to that at which cantilever spring 56 is mounted. Spring 60 has a down-turned outer end 64 which contacts with or is closely adjacent tension member spring 42 when the tension center line of the tension member is above pivot point 54. When pressure is applied to button 62 down-turned end 64 bows tension spring 42 downward. When the tension center line is forced downwardly sufficiently with respect to pivot point 54 the connected end 50 snaps downwardly to again close the circuit through stops 52, that is, the switch returns to the position illustrated in Fig. 3 and remains there upon release of the pressure on button 62.

The construction of Fig. 3 may be varied in that the one or both cantilever springs 56 and 60 may be operatively associated with devices used for temperature control or thermostatic metal strips may be substituted for them. For example, assume that a strip of thermostatic metal is substituted for spring 56 and that the position of the switch as shown is the low temperature position of the thermostatic metal and the "on" position of the heating element controlled thereby. Assume that with increase in temperature, the thermostatic metal bows downward. On reaching a predetermined temperature the pivot point 54 drops low enough to snap the contacts 50 upwardly and break the flow of current through the heating element. On cooling to the normal temperature the switch does not return to the "on" position but only returns to that position if the switch is reset by pushing on button 62. If spring 60 is replaced by thermostatic metal or operatively associated with a device used for temperature control the switch may be arranged so that it snaps back to the "on" position automatically when a predetermined temperature is reached on cooling.

In another variation of the switches of Figs. 1 and 3 in which the pivot point 26 and support 20 are mounted so as to be operated separately, the operative forces are so separated and controlled that one force depresses pivot point 26 to cause the switch to snap over to contact with stop 32 whereas the other force depresses support 20 to reset the switch by causing the switch to snap over to contact with stop 30 (or vice versa).

It is also possible to avoid making both the tension strip 16 and compression spring 22 a part of the electrical circuit by replacing either single contact 30 or 32 or both with pairs of contacts 70 and 72 of Fig. 4. These contacts are insulated from each other as shown and form the terminals of an electrical circuit. The movable bi-metal contact 74 flexibly mounted on tension strip 76 closes the circuit between 70 and 72.

The snap action may be assisted somewhat by the magnetic means also illustrated in Fig. 4. A magnet 78 is mounted with its poles adjacent the

movable terminal 74 which contains an iron backing for the silver facing. This movable terminal is therefore attracted by the magnet, thereby increasing the force necessary to cause terminal 74 to move from stationary contacts 70 and 72. The snap action is increased thereby since the magnetic attraction decreases rapidly as the contacts separate further from each other.

If it is necessary to have one of the two stationary contacts of Fig. 4 break contact later than the other or make contact before the other, this may be accomplished by an auxiliary contact 79 mounted on a very flexible spring such as a strip spring as shown. This flexible spring contact is mounted on contact 70 so that its contact surface is normally above the surface of contact 70. The spring supporting it is weak enough so that the compression spring means of the switch depress it and allows movable contact 74 to make the desired contact with 70 and 72.

In my modification of the McGall switch as described herein the radius of action of the compression spring also is different than that of the tension strip. If tension member 16 is made of a strip spring my switch also may be operated by pressing thereon near the supported end as described in the McGall patent. If the tension member is sufficiently stiff to mask any spring action, continuing pressure on the tension member equal to that which causes contact 28 to leave contact 30 will cause a rapid or snap movement of contact 28 toward the stop 32 since the pressure necessary to continue the movement so started decreases with the distance travelled by contact 28. This decreasing pressure characteristic is only applicable within limits when the distance between stops is relatively small.

The thermostatic device of Figs. 5 to 8 is a variation of that shown in Fig. 1. The U-shaped thermostatic metal strips with legs 80 and 82 are mounted on base 84 by bolts 86 and 88. These bolts also serve to convey the electric current from the switch members to the terminals 90 and 92. A hook or hair-pin shaped strip spring 94 is mounted at the outer end of leg 80 by means of adjusting screw 96 and bushing 98. The end of the adjusting screw 96 bears against one leg of the hook spring 94 to vary the position of the support 100 of the tension member 106. This in turn varies the position of tension member 106 with reference to the pivot point 108 of the compression spring 110. Pivot point is formed by the inturned outer end 112 of leg 82. The shifting of their relative positions changes the operating characteristics of the switch thereby allowing such changes to be made easily by means of adjusting screw 96. Tension member 106 contains an opening 114 (see Fig. 6) at the point of support 100 the outer edge of which is straight thereby providing edgewise stability to the structure because of the appreciable width of the knife-edge contact with the hooked end portion of spring 94. The free end of the tension member 106 is attached to the free end of the compression spring 110 by means of an electrical contact 116 which operates between upper contact 118 and lower stop 120. Lower stop 120 is attached to the interior of the U of thermostatic metal and base 84 by means of bolt 86 and may be grounded to the thermostatic metal. Upper contact 118 is attached to the base 84 on the interior portion of the base of the U of thermostatic metal by means of bolt 88 and is insulated from said thermostatic metal by in-

5 insulation 122. Insulation 124 also is inserted on the outer portion of the base of the U of thermostatic metal. In the thermostatic device shown, the source of electrical energy is connected to terminal 90 thereby energizing the thermostatic metal and movable electrical contact 116 through both compression spring 110 and tension member 106. The load is connected through terminal 92 to upper contact 118. When movable contact 116 contacts with upper contact 118, the circuit is completed from the source of energy through the load. As in Fig. 1 the legs 80 and 82 of thermostatic metal move outward and away from each other with variations in temperature thereby causing the tension center line of tension strip 106 to pass the pivot point 108 and thereby also causing the connected free ends of the tension strip and compression spring and contact 116 to move with a snap. If either leg 80 or 20 82 is made of spring metal, either thermostatic or non-thermostatic, the device is operative by a manual or mechanical movement of these legs as described previously.

25 The switches of Figs. 1 or 5 also may be used to provide a flasher device in which the alternate flashing is slower than that which may be obtained with the device of Fig. 16. Electric resistance heating elements, such as are widely used, are mounted adjacent the thermostatic metal legs of these switches whereby the heat generated by an electric current passing through such elements is transmitted rapidly to the thermostatic metal, thereby operating the switch. A wiring diagram is shown in Fig. 9 in which the thermostatic legs are heated by elements 130 and 132 in series with stationary contact 134 and movable contact 136. When the movable contact snaps over to the stationary contact 134 the current passes through the heating elements 130, 132 and load 133 (flashing lamp). This causes the heating elements to heat the thermostatic metal legs. These legs bend, and movable contact 136 snaps over to stationary contact 138, opening the heater and load 133 circuit. Stationary contact 138 is in series with the load 135 (a second flashing lamp). During the contact with stationary contact 138, the heater coils cool whereby the thermostatic legs return to their original position and the movable contact 136 again snaps into contact with stationary contact 134. The cycle is thereby repeated causing alternate flashing if lamps constitute the loads 133 and 135. The load also may be omitted from either circuit as desired.

55 Fig 10 shows an embodiment in which a pivoted or toggle member is incorporated in the switch, this member operating the pivot point of the compression member. The switch comprises an insulating base member 140 on which the tension member 142 is supported by screw or bolt 144. At the free end of said tension member is attached compression spring 146 and contact 148. Contact 148 operates between stop 150 carried by the base and electrical contact 152 which is mounted on base 140 by means of screw 154. The opposite end of compression spring 146 is operatively pivoted in notch 156 in a toggle member 158. As shown the toggle member is in the form of a shallow U. The opposite end of the toggle is pivoted in notch 160 in member 162 which is attached to base 140. A hinge may be used in place of the notch construction shown and such a hinged construction is one of the constructions included when a toggle member or 70 toggle is referred to in the specification. The

switch is operated by means of plunger 164 which acts upon toggle 158. As shown, the plunger is acting against the force of the compression spring 146 which tends to bring its pivot point in line with the notch 160 and the connected free ends of tension strip 142 and compression spring at contact 148. If the force holding plunger 164 against toggle 158 is released, notch 156 drops through the tension center line of tension member 142 and contact 148 snaps upward to press against upper contact 152, thereby electrically connecting leads 166 and 168.

10 In Figs. 11 and 12 a relay incorporating a toggle type snap switch is shown. The tension member 170 is mounted on an adjustable post 172 screwed into an iron or steel bar 174. This bar, which forms the base or support extends through a solenoid coil 176 and has its opposite end 178 formed into an upward reverse bend as shown. An iron or steel toggle member 180 in the form of a hollow rectangle with the right-hand end turned downward is pivoted at 182 in a notch in upturned end 178 of bar 174. The free end of tension member 172 is attached to the free end of compression springs 186 by means of contact 184. The opposite ends of the compression springs are pivoted in notches 188 in toggle member 180. Contact 184 operates between a lower stop 190 and an upper stop or terminal 192. Stop 190, which also may be insulated and form an electrical contact, is formed by a machine screw mounted in bar 174. Upper terminal 192 is mounted in but insulated from part 178 of bar 174 as shown in the drawing, which illustrates the normal position of the switch, and pivot points 188 are above the tension center line of tension member 170 so that contact 184 is adjacent lower stop 190. Pivot points 188 also are above a line connecting the support point of tension member 170 and pivot 182, thereby urging the free end of toggle member 180 continuously upward against a stop 189. Upon passage of an electric current through solenoid coil 176 bar 174 becomes magnetized and attracts the turned-down end of toggle 180. When toggle 180 is pulled downwardly pivot point 188 passes the tension center line of tension member 170, but does not pass below the line connecting pivot 182 and the support for tension member 170. Thereupon contact 184 snaps upwardly to stop 192, and closes the electrical circuit to be controlled. The circuit is connected to the switch through terminal or contact 192 and the movable contact 184 by means of tension member 170 to the balance of the switch structure. Electrical connection may be made with the switch structure at any convenient place, for example, at machine screw 194. This screw is threaded through bar 174 and acts as a stop for the downward end of toggle 180 to control the amount of movement thereof. Upon breaking the circuit through coil 176 the electro-magnet 174 is de-energized and the force of compression springs 186 tending to urge the toggle member 180 upward is sufficient to overcome the force of attraction due to residual magnetism between bar 174 and toggle 180. The toggle member 180 is thus caused to move upwardly. When pivot points 188 pass through the tension center line of tension member 170, contact 184 snaps downwardly to stop 190 and breaks the electrical circuit controlled by the switch. This automatic return of the contact 184 to the normal position does not occur if pivot points 188 drop below the line connecting the support point of tension 75

member 170 and pivot 182 when contact 184 engages upper contact 192 since compression springs 186 are then urging toggle member 180 downwardly.

5 A modification in which the toggle member is in compression is shown in diagrammatic form in Figs. 13, 14 and 15. In this modification there is used the usual tension strip element 200 and the bowed compression spring 202 connected by contact 204 at their free ends. The tension member 200 is supported at its opposite end at 206. Stops or contacts 208 and 210 limit the movement of the connected ends and contact 204. The end of the compression spring 202 10 opposite to the connected end is pivoted at 212 so that the pivot may be moved vertically across the tension center line of tension element 200 by forming the pivot in toggle member 214. Toggle member 214 is pivoted in turn at 216. Although the pivot at 216 is shown as stationary it also may be constructed so that it may be moved vertically. In the position shown in Fig. 13 the pivot 212 is above the tension center line of tension member 200 and the contact 204 presses against lower stop contact 210. Compression spring 202 urges pivot 212 and toggle member 214 upward. When the toggle member is pressed downward by pivoting at 216, pivot 212 is depressed below the tension center line of tension member 200, as shown in Fig. 14. The connected ends and contact 204 then snap upwardly against contact 208 as pivot 212 crosses said center line. However, if pivot point 212 is not depressed below the plane or line connecting pivot 216 and the connected ends of compression spring 202 and tension member 200, (that is, not beyond the position illustrated in Fig. 14) pivot 212 will return to the position shown in Fig. 13 and the contact 204 will snap back to its original position against stop contact 210 when the force operating against toggle member 214 is released. On the other hand, if pivot 212 is forced below this plane or line as shown in Fig. 15 it will not snap back to the original position until pivot 45 point 212 is brought back above the said plane or line. It is possible also to cause the switch to operate by moving pivot point 216 or support point 206 or both in a vertical direction, thereby making it possible to adapt a switch of this type to various operating requirements.

50 In Figs. 16 and 17 a further modification and adaptation of my improved switch is shown. The construction may be used wherever it is desirable to secure controlled intermittent passage of current. The specific application shown is for the operation of a flasher device in which a neon-filled tube or other partially evacuated or fluorescent tube is used. In Fig. 16 the switch is combined with an induction coil and is operated by the magnetic field thereof by means of an armature mounted upon an element of the switch. The snap switch is mounted directly on the electromagnet of the induction coil which is used to step up the voltage to that required to flash the luminous tube operated thereby. Since the source of energy is unidirectional, for example, that supplied by a primary or secondary battery, means are provided for interrupting the energy supply in order to produce pulsations in the primary of the induction coil whereby the required higher voltages are induced in the secondary thereof. In flashing devices of this type, especially when they are used for roadside warning signs, it is desirable to have the device flash 75 at comparatively long intervals of time, say one

flash every one-half to three seconds, it being necessary further to be able to control exactly the timing of these flashes. My improved switch when mounted as shown in Fig. 16 fulfills these requirements, and furthermore is rugged, economical to operate and has a minimum of moving parts.

10 In the electromagnet shown in Fig. 16 the windings 220 set up a magnetic field in the laminated iron core 222. The switch mechanism is mounted above it upon the brass or other non-magnetic base member 224 attached to the core and cross members 226 and 228. The contact end of the switch is mounted upon the frame cross member 226 which forms one side of the circuit. Upon this cross member is attached in cantilever fashion a switch actuator consisting of a strip spring member 230 which extends rearwardly as shown. Other equivalent constructions having an inherent natural period of vibration may be used in place of the cantilever mounted strip spring. For example, I may employ a stiff strip member hinged at 226 and mounted at its opposite end upon a coiled or other suitable spring whereby the stiff strip vibrates when released after flexing the spring either in compression or tension. At the opposite end and bottom of said strip spring 230 is attached a magnetic armature 232 which is spaced from the core 222. The core is slotted at 234 under the armature to provide the leakage flux required for increasing the efficiency of the magnetic action on the armature. The cross member 228 carries a vertical adjusting stud 236 on which is supported the tension strip or follower 238 of the snap switch. As shown the stud has a necked portion 240 which fits into opening 241 (see Fig. 17) of the tension strip. The opposite free end 242 of said tension member is attached to compression spring 244 and contact 246 is mounted thereon. The opposite end of compression spring 244 is pivoted in a notch 248 which is formed in a mounting member 249 on said cantilever spring strip 230. Notch 248 is normally (when said switch is not operating) 45 above the tension center line of said tension strip 238 so that contact 246 is normally pressing against the lower stop 250. An important feature of this construction is that the bottom part of the bow of compression spring 244 constitutes a bumper and normally just touches spring strip 230 or lies in close proximity thereto. The lower stop 250 is an electrical contact which is insulated from the rest of the switch and frame except through contact 246 and either or both the connecting tension strip 238 and compression spring 244. The circuit from the source of electrical energy therefore passes through contacts 246 and 250, through the energizing coils and back to the source of energy. An upper stop 252 may be used to limit the upward movement of contact 246.

50 Since the contacts 246 and 250 are normally pressing against each other, the electromagnet 220 becomes energized when a source of energy is applied across the terminals of the primary circuit. The armature 232 is attracted by the energized electromagnet and is pulled downwardly thereby causing spring strip 230 to bend and be stressed with it. The mounting 249 thereon with notch 248 drops, and the pivot point of compression spring 244 thus drops below the tension center line of tension member 238. This forces the free end of the compression spring and contact 246 to move upwardly 75

with a snap from contact 250, simultaneously breaking the electrical circuit and inducing a sufficient voltage in the secondary to cause a space discharge in a gas-filled tube (not shown), such as a neon tube, in circuit therewith. A distinct bright flash thereupon occurs in said tube. The electromagnet is deenergized immediately so that it releases armature 232. Spring strip 230 and armature 232 then spring upward and in so doing move the notched member 249 up to carry the pivot point of the compression spring 244 above the tension center line of the tension member 238 and to force the contact 246 to move with a snap action down against the stationary contact 250. Because of the inertia of the combined spring strip 230 and armature 232 this combination member does not come to rest immediately at the normal place, but travels upwardly past the normal position. As it passes upwardly through the normal position, spring strip 230 comes in contact with the bottom of compression spring 244 and forces it upwardly, together with the contact 246, thereby lifting contact 246 off the stationary contact 250 to prevent the circuit from being closed for a sufficient length of time to energize the electromagnet and attract armature 232. Tests indicate that the circuit probably is closed for a comparatively minute length of time as the device passes through the normal position. After the vibrator, that is, combined spring strip 230 and armature 232, has reached the upper limit of movement due to its inertia, the flexed strip spring 230 causes this vibrating member to travel downward again. The weighted cantilever spring or actuator 230 continues for a time to vibrate with decreasing amplitude and in so vibrating beats against bowed compression spring 244 to lift the contact 246 to repeatedly off the contact 250. This oscillation of the cantilever actuator 230, contact 246 never lies in engagement with contact 250 long enough at one time to produce a distinct bright flash in a connected luminous tube (not shown). After the strip spring 230 is practically at rest in the normal position, contact 246 again touches contact 250 for a length of time which permits energization of the electromagnet sufficient to cause armature 232 to be attracted to it.

During the oscillatory movement of contact 246 a series of low intensity flashes may be produced. The intensity of these dim flashes is largely dependent upon the gas used in the tube, some gases, such as argon, being more effective than neon for example, under these conditions. These low intensity flashes follow each other with sufficient rapidity that the tube glows as steadily as when a 60 cycle alternating current is applied to the tube. The tube may glow with sufficient intensity with certain gases so that it may be used for purposes where a continuous lower intensity illumination is desirable. The apparently continuous glow has, of course, a bright flash passing through it each time when the circuit is broken after contact 246 comes to rest against contact 250, but not during the period when the oscillations are diminishing in amplitude as explained previously. The characteristics of the device may be changed by changing the proportions and setting of the various parts as by raising or lowering the point of support 240 of the tension member 238 by means of stud 236. The interval between flashes may be varied by screwing stud 236 up or down to thereby vary the number of degrees above or below normal,

or rest, position of the vibrator, which this vibrator must move in order to break the contact. The interval between flashes also may be decreased by damping directly the oscillations of vibrator 230, 232 by suitable means as by a stud 254 in cross member 228. The amplitude may be decreased sufficiently by these various means to cause the flasher to flash a considerable number of times per second. The construction described allows a variation in flasher speeds of from one every three seconds or greater to a "flutter".

In Fig. 18 my switch construction, which may be operated by a thermostatic member as shown, is used to control heavy electric currents through a secondary switch. The usual snapswitch structure is used and is mounted on base 260. A thermostatic member 262, subject to the heating effect of a heating coil 264 in either direct or indirect association with the circuit which is controlled by the secondary switch, is mounted on the base in cantilever fashion on post 265. Attached to the thermostatic member 262 is a stud 266 having a necked portion 268 on which is mounted the usual tension strip member 270. Tension strip 270 is connected at 272 to compression spring 274, the combination being of the type shown in Fig. 2. The compression spring is pivoted at 276 in member 278 which is attached to base 260. A loosely-mounted iron or other magnetic pendulum-like member 280 is suspended from a suitable stud support 282. The bottom of the pendulum-like member 280 is turned back on itself, as shown. Attached to the bottom part of member 280 is a contact 284 which bridges stationary double contacts 286 as illustrated in Fig. 4, whereby the circuit to be controlled is closed. A magnet 288 is mounted in base 260 and spaced from pendulum 280. The magnet tends to attract the pendulum and thus insure good electrical connection between contacts 284 and 286. It is obvious that the magnet may be mounted on the pendulum and that 288 may be a material attracted thereby. Upon heating of element 264 the thermostatic metal 262 bows outwardly so that the tension center line of the tension strip 270 crosses the pivot point 276 of the compression spring 274 to thereby cause the connected end 272 with its attached weight 289 to snap over and hit a hammer-like blow on the backwardly turned part 290 of the pendulum 280. This blow, in combination with the decrease in magnetic pull as member 280 is separated further from magnet 288, quickly separates contact 284 from contacts 286 thereby breaking the circuit. This break is rapid enough so that heavy currents may be handled. The spring action of the compression spring 270 keeps part 290 against stop 291 thereby keeping the contacts apart until the switch returns with a snap to the original position when electrical contact is again resumed.

Throughout the specification the directional terms horizontal, vertical, below, above, etc. are used for convenience and to facilitate the description and are not used in a restrictive sense. It is further obvious from the description that a vertical movement refers to a generally up or down movement and is not restricted to one that is exactly 90° to the surface of the earth.

The invention is not limited to the constructions illustrated and described but contemplates variations thereof without departing from the invention as recited in the appended claims.

The construction of the switch arm assembly of Fig. 2 may be varied without departing from 75

the described principle of operation. More than one tension arm may be used. Similarly, one or more compression arms may be used. Both or either the compression and tension arms may contain S and other curves as illustrated and described in the McGall patent. Coiled springs may be used for the tension and compression arms instead of the elongated strip members illustrated and herein described.

Although the compression spring is shown in the illustrative constructions to be laterally adjacent or parallel to the tension member, nevertheless it may be above or below the tension member provided that the pivot point is correctly placed and it does not interfere with the action of the tension member. The pivot point or operative mounting of the compression spring has to be placed so that it moves vertically past the tension center line. It is possible to provide an opening in the tension member as shown in Fig. 19, and mount the pivoted end therein. The tension strip 290 supported at one end at opening 294 is attached at its other end 296 to downwardly bowed compression strip spring 298 which in turn is pivoted or mounted at 300 in a separate member in opening 302 so that the pivot point may pass in a vertical direction through the tension center line of the tension member 290 without interference.

The compression strip spring preferably is mounted at the end opposite its connected end by a pivot or hinge. However, under some conditions the strip spring may be rigidly held at this point especially if an easily flexible spring is used whereby the equivalent of a pivot or hinge action is obtained. With a stiff strip spring held rigidly the operation of the switch may be slightly modified in that the snapover of the connected end may be shifted slightly from the tension center line of the tension member or the snap action may be prevented entirely. On the other hand, if another type of compression spring is used, such as a coiled spring which is much more flexible in lateral movement, the snap action may not be influenced very much by the rigid fastening of the fixed end. However, when reference is made in the claims to the snapping of the switch when the pivot point passes through the tension center line, it is intended to include those constructions where a small deviation therefrom occurs.

The switch of my invention also may be made by making the tension arm of spring material such as a coiled spring or a strip spring containing folds or S-shaped curves and the compression arm or arms thereof of stiff material. Such a switch may be operated by shifting the relative positions of the mounting points of the tension and compression members as described.

I claim:

1. A snapswitch comprising the combination of an elongated tension member operatively mounted at one end thereof with the other end free to move and an adjacent spring strip connected to the free end of said tension member, said spring strip being bowed in longitudinal compression and being pivoted at the end opposite to said connected end at a point between the mounted and free ends of said tension member, said pivot point being movable in a transverse direction to cross the tension center line of said tension member, said member and said spring strip being so arranged that said connected end is caused to move with a snap action as said pivot point is moved through the tension center

line of said tension member, the element on which said spring strip is pivoted being operatively independent of the element on which said tension member is operatively mounted.

2. A snapswitch comprising the combination of a spring strip tension member operatively mounted in pivotal fashion at one end thereof with the other end free to move and adjacent compression spring means connected to the free end of said tension member and operatively mounted at the end opposite to the connected end thereof at a point whereby it has a different radius of action than said tension member, the relative position of said mounting points being changeable with respect to each other, said member and said compression spring means being so arranged that said connected end moves with a snap action as said mounting point of said compression spring means and the tension center line of said tension member cross, the element on which said compression spring means is operatively mounted being operatively independent of the element on which said tension member is operatively mounted.

3. A thermostatic snapswitch comprising, in combination, a tension strip operatively mounted at one end thereof with the other end free to move, an adjacent strip spring having one end connected with the free end of said tension strip, the opposite end of said strip spring being pivoted at a point laterally adjacent said tension strip and in such relation to the connected end thereof that said strip spring is in longitudinal compression, a metallic thermostatic member, means whereby at least either the mounting for said tension strip or said pivot point is operatively connected to said thermostatic member to cause said pivot point and the tension center line of said tension strip to cross with changes in temperature of said thermostatic member, said construction being so arranged that said connected end moves with a snap action at predetermined temperatures of said thermostatic member, the element on which said strip spring is pivoted being operatively independent of the element on which said tension strip is operatively mounted.

4. A thermostatic switch comprising, in combination, a U-shaped strip of multi-layered thermostatic metal, an elongated tension strip operatively mounted in spaced relation to the interior surface of one leg of said U-shaped strip and extending toward the base of said U, the interior end of said tension strip being free to move, an adjacent strip spring bowed in longitudinal compression connected to the free end of said tension strip and pivotally mounted at its other end laterally adjacent said tension strip and operatively associated by means of said pivotal mounting with the second leg of said U-shaped strip, said construction being so arranged that said connected end moves with a snap action when said thermostatic metal reaches a predetermined temperature with variations in temperature thereof.

5. The construction of the immediately preceding claim wherein the means for operatively mounting said tension strip comprises a hairpin shaped strip of metal, the end of one leg thereof being attached to said first leg of said U-shaped strip and extending outwardly therefrom, the second leg of said hair-pin extending inwardly toward the base of said U and being operatively connected to said tension member whereby movement of said first leg of said U-shaped strip of thermostatic metal is transmitted to said tension member.

6. A thermostatic switch comprising, in combination, a U-shaped strip of multi-metallic thermostatic metal having a short leg and a long leg, the end of the short leg being turned inwardly toward said long leg, pivot-forming means associated therewith, a metal tension strip operatively mounted at the extremity of said long leg in spaced relation thereto and extending into the space between said legs of thermostatic metal, the interior end of said tension strip being free to move, a strip spring adjacent said tension strip and connected to the free end thereof with its opposite end cooperating with said pivot-forming means of said intumed end, said strip spring being of sufficient length to be bowed in horizontal compression when so mounted, said pivot point being in proximity to the tension center line of said tension strip, electrical contact means at said connected end, and a cooperating electrical contact stop mounted interiorly of said U-shaped section, the construction being so arranged that when said legs of thermostatic metal are subject to variations in temperature said switch operates with a snap action at a predetermined temperature.

7. A snap switch construction comprising an elongated tension member operatively mounted at one end thereof with the other end free to move, adjacent downwardly bowed spring strip means in longitudinal compression connected to the free end of said tension member and having its opposite end so pivoted laterally adjacent thereto as to provide a shorter radius of action than that of said tension member, said construction being so arranged that said connected end portion moves with a snap when the pivoted end of said compression spring is moved across the tension center line of said tension member, said connected end portion comprising electrical contact means, a stop comprising electrical contact means for said connected end with which it normally contacts, and strip spring means below and contiguous said compression spring mounted in cantilever fashion with a mounting thereon for said compression spring pivot, said construction being so arranged that when said strip spring means is released after being flexed downwardly and causing said connected end portion to move from said stop with a snap said tension member vibrates with continuously decreasing amplitude before returning to its normal non-vibratory position.

8. The construction of the immediately preceding claim wherein the unsupported part of said strip spring comprises an armature and in which an electromagnet is associated with said armature, the construction being so arranged that said armature is moved downwardly sufficiently to cause said snap action by the magnetic forces generated when an electric current is passed through the electrical winding thereof, said electrical winding thereof being in series with said abutting pair of electrical contacts.

9. The combination of an induction coil comprising primary and secondary circuits a source of direct current electrical energy and a snap switch in the primary circuit thereof, said snap switch being mounted on the electromagnetic core of said induction coil and operated by the magnetic forces generated therein, said snap switch construction comprising an elongated tension member operatively mounted at one end thereof with the other end free to move, adjacent downwardly bowed spring strip means in longitudinal compression connected to the free end of

said tension member and having its opposite end so pivoted laterally adjacent thereto as to provide a shorter radius of action than that of said tension member, said construction being so arranged that said connected end portion moves with a snap when the pivoted end of said compression spring is moved across the tension center line of said tension member, said connected end portion comprising electrical contact means, a stop comprising electrical contact means for said connected end with which it normally contacts, said stop being in said primary circuit and the circuit through said electrical energy means, said primary circuit being closed when said connected end portion and said stop are in contact, strip spring means below and contiguous said compression spring mounted in cantilever fashion with a mounting thereon for said compression spring pivot, and an armature mounted on the unsupported part of said compression spring and normally spaced in proximity to said electromagnetic core whereby it is attracted toward said core when an electric current passes through said primary circuit, said switch and core construction being so arranged that when said armature is attracted toward said core said connected end portion moves from said stop with a snap to open said primary circuit, and after the release of said armature upon the opening of said primary circuit said tension member vibrates with continuously decreasing amplitude before returning to its normal non-vibratory position.

10. The combination of a solenoid coil and a member magnetized by said coil upon passage of an electrical current through said coil and a snap switch comprising the combination of a tension member and an adjacent spring compression member each operatively mounted at one end and connected together at their opposite ends which are free to move, said compression and tension members having different radii of action and being so mounted that said connected end portion is movable, said compression member having its opposite end pivotally mounted on a third member comprising an armature so pivotally mounted that the pivoted end of said compression spring may be moved across the tension center line of said tension member upon movement of said third member on its pivot, said members being so arranged that said connected end portion moves with a snap action as said mounting point of said compression member and the tension center line of said tension member cross, a stop comprising electrical contact means for said connected end, said armature being mounted in such proximity to said magnetizable member that it is attracted thereto upon the energizing of said solenoid coil and thereby causing the pivoted end of said compression spring to cross the tension center line of said tension member to thereby move said connected end portion with a snap.

11. In combination with a snap switch comprising a tension member and an adjacent compression member each operatively mounted at one end and connected together at their opposite ends which are free to move, at least one of said members comprising spring means, said members having different radii of action and being so mounted that said connected end portion is movable, and a pair of stops between which the free end of said members is free to move, of magnetic means associated with one of said stops and said connected end and so arranged that said connected end is attracted toward said stop by magnetic force when in close proximity thereto.

12. In a device of the class described a switch comprising a stationary contact member and a stationary stop member in spaced opposed relation to each other, the position of at least one of said members being adjustable, two elongated relatively movable members extending in the same direction, a movable contact mounted upon and connecting said members, and two movable supports each movable independently of the other relative to said stationary contact member and stationary stop member, the ends of said elongated members opposite to their connected ends being operably mounted upon said movable supports, said movable contact being adapted to move between said stationary contact and said stop upon predetermined relative movement of said supports, said predetermined relative movement being dependent upon the positions of said stationary contact and said stop.

13. In a device of the class described a switch comprising a stationary contact member and a stationary stop member in spaced opposed relation to each other, the position of at least one of said members being adjustable, two elongated relatively movable members extending in the same direction, a movable contact mounted upon and connecting said members and two relatively movable heat-responsive supports, the free end portions of said elongated members being operatively mounted upon said heat-responsive supports, said movable contact being adapted to move between said stationary contact and said stop member upon predetermined temperature changes within said supports, the temperature at which said switch opens being dependent upon the position of said stationary contact and the temperature at which said switch operates being dependent upon the positions of said stationary contact and said stationary stop.

14. In combination in a snap switch construction of the class described, a first mounting member, a strip tension member operatively mounted at one end thereof on said first mounting member with the other end of said strip free to move, a pair of stops between which the free end of said tension member moves, adjacent spring strip means in longitudinal compression connected to the free end of said tension member and having its opposite end so mounted as to provide a shorter radius of action than that of said tension member, a second mounting member on which said compression spring strip is mounted, said tension member and said compression spring strip means being so arranged that said connected end portion moves with a snap when the mounted end of said compression spring and the tension center line of said tension member cross, and means including at least one of said mounting members for moving the points of support of said tension member and compression spring relative to each other to effect the crossing of said tension center line by the mounted end of said compression spring, said one mounting member comprising a flexible strip mounted in cantilever fashion and having the point of support for said tension member or compression spring at its free end.

15. In combination in a thermostatic switch, a U-shaped support member, an elongated tension strip operatively mounted in spaced relation to the interior surface of one leg of said U-shaped support member and extending toward the base of said U, the interior end of said tension strip being free to move, an adjacent strip spring bowed in longitudinal compression con-

nected to the free end of said tension strip and pivotally mounted at its other end laterally adjacent said tension strip and operatively associated by means of said pivotal mounting with the second leg of said U-shaped support member, at least one of said two legs of said U consisting of a strip of multi-layered thermostatic metal, the construction being so arranged that said connected end of said tension and compression members moves with a snap action when said thermostatic metal reaches a predetermined temperature upon variations in temperature thereof.

16. In combination in a snap switch of the class described, a pivoted toggle, a tension member and an adjacent compression member each operatively mounted at one end, the compression member being pivoted on said toggle at a point thereof removed from the pivotal support of said toggle, said tension and compression members being connected together at their unmounted ends, said connected ends being free to move, said compression member including a bowed leaf spring, said members having different radii of action, said toggle being rotatable about its pivot to change the relative positions of the mounting points of said tension and compression members, a line between the pivotal support of said toggle and the point of pivotal support of said compression member on said toggle lying in substantially the same direction as the tension center line of said tension member, said tension and compression members being so arranged that said connected end portion moves with a snap action when said mounting point of said compression member and the tension center line of said tension member cross.

17. In combination in a snap switch construction, a tension member and an adjacent bowed compression spring member each operatively mounted at one end and connected together at their opposite ends, said connected opposite ends being free to move, stops between which said connected ends move, said members having different radii of action, the relative positions of the mounting points of said tension and compression members being changeable with respect to each other, an elongated vibratory means contiguous to the bowed portion of said compression spring and having an inherent natural period of vibration, said elongated vibratory means being movable out of its normal rest position to change the relative positions of said mounting points of said tension and compression members, said elongated vibratory means being operatively so arranged and connected with said tension and compression members as to cause said mounting point of said compression member and the tension center line of said tension member to cross when said elongated vibratory means is flexed away sufficiently from said bowed spring member, said spring members being so arranged that said connected end portion moves with a snap action when said mounting point of said compression member and the tension center line of said tension member cross, said combination being so constructed and arranged that when said vibratory means is released after being fixed sufficiently to cause said connected end portion to move away from said stop with a snap, said connected end portion vibrates with a continuously decreasing amplitude before returning to its normal non-vibratory contact position.

18. In combination in a snap switch construc-

tion, a tension member and an adjacent bowed spring compression member, each operatively mounted at one end and connected together at their opposite ends, said connected end portion
 5 being free to move, a stop for said connected end portion with which said connected end portion normally engages, said tension and compression members having different radii of action, the
 10 relative positions of their mounting points being changeable with respect to each other so that the mounting point of said compression spring and the tension center line of said tension member
 15 cross to induce a snap action of said connected end portion of said tension and compression members, elongated vibratory means contiguous to the bowed portion of said compression spring
 20 and having an inherent natural period of vibration and being operatively so arranged and connected with said tension and compression members as to cause said mounting point of said
 25 compression spring and the tension center line of said tension member to cross when said elongated vibratory means is flexed away sufficiently from said bowed spring means and also to cause said
 30 connected end portion to move away from said stop when said vibratory means move an appreciable amount from its normal position toward said tension member.
 35 19. In combination in a snap switch, a tension member and an adjacent compression member, each operatively mounted at one end and connected together at their opposite ends, said connected ends being free to move, at least one of
 40 said members comprising spring means, said members having different radii of action, the relative positions of their mounting points being changeable with respect to each other to cause the mounting point of said compression spring and the tension center line of said tension member cross to move across each other, a stop for

said connected end portion, said tension and compression members being so arranged that said connected end portion moves with a snap action when said mounting point of said compression member and the tension center line of
 5 said tension member cross, and magnetic means associated with both said stop and said connected end and so arranged that said connected end is attracted toward said stop by magnetic force when in close proximity thereto.
 10

20. A thermostatic switch comprising in combination, an arm of thermostatic metal having an end portion thereof turned at an angle thereto to provide a support removed from the main
 15 portion of said thermostatic arm, a pair of switch members comprising an elongated tension strip mounted at one end and an elongated spring strip bowed in longitudinal compression having one end pivotally mounted and the other end
 20 connected to the unmounted end of said tension strip, said tension strip lying in substantially parallel relation to the main portion of said thermostatic arm and lying adjacent the pivotally mounted end of said bowed compression
 25 spring, a second support, one of said switch members being mounted on said second support and the other being mounted on the support provided by said turned up end of said thermostatic arm, the relative arrangement of said parts being
 30 such that the bending of said thermostatic arm under influence of temperature change moves said switch members longitudinally and changes the compression of said compression strip.

21. The combination of claim 14, wherein said flexible strip which constitutes a part of said one
 35 mounting member, and which supports one of said mounting members upon its free end, is more rigid than either said strip tension member, or said compression spring strip means.

MALCOLM WEBSTER EATON. 40