Oct. 25, 1949. J. YOUHOUSE 2,486,365

THERMOSTATIC SWITCH

Filed Dec. 23, 1943

Fig. 1

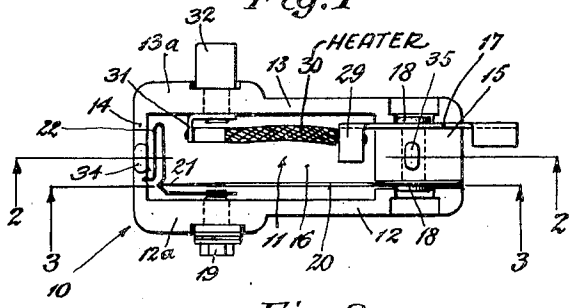


Fig. 2

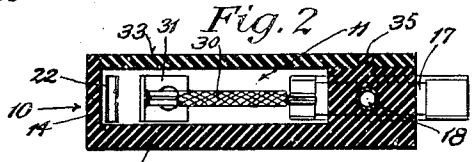


Fig. 4

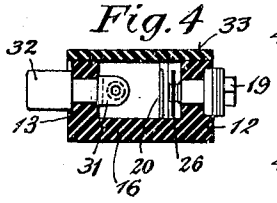


Fig. 3

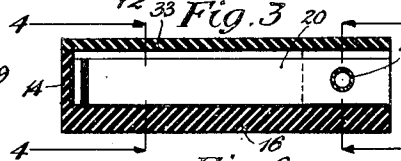


Fig. 5

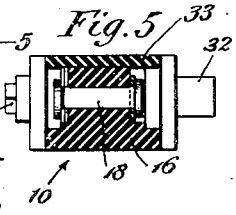


Fig. 6

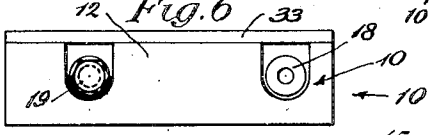


Fig. 7

Fig. 8

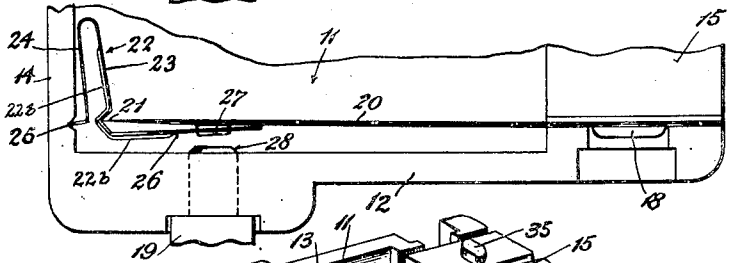
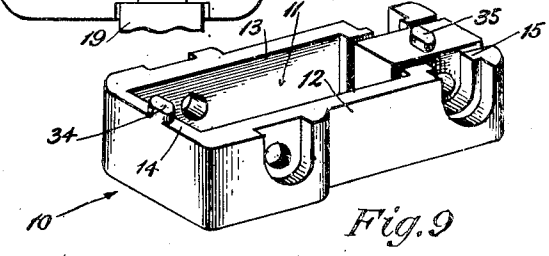


Fig. 9



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Patented Oct. 25, 1949 2,486,365

UNITED STATES PATENT OFFICE

2,486,365

THERMOSTATIC SWITCH

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Application December 23, 1943, Serial No. 515,413

11 Claims. (Cl. 200—122)

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This invention relates to switches, and more particularly to heat-responsive switches such as are used in electric heating pads and the like.

An object of the invention is to provide in a heating pad and the like an improved, simple heat-responsive switch which has small dimensions and which operates to open and close a circuit with an abrupt quick action.

In accomplishing this object, the invention provides a thermostatic switch having a novel contact and actuator assembly of quick-acting characteristics which has very few moving parts, and which requires no additional space than the usual thermostat in a heating pad, yet the arrangement is such that a positive and reliable quick action of the switch contacts is obtained in response to temperature changes, for controlling the circuit.

In the embodiment shown herein, the abrupt make and break of the circuit in response to temperature changes is accomplished by the addition of but a single movable part, together with several slight alterations to the existing structures of the switch.

The contact-actuating mechanism is arranged to act like a toggle, the pivotal connection for actuating the switch contact being formed at the junction of two movable members having their other ends fixed and located so that movement of the junction in response to heat applied to the switch causes the said junction to approach a dead center position in line with the fixed ends of the members. One of the members of the mechanism comprises a bimetallic arm which acts as a driver and moves in response to heat in a direction to separate the contacts, and the other or driven member resiliently opposes said movement. As the movement begins, this opposition or restraint decreases, causing a resultant acceleration of said movement which causes an abrupt separation of the contacts. In a like manner the closing action of the switch is quick-acting by a reversal of the above movements.

Another object of the present invention is to provide in a heating pad and the like a simple quick-acting thermostatic switch wherein the opening and closing of the circuit takes place within a very narrow range of temperature, so that the control of the temperature of the pad is very close.

A feature of the invention is the provision of an adjustment which enables the switch to be initially set within a certain range for any desired predetermined cut off point regardless of

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slight variations which may occur in the members of the actuating mechanism during the manufacture thereof.

Another feature of the invention is the provision of an improved switch construction in which the parts may be made with a minimum of cost and assembled with ease.

Other features and advantages of the invention will hereinafter appear.

In the accompanying drawings, showing one form of the invention—

Figure 1 is a plan view of the thermostatic switch of the invention with the cover removed.

Fig. 2 is a longitudinal section taken on the line 2—2 of Fig. 1.

Fig. 3 is a longitudinal section taken on the line 3—3 of Fig. 1.

Fig. 4 is a transverse section through the switch taken on the line 4—4 of Fig. 3.

Fig. 5 is a transverse section taken through the switch on the line 5—5 of Fig. 3.

Fig. 6 is a side elevation of the switch with the cover in place.

Fig. 7 is an enlarged fragmentary plan view showing the actuating mechanism of the switch in closed-circuit position.

Fig. 8 is an enlarged fragmentary plan view showing the actuating mechanism in open-circuit position.

Fig. 9 is a perspective of the molded housing of the switch.

Referring to Fig. 1 the improved switch of the present invention in its embodiment at present preferred comprises a molded housing 10 having the usual external shape for adapting it for use in electric heating pads and the like, said housing having a rectangular recess 11 in which the operating parts of the switch are disposed. The housing 10 has side walls 12 and 13, end walls 14 and 15, and a bottom 16 which may be integral. The end wall 15 is slotted to receive an electrical terminal strip 17 which is fastened in the slot by means of a metallic eyelet 18 passing through a suitable hole in the end wall as shown, and for the purpose of preventing accidental contact between parts of the heating pad circuit and the head of the eyelet 18, the latter is preferably countersunk in the housing so as to not extend outside the surface thereof. A terminal screw 19 is provided in the side wall 12 of the housing to furnish a second electrical connection to the switch, said side wall being thicker at 12a and the terminal being preferably screwed into a tapped hole in the wall.

According to the present invention, there is

provided an improved switching and contact means for controlling an external circuit connected to the terminals 17 and 19, this switching means being responsive to heat, and functioning in such a manner that the circuit is closed or opened abruptly so as to minimize sparking and also to minimize the collection and effect of dirt on the switch contacts. The actuation of this improved switching mechanism is accomplished by the provision of a bimetallic driving arm 20, located within the housing 10 to extend along the side wall 12 thereof, and anchored at one end by the eyelet 18. The bimetallic arm 20 is free at its other end 21 to move in a lateral direction in response to heating or cooling of the arm, the free end extending close to the end wall 14 of the housing.

For the purpose of controlling the movement of the free end 21 of the bimetallic arm 20 so as to cause the movements thereof to be quick and abrupt, the present invention provides a novel controlling or restraining driven member which, in the embodiment shown, is in the form of a U-shaped metallic spring 22, made preferably of phosphur bronze, having one end adapted to engage the tip 21 of the bimetallic arm, and having the other end adapted to pivot on a fixed member such as the end wall 14 of the housing. The U-shaped spring 22 has legs 23 and 24 which are preferably of unequal length, the leg 24 being the shorter, and said spring is located to extend across the end wall 14 of the housing in a direction substantially at right angles to the bimetallic arm 20.

The longer leg 23 of the spring is formed with two bends so as to provide a socket 23*a* for receiving the free end of the bimetallic arm 20 so as to move therewith and pivot thereon, and the short leg 24 of the spring is bent outwardly substantially at right angles thereto to provide a pivot point 24*a* which is carried in a groove 25 in the inner surface of the wall 14 of the housing, said groove functioning as a socket about which the spring 22 pivots.

The groove 25 in the end wall of the housing is located slightly out of line with the socket 23*a* and the ends of the bimetallic arm 20, and is in a position so that, as the latter responds to heat, its free end will move in a direction which tends to line up the arm with the groove. In the drawings, this position is shown as being located just off the free tip of the arm 20, towards the center of the end wall. When the arm 20 becomes warm, the tip thereof will move toward the center of the housing 10.

It should be noted that the spring 22 normally tends to move outwardly so that, when it is in position in the switch, the ends are under pressure, one pressing against the free end 21 of the bimetallic arm and the other pressing into the groove 25 of the housing.

The functioning of this arrangement is similar to a toggle mechanism in many respects, since there are two movable members, the bimetallic driver 20 and the U-shaped driven member or spring 22, having a common pivotal junction, said members at their other ends being restricted in movement. The pivotal junction of the members is normally to one side of a dead center position, and in response to heating of the arm 20 said junction will move toward the dead center position, but not past same appreciably.

For the purpose of controlling a circuit, the long leg 23 of the U-shaped spring is provided with a contact arm or extension 26 thereof which carries an electrical contact 27 adapted to engage a contact 28 connected with the terminal 19 when the bimetallic arm 20 is in its cooler position thereby functioning as a stop for the movable mechanism of the switch. The tensions of the spring 22 and the arm 20 are adjusted so that a relatively strong pressure exists between the contacts 27 and 28 when the bimetallic driver 20 is cold. As the driver becomes hot, see Fig. 8, its tip 21 will move inwardly causing the spring 22 to pivot about the groove 25, and moving the contact arm 26 so as to separate the contacts 27 and 28. In so moving, the contact arm 26 strikes against the bimetallic arm 20, which acts as a second stop for the movable mechanism.

A double advantage is gained by locating the contact arm 26 alongside the bimetallic driver 20, inasmuch as by so doing the housing 10 is kept small and compact in dimension, and also a leverage effect is obtained whereby the contact 27 has a greater travel than the socket 23*a* of the spring.

The spring 22 constantly exerts substantial pressure on the end 21 of the bimetallic driver, forming a low-resistance electrical connection thereto. Therefore, when the contact 27 engages the contact 28, an electrical circuit is established from the terminal strip 17, eyelet 18, the bimetallic arm 20 and the spring 22 and extension 26 thereof, then through the contacts 27 and 28 to the terminal 19.

Normally when the bimetallic arm 20 is in its cool position, as in Fig. 7, it is under stress caused by the pressure of the spring 22, said pressure being in a direction diagonal to the bimetallic arm. This diagonal pressure can be resolved into a component parallel with the arm, which does not oppose inward lateral movement thereof, and a component directed laterally of the arm which does oppose inward lateral movement thereof. If desired, the arm 20 may also be made to exert a slight pressure laterally thereof on the spring 22 in a direction toward the wall 12 of the housing, so that both these lateral pressures tend to hold the contacts 27 and 28 tightly together. As heat is applied to the bimetallic arm 20 it will reverse its own lateral pressure and tend to flex so as to urge the free end 21 thereof inwardly in the housing 10. However, during the initial heating of the bimetallic arm the end 21 thereof does not move because of the lateral component of the opposing force exerted by the spring 22. As the heating of the arm 20 continues, the stress therein becomes sufficiently great to overcome the opposing force exerted by the spring. When this point is reached the end 21 of the arm begins to move inwardly in the housing 10. This causes the spring 22 to pivot about the groove 25, changing its position, whereupon immediately the direction of the pressure exerted by said spring on the end 21 of the bimetallic arm is changed. As a result the component of said pressure which is parallel to the arm 20 immediately becomes greater, and the component of the pressure which is directed laterally of the arm and which opposes inward lateral movement thereof, immediately becomes smaller. Therefore, there results a sudden and quick movement of the end 21 of the bimetallic arm, and of the spring 22 and contact arm 26, especially since the driving force of the bimetallic arm does not lessen but continuously becomes stronger. This results in a snap-separation of

the contacts 27 and 28, quickly opening the circuit connected to the switch.

This quick opening of the circuit is particularly desirable in connection with appliances such as heating pads and the like, where the proper continued functioning of the pad is dependent on the proper operation at all times of the switches therein, especially since the latter are not readily accessible for adjustment, cleaning, etc. As a result of the quick and abrupt separation of the contacts 27 and 28, sparking and arcing are reduced materially, thereby resulting in longer useful life for the contacts, and longer continuous operation without requiring repair. Furthermore, inasmuch as the circuit-closing movement of the switch is also quick and abrupt, as will be hereinafter described, a more positive electrical connection is provided at all times, since small particles of dirt, etc., which might tend to accumulate on the contacts are dislodged by the impact when the latter strike each other. Since the arcing at the contacts is reduced, and since the movable contact is not in close heat-conducting relation with the bimetallic arm 20, the response of the latter will not be affected by heat from the contacts, but only by heat from the pad, and therefore a more accurate control of the pad heat is accomplished.

When the electrical circuit of a device, such as a heating pad, is thus opened and the heat which caused the thermostatic switch to operate begins to dissipate, the switch and more particularly the bimetallic arm 20 cools off and the flexing force thereof decreases without appreciable movement of the arm 20. However, at the instant that the pressure exerted by the tip 21 of the arm against the spring 22 becomes less than the lateral component of the resisting force of said spring, and movement of the arm and spring begins, the spring 22 will pivot about the groove 25 thereby causing a change of the direction of the force exerted by the spring on the tip 21 of the bimetallic arm and resulting in a quick or snap return movement of the spring 22 and arm 20 to normal circuit-closing position, since the lateral component of the pressure exerted by the spring 22 increases very quickly, while the resistance to said component, as offered by the bimetallic arm, is decreasing.

I have found that the speed of the make and break in the switch of the present invention can be adjusted by controlling the initial tension of the spring 22 and the bimetallic arm 20. If the pressure exerted by the spring 22 on the arm 20 is made greater or less, the speed of movement of the switch mechanism will be respectively increased or decreased, to provide a very quick or a comparatively slow snap-action. It should be noted that, when the switch is in closed-circuit position and the arm 20 is cold, the latter need not exert any lateral pressure of its own on the spring 22, since adjustment of the contact 28 can be made to cause the bimetallic arm to assume the same position, as held by the spring 22, that it would assume if said spring were removed and the arm were free.

In the improved switch of the present invention, the opening and closing of the circuit takes place within a very narrow range of temperature. This is because the movable junction of the spring 22 and the bimetallic arm 20 does not go substantially beyond a dead center position. During the period that the switch is being warmed, the spring 22 continues to exert on the tip 21 of the arm a pressure having a component which is directed laterally of said arm, and opposing the driving or contact-opening movement of the latter. This component is overcome when the switch snaps to open the circuit, but because the movable junction does not go substantially past dead center, the component is not replaced by a component in a reverse direction. Instead, the lateral component merely reaches a value close to zero. After the circuit has been opened and the arm begins to cool, the tendency for the latter to resume its initial position is therefore not interfered with. If the junction of the spring 22 and the arm 20 did substantially pass the dead center position, a reversal of said lateral component of the pressure exerted by the spring on the arm would occur. In this circumstance, the bimetallic arm, upon cooling, would have to overcome an opposing force before it could move to contact-closing position, and as a result a time lag would be introduced which would spread the temperature range over which the switch would function. According to this invention, any tendency for the bimetallic arm to lag in its return to normal closed-circuit position is overcome by the action of the spring 22 which, as the return movement begins, again applies lateral pressure on the arm and aids in its return.

For the purpose of strengthening the leg 23, socket 23*a* and arm 26 of the spring 22, a plurality of ribs 22*b* are embossed in the material of these parts, as shown in Figs. 7 and 8.

As shown in the accompanying drawings, the proportions of the parts is such that the lever arm of the bimetallic strip 20 is approximately nine times the distance between the pivot point 24*a* and the socket of the spring 22, and so that the working length of the contact arm 26 is approximately twice this distance. The spring 22 and arm 26 function as a lever, whereby the end of the arm carrying the contact 27 moves a greater extent than the socket of the spring. But, it should be understood that any other suitable or desirable proportions of these parts may be employed, within the scope of this invention.

Where thermostatically controlled switches are embodied in appliances such as heating pads, it is often desirable to include a supplemental heating unit within the switch housing so that heat therefrom is transferred directly to the heat-responsive actuator of the switch. The improved switch of the present invention is adapted for this purpose by providing space within the housing for such a unit and providing on the inner end of the terminal strip 17 a connection clip 29 which is adapted to connect to and support one end of a heating coil 30 carried in the housing 10. The other end of the coil 30 is connected through a metal clip 31 to a terminal post 32 passing through the wall 13 of the housing 10, said wall having a thick portion 13*a* at the terminal for purposes of reinforcement. The bimetallic arm 20 is thus in close heat-receiving relation with the heating coil 30, and functions to control a circuit in which said coil is included.

For the purpose of closing the housing 10 a cover plate 33 is provided, having apertures through which lugs 34 and 35, carried by the end walls 14 and 15 respectively, extend, the lugs fitting closely in the apertures so that the cover is frictionally held in place.

Variations and modifications may be made within the scope of this invention and portions of the improvements may be used without others.

I claim:

1. In a quick-acting switch, an elongate member anchored at only one end and adapted to respond along its length to heat to cause the other

end of the member to move in a lateral direction; a metal U-shaped expansion spring having a narrow bow locating the legs closely adjacent one another, the end of one leg being pivoted and located out of the line of movement of the end of the elongate member, the end of the other leg of the spring being movable and pivotally engaging under continuous pressure the movable end of the elongate member to move therewith, the distance between the ends of the spring being less than the length of the elongate member, and at least one end of said spring pressing against an electrical conductor to receive current therefrom; an arm mounted on the movable end of the spring as an extension thereof, said arm having a free end carrying an electrical contact electrically connected with the spring, said arm being radially longer than the radial distance between the ends of the spring proper to impart a greater travel to the contact than the travel of the movable end of said spring; and a stationary contact engaging the contact carried by the arm to control a circuit thereby.

2. In a quick-acting switch, a heat-responsive means including a driver; a current-conducting U-shaped spring having one end pivoted and located out of the line of movement of said driver, the other end of the spring pivotally engaging the driver under continuous pressure and moving therewith, at least one end of said spring pressing against an electrical conductor to receive current therefrom; an integral extension on the movable end of the spring and having a free end carrying a contact, the lever arm of the extension being longer than that of the spring proper to impart a greater travel to the contact; and a stationary contact engaging the contact carried by the arm to control a circuit thereby.

3. In a quick-acting switch, an elongate heat-responsive driver anchored at only one end and adapted to respond to heat to cause the other end thereof to drive in a lateral direction; a U-shaped driven member having a narrow bow and substantially parallel legs, one end of the member pivotally engaging the driving end of the driver, the other end being restricted in movement and being located out of line with the ends of the driver and in a position where driving movement of the latter in response to heat tends to bring into alignment all ends of both members, said driven member yielding in response to pressure on its driver engaging end and pressing continuously on the driving end of the driver in a direction which, as heat is applied to the latter and the end thereof moves, approaches a line normal to the path of travel of said driving end; a resilient extension connected to the end of the movable leg of the member to project therefrom at substantially a right angle thereto; a movable contact carried by the resilient extension and actuated by the driver; and a stationary contact positioned to be engaged by the movable contact to control a circuit, said movable contact being disposed between the driver and the stationary contact and being located closely adjacent the driver to engage the same and be limited thereby in open-circuit position.

4. The invention as defined in claim 3, in which the length of the lever arm of the driver is greater than that of the driven member whereby the angular movement of the latter is greater than that of the driver, and in which the resilient extension, carrying said movable contact on its end, is longer than the lever arm of the driven member whereby the travel of the contact is greater than that of the pivotal end of the driven member.

5. As a new article of manufacture, a quick-acting switch having an elongate metallic driver anchored at only one end and having an electrical terminal connected to said end, said driver being adapted near its anchored end to respond to heat to cause the other end thereof to move in a lateral direction; a U-shaped metallic driven member having the end of one arm electrically contacting and pivotally engaging the driver, the other arm having its end being restricted in movement and located out of line with the ends of the elongate member and in a position where driving movement of the latter in response to heat tends to line up all ends of both members, the distance between the ends of the driven member being less than the length of the driver, said driven member yielding in response to pressure on its pivotal end, said end pressing continuously on the driving end of the driver in a direction which, as heat is applied to the latter and the end thereof moves, changes and approaches a line normal to the path of movement of said driving end; a resilient arm mounted on the free end of the driver engaging arm of the driven member to function as an extension thereof, said resilient arm having a free end carrying an electrical contact electrically connected to the driven member, said arm being longer than the distance between the ends of the driven member to impart a travel to the contact at least twice the travel of said pivotal end; a stationary contact engaging the movable contact to control a circuit thereby; and an electrical terminal connected with said stationary contact.

6. As a new article of manufacture, a heat-responsive quick-acting switch having a housing with a recess therein; a pair of terminals located in the walls of the housing; an elongate heating coil carried in the recess, the ends of the coil being fastened respectively to said terminals; an elongate bimetallic member extending lengthwise in the recess alongside the heating coil, one end of said member being fastened to one of the terminals of the heating coil, and the other end being movable, said member being adapted to receive heat along its length from the coil; a U-shaped metallic spring located in the recess to extend substantially at right angles to the movable end of the bimetallic member, said spring having legs of unequal length, the longer leg thereof having a socket engaging the movable end of the bimetallic member, and the shorter leg having a pivot point projecting outward laterally thereof, said housing having in its wall adjacent the spring a socket receiving the pivot point of the spring, and the latter being biased to cause the legs thereof to continuously press outward, one against said wall socket and the other against the movable end of the bimetallic member; an arm connected to the long leg of the spring to move therewith, said arm extending alongside the bimetallic member and the latter acting as a stop to limit movement of the arm; a contact carried near the end of the arm; and a stationary contact and terminal therefor mounted in the wall of the housing, the contact engaging the contact carried by the arm for controlling a circuit thereby.

7. The invention as defined in claim 6, in which the movable end of the bimetallic member is provided with a knife edge where it engages the spring.

8. The invention as defined in claim 3, in which

the length of the lever arm of the driver is greater than that of the driven member whereby the angular movement of the latter is greater than that of the driver, and in which the resilient extension, carrying said movable contact on its end, is longer than the lever arm of the driven member whereby the travel of the contact is greater than that of the pivotal end of the driven member, said extension overlapping the driver so that the overall length of the switch is not increased by the extension.

9. In an electric switch structure, a housing having a wall; a rib within the housing disposed adjacent the wall and having a flat surface; a flat thermostatic switch-operating arm adapted to be supported by the flat surface; a terminal projecting from the wall and extending into the housing alongside the rib; and means passing through the rib for clamping the thermostatic arm and terminal to opposite sides of the rib in current-conducting relation.

10. In an electric switch structure, a housing including an end wall having parallel slots therein; a terminal mounted in one slot to project beyond the end wall; a thermostatic switch operator mounted in the other slot; and means passing through the housing and securing the terminal and operator in the slots, said means electrically connecting the terminal to the switch operator and terminating within the exterior surfaces of the housing.

11. As a new article of manufacture, a heat-responsive quick-acting switch having a housing with a recess therein; an elongate bimetallic member extending lengthwise in the recess, one end of said member being fastened to the housing and the other end being movable; a U-shaped metallic spring located in the recess to extend substantially at right angles to the movable end of the bimetallic member, said spring having

legs of unequal length, the longer leg thereof having a socket engaging the movable end of the bimetallic member, and the shorter leg having a pivotal connection with the housing, the spring being biased to cause the legs thereof to continuously press outward, one against the pivotal connection with the housing and the other against the movable end of the bimetallic member; an arm connected to the long leg of the spring to move therewith, said arm extending alongside the bimetallic member and the latter acting as a stop to limit movement of the arm; a contact carried near the end of the arm; and a stationary contact and terminal therefor mounted in the wall of the housing, said contact engaging the contact carried by the arm for controlling a circuit thereby.

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