Sept. 13, 1960 J. ELLENBERGER 2,952,758

THERMAL CIRCUIT BREAKER

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FIG. 1

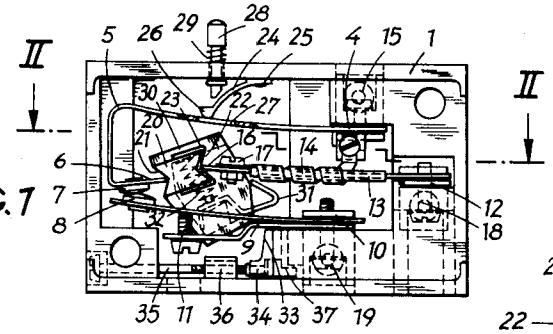


FIG. 3

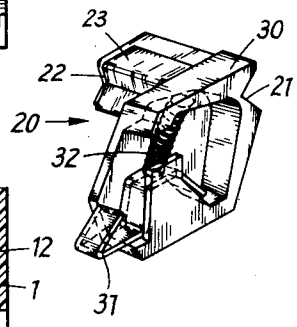


FIG. 2

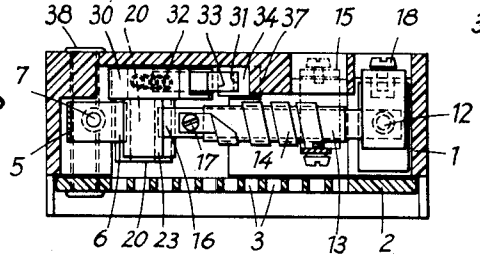


FIG. 4

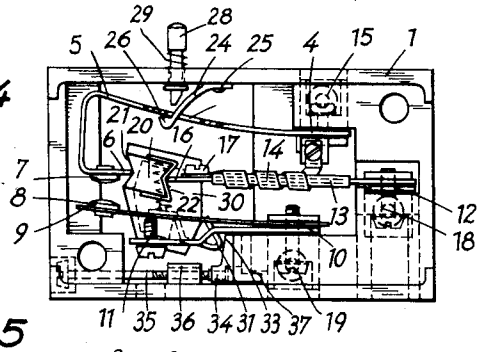


FIG. 5

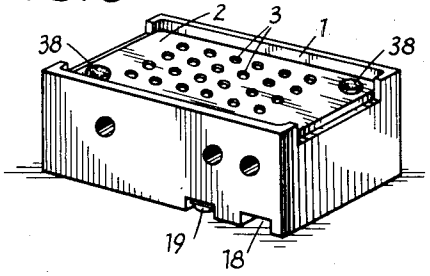
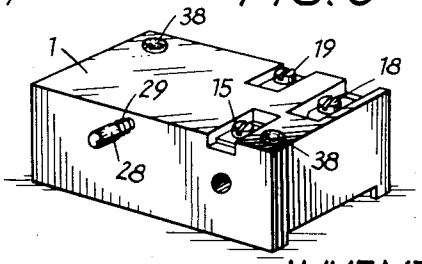


FIG. 6



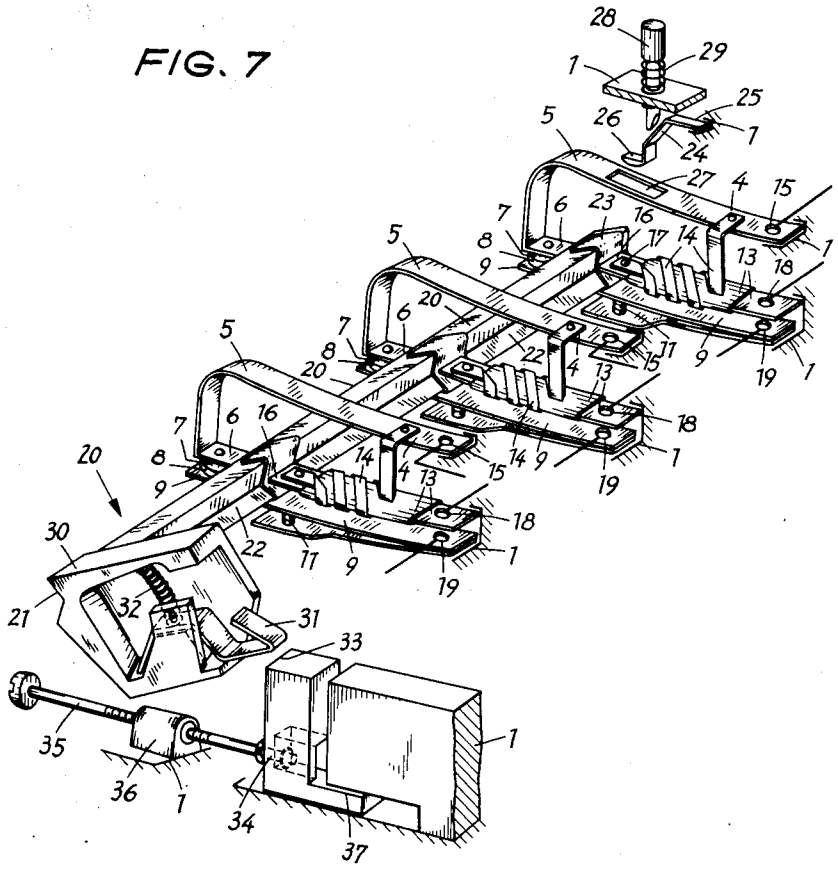
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FIG. 7



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THERMAL CIRCUIT BREAKER

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11 Claims. (Cl. 200—122)

The present invention relates to a novel design of a thermal circuit breaker of the type comprising a contact spring with a contact on its free end and a bimetallic spring which is adapted to pivot the contact spring into the connecting or disconnecting position by means of a rocking member which is provided with a pair of opposite V-shaped recesses. In such circuit breakers which are designed as quick-action or snap switches, the contacts are opened and closed rapidly in order to prevent them from sparking. In some of the known switches of this type, the contact spring had three tongues. The central tongue of this spring consisted of two parts, the inner ends of which engaged in V-shaped recesses in a rocking member, while each of the two outer tongues was bent to have an S-shape whereby a snap action was produced. On its free end, the three-tongued spring had a contact which, in the connecting position, was in engagement with the contact of a bimetallic spring. At the occurrence of an excess current, the bimetallic spring was heated and bent by the action of a heating coil so that the contact of the three-tongued spring was disengaged. At such an opening movement of the spring, the longer part of the central tongue was taken along so that it formed an acute angle relative to the shorter part of the central tongue. Due to the special design of the outer tongues, the longer part of the central tongue exerted a pressure upon the rocking member so that the latter would pivot about the inner edge of the shorter part of the central tongue whereby the snap action of the three-tongued spring would be released and the contacts be separated. This known switch had the disadvantage that the three-tongued spring had a very complicated structure which rendered the production of the switch rather difficult and made the switch rather expensive.

There has also been a prior disclosure of an overload switch which had a bimetallic spring and a contact spring. The bimetallic spring had a recess into which the contact spring was adapted to engage. Between the free movable end of the contact spring and the end of the recess in the bimetallic spring a coil spring was interposed, one end of which engaged with the bimetallic spring while the other end engaged with the contact spring. As soon as the bimetallic spring was heated and thereby bent, the coil spring would, after exceeding the dead-center position, suddenly become effective and bend the contact spring abruptly so that the contact thereon was disengaged from the opposite contact and the entire circuit was interrupted. In order to attain a proper snap action, the coil spring had to be made quite strong with the result that relatively great forces were exerted upon the contact spring which caused a correspondingly severe bending of this spring. A switch of this type consequently had the disadvantage that fatigue failures of the contact spring due to the strong alternating stresses thereon were liable to occur, resulting in a breakdown of the switch.

It is an object of the present invention to provide a

thermal circuit breaker of the above-mentioned type operating in the nature of a snap-action switch, which may be very easily manufactured and assembled, and in which the movable parts, that is, the contact spring and the bimetallic spring carry out only relatively small movements so that they will not suffer from fatigue failures and the life of the switch will be lengthened, and in which the contacts will be separated suddenly and properly and may be closed with a delay of such movement. A suitable delay of the closing movement is according to the invention to be attained especially if the contacts have automatically opened due to an excess current or heating from the outside and should again close automatically after a certain length of time. A further object of the invention is to provide a thermal circuit breaker of a design which may also be applied to a three-phase alternating current and which is designed to separate all three phases if an excess current occurs in any one of these phases.

For attaining these objects, the invention provides that the rocking member with the V-shaped recesses therein is mounted on the opposite ends of the contact spring and the bimetallic spring and that the contact spring engages in the respective V-shaped recess in the rocking member under an initial tension. Since the rocking member lies between the ends of the two mentioned springs, the end of the bimetallic spring forms the pivot point of the rocking member. When the bimetallic spring is heated and thus bends in one direction and when it cools off and thus bends in the other direction, the pivot point of the rocking member will automatically be shifted, whereby a tipping of the rocking member into one or the other position will occur suddenly when the movement of the bimetallic spring has shifted the pivot point of the rocking member at the point of engagement of the end of the bimetallic spring with the apex of the V-shaped recess in the rocking member to a point slightly beyond a straight-line connection between the ends of the two springs and the central line connecting the apexes of the two V-shaped recesses in the rocking member.

Since the rocking member can pivot freely and since there is no fixed pivot point, a certain delay in the pivoting movement may be provided by preventing the movement of the rocking member to its tipping point from automatically resulting in an immediate tipping thereof to the other end position. This may be attained since it is possible to maintain a straight-line connection between the two springs during a certain pivoting range. The actual tipping of the rocking member, however, will result in a pivoting of the contact spring in one or the other direction, that is, from the closed position to the open position of the contacts or vice versa. It is then immaterial whether the bimetallic spring will be bent by being heated indirectly by its heating coil which is energized by an excess current or whether the circuit breaker is acted upon directly by a heat source, for example, the windings of a motor.

The rocking member according to the invention is preferably made of a suitable insulating material in order to insulate the contact spring from the bimetallic spring. However, at least the V-shaped recess into which the bimetallic spring engages is preferably provided with a metallic lining in order to prevent undue wear on the rocking member itself. This metallic lining is also of importance insofar as it will protect the insulating material of the rocking member from the effects of the heat transmitted by the bimetallic spring.

In order to delay the tipping movement and to predetermine the size of the tipping or rocking force which the bimetallic spring has to produce in order to operate the circuit breaker, the rocking member may, according

to another feature of the invention, be connected to or provided with a brake element which is adapted to engage with a cooperating brake surface at least during the pivoting movement of the rocking member in one direction. The brake element may for this purpose be provided with a brake arm which is pivotable against the action of a spring only in one direction of the rocking movement of the rocking member. Consequently, the brake arm will yield resiliently only during the movement in one direction, for example, during the disconnecting movement, but not during the movement for closing the contacts in which an additional friction is thus produced. This friction requires that the bimetallic spring has to cool off considerably and produce a greater force in the direction toward the cold side until the tipping point is reached. The friction factor is then determined by the length of the friction surface, which will thus also determine the length of time of the return movement of the switch. Thus, if the length of the friction surface is increased, it will take a correspondingly greater length of time until the movement of the bimetallic spring will bring the rocking member to the tipping point.

The mentioned brake surface which is to be engaged by the brake arm on the rocking member is provided within the housing of the circuit breaker and preferably on a part of the housing, although it may, of course, also be provided on the cover of the housing. For increasing or reducing the length of the brake surface, the invention further provides the same or the part of the housing carrying the same to be adjustable relative to the brake arm on the rocking member.

In some instances it is desirable in a circuit breaker of this type that the contacts thereof will be retained in the open position even though the bimetallic spring has cooled off and would normally cause the contacts again to be closed. For this purpose, when the contact on the contact spring is in the open position, an arresting device which is provided with a release key is adapted to engage with the contact spring to retain it in the open position. When the release key is then depressed, the contact spring will again be released from the arresting device and move automatically to the closing position because of the pivotal movement of the rocking member.

The circuit breaker according to the invention may also be used as a three-pole relay for three-phase induction motors and similar apparatus by mounting three of these circuit breakers in a row behind each other within a common housing and by connecting them by means of a common rocking member. Such a circuit breaker requires only a single locking device which is adapted to engage with one of the three contact springs to arrest all of these springs in the open position, and which is releasable by a single release key. If the circuit breaker is intended to operate only thermally, it is advisable to mount the same in a manner so as to permit the heat, for example, of a motor winding, to act directly upon the bimetallic strip of the circuit breaker. For this purpose, the housing of the circuit breaker is preferably provided at one side with a perforated cover plate through which the outside heat may enter into the housing.

Further objects, features, and advantages of the present invention will become apparent from the detailed description thereof, particularly when read with reference to the accompanying drawings, in which—

Figure 1 shows a side view of the thermal quick-acting circuit breaker according to the invention with its contacts being in the closed position;

Figure 2 shows a cross section taken along line II—II of Figure 1;

Figure 3 shows a perspective view of the rocker member according to the invention with the brake element thereon;

Figure 4 shows a view of the circuit breaker according to Figure 1, with its contacts in the open position;

Figure 5 shows a perspective view of the lower side of the housing of the circuit breaker;

Figure 6 shows a perspective view of the upper side of the housing; while

Figure 7 shows a diagrammatic perspective view of a circuit breaker mechanism according to the invention used as a three-pole relay.

Referring to the drawings, and first particularly to Figures 1 to 6, the circuit breaker according to the invention is mounted within a housing **1** which is provided with a cover plate **2** with a plurality of apertures **3** therein for conducting the heat developed within the housing to the outside without, however, permitting any heat to pass from the outside into the housing, which is of importance if the circuit breaker is supposed to work purely thermally. A contact spring **5**, the free end **6** of which carries a contact **7**, is mounted in housing **1** at **4**. Contact **7** cooperates with a contact **8** on a second contact spring **9** which is mounted in the housing at **10** and adapted to be adjusted to have a certain initial tension by means of a screw **11**. Housing **1** further contains a bimetallic spring **13** which is mounted at **12** and surrounded by a heating coil **14**. This heating coil **14**, as well as the contact spring **5**, is conductively connected at **4** to a terminal screw **15** to which a separate circuit may be connected. The free end **16** of the bimetallic spring **13** carries a screw **17** through which the heating coil **14** is conductively connected to the bimetallic spring which, in turn, is connected at its mounting point **12** to a terminal screw **18**. As shown particularly in Figure 6, a third terminal screw **19** is mounted on housing **1** adjacent to screw **18**. This terminal screw **19** is connected to the second contact spring **9** and secures the same at **10** to the housing **1**.

A rocking member **20** which preferably consists of a plastic material and has a substantially double-trapezoidal cross section, as shown particularly in Figure 3, is interposed between the free ends **6** and **16** of contact spring **5** and bimetallic spring **13** and provided with **V**-shaped recesses **21** and **22** in its opposite end surfaces which are associated with springs **5** and **13**. Recess **22** is reinforced by a lining of sheet metal **23** in order to protect the rocking member **20** of plastic from being unduly worn when it is heated by the bimetallic spring **13**.

Housing **1** further carries at **25** an arresting spring **24** which is disposed above the contact spring **5** and the hooked end portion **26** of which is adapted to pass through an aperture **27** in spring **5** and to engage with the lower side of this spring when the latter is bent to the position as shown in Figure 4. For releasing the contact spring **5** and disengaging it from the hooked end portion **26** of the arresting spring **24**, a release key **28** is slidably mounted in housing **1** and adapted to be depressed against the action of a spring **29**. As shown particularly in Figure 3, the rocking member **20** forms at one side a brake part **30** comprising a brake arm **31** which is adapted to be pivoted upwardly against the action of a spring **32** and to engage with a brake surface **33** on housing **1**, as illustrated in Figures 1 and 4. The length of this brake surface **33** may be enlarged or reduced by providing it on a slide member **34** which may be adjusted toward the right or left, as viewed in Figure 1, by means of a screw spindle **35** which is mounted in housing **1** at **36**. In order to prevent the slide member **34** from turning with spindle **35**, it is provided with an angular projection which engages into a corresponding recess **37** in housing **1**, as shown particularly in Figures 4 and 7. The cover plate **2** is preferably secured to housing **1** by hollow rivets **38** through which suitable screws may be inserted to mount the switch on a wall surface or on the apparatus which it is designed to protect or control.

The operation of the switch according to Figures 1 to 6 is as follows:

Normally, contacts **7** and **8** are in the closed position,

as shown in Figure 1, in which the ends **6** and **16** of contact spring **5** and bimetallic spring **13** facing toward each other are offset relative to each other and the rocking member **20** is disposed in an oblique position with respect to the direction of springs **5** and **13**. If an excess current then occurs and heats the heating coil **14** which, in turn, heats up the bimetallic spring **13**, or if the bimetallic spring is heated directly by the current flowing therethrough, or if the bimetallic spring is heated by the temperature coming in from the outside, it will be bent downwardly. This, in turn, causes the pivot point of rocking member **20** at the free end **16** of bimetallic spring **13** within recess **22** to shift slowly until the ends **6** and **16** of the springs assume a straight-line direction with the center line connecting the apexes of the V-shaped recesses of rocking member **20**. When the bimetallic spring **15** then bends further downwardly, the rocking member **20** will suddenly swing in a clockwise direction to the position as shown in Figure 4 and thereby abruptly separate contacts **7** and **8**. If an arresting device such as the arresting spring **24** is provided, its free end **26** will during this upward movement of contact spring **5** pass through the aperture **27** in spring **5** and then engage with and arrest this spring in its bent position according to Figure 4.

During the sudden rocking movement of rocking member **20** as above described, the brake arm **31** has also passed over the brake surface **33**. Since spring **32** then allowed brake arm **31** to yield resiliently, the rocking movement of member **20** could proceed practically without friction. If there is no arresting device **24** provided, bimetallic spring **13** will cool off after contacts **7** and **8** are separated according to Figure 4 and slowly swing back to its upper starting position. During this upward movement of the bimetallic spring **13**, rocking member **20** will also be shifted upwardly since it is freely suspended between the ends of springs **6** and **16**. Such dislocation of rocking member **20** will result in a delay of the tipping movement thereof. A further delay results from the fact that the brake member **31** will during this movement slide nonresiliently along the brake surface **33**. The length of such delay also depends upon the adjustment of this brake surface by screw **35**. Only after the brake member **31** has slipped off the brake surface **33** and when rocking member **20** has reached the tipping point, that is, when the ends of springs **6** and **16** are in a straight line with the center line of rocking member **20**, the latter will be able to swing back to the position as shown in Figure 1, in which contacts **7** and **8** will automatically engage.

Although if the arresting spring **24** is provided, the bimetallic spring **13** will likewise cool off after contacts **7** and **8** are separated, such cooling will have no effect since contact spring **5** will be held arrested in the bent position by spring **24**. If the release key **28** is then depressed to disengage the arresting spring **24** from contact spring **5**, the latter will swing back to the contact-closing position, and such movement will proceed rapidly because of the cooperation of the spring tension of contact spring **5** with the spring tension of bimetallic spring **13** through rocking member **20**.

Figure 7 illustrates a modification of the circuit breaker according to the invention which is designed to form a three-pole relay, for example, for a three-phase induction motor. It will be seen that all of the elements contained in the circuit breaker according to Figures 1 to 6 are provided three times, except the housing **1** (not shown) with its cover **2** and the rocking member **20** with the brake part **30** and brake surface **33**, and the arresting spring **24** with its release key **28**. The individual contact springs **5** and **9** and the parts connected thereto, as well as the bimetallic springs **13** are disposed behind each other and connected by a single rocking member **20**. Since there is only one arresting spring **24** provided, only one of the contact springs **5** has to have an aperture **27** for receiving the arresting spring. Since the switch according to Figure 7 in effect forms three switches according to Figures 1 to 4 behind each other, rocking member **20** is also approximately three times as long as that shown in Figures 1 to 4.

As will be clearly apparent from Figure 7, the rocking member **20** may be slipped from one side or the other between the ends **6** and **16** of springs **5** and **13**. This facilitates the installation of the switch considerably especially if suitable provision is made that the rocking member **20** may be inserted from the open side of the housing **1**, as shown in Figure 5. In that case, the brake part **30** would be shaped inversely to that shown in Figure 3 and mounted at the end of rocking member **20** opposite to that on which it is mounted in Figure 3, so that it will face toward the cover plate **2** of the housing on which the brake surface **33** will then be provided either rigidly or adjustably.

The principal advantage of the present invention consists in the fact that the rocking member **20** as distinguished from previous circuit breakers with snap contacts does not have a fixed point of location, so that very long return periods are attainable. The invention affords the additional advantage that the switch operation may be delayed due to the fact that the bimetallic spring has to accumulate a greater force until it can swing to the position in which the tipping point of the rocking member will be reached, and that the sudden tipping of the rocking member produces a pivoting of the end **6** of contact spring **5** and thus either a sudden separation or closing of contacts **7** and **8**. As distinguished from the known circuit breaker designs of this type, in which the bimetallic spring directly effects a relative movement of the contacts, the contact spring of the circuit breaker according to the invention is moved from one to the other position by the intermediate action of a rocking member which pivots about the free end **16** of the bimetallic spring **13**.

Although my invention has been illustrated and described with reference to the preferred embodiments thereof, I wish to have it understood that it is in no way limited to the details of such embodiments, but is capable of numerous modifications within the scope of the appended claims.

Having thus fully disclosed my invention, what I claim is:

1. A thermal circuit breaker comprising a contact spring mounted at one end and bent at its opposite end into a U-shaped configuration, said contact spring carrying a contact on the free of the U, a second contact adapted to be engaged by said first contact, a normally substantially straight bimetallic spring mounted at one end, and a rocking member having a pair of opposite V-shaped recesses therein interposed between and receiving, respectively, the free end of said free leg of said contact spring and the free end of said bimetallic spring, said rocking member being adapted to be freely movable on said free ends within said recesses, said contact spring engaging into one of said recesses under an initial tension, said bimetallic spring when heated being adapted to bend and through said rocking member to swing said contact spring and the contact thereon to a connecting and disconnecting position relative to said second contact.

2. A circuit breaker as defined in claim 1, wherein said rocking member consists of insulating material, and further comprising a metal lining within at least one of said V-shaped recesses.

3. A circuit breaker as defined in claim 1, further comprising a brake member connected to said rocking member, and a member having a brake surface thereon, said brake member being adapted to engage said brake surface at least in one direction of the reciprocating movement of said rocking member.

4. A circuit breaker as defined in claim 3, wherein said

brake member comprises a supporting member mounted on said rocking member, a brake arm pivotally mounted on said supporting member, and a spring acting upon said brake arm, said brake arm being adapted to be pivoted in one direction of the reciprocating movement of said rocking member against the action of said spring.

5. A circuit breaker as defined in claim 3, further comprising a housing containing said circuit breaker, said brake surface being disposed on and within said housing.

6. A circuit breaker as defined in claim 3, further comprising means for adjusting the position of said brake surface relative to said brake member.

7. A circuit breaker as defined in claim 5, further comprising means for adjusting the part of said housing containing said brake surface relative to said brake member.

8. A circuit breaker as defined in claim 1, further comprising means for arresting said contact spring in the open position of said contacts, and means for releasing said arresting device from said spring engaging position.

9. A circuit breaker comprising a housing, three contact springs, each mounted at one end within said housing and in a spaced relation behind each other, each of said contact springs being bent at its opposite end into a U-shaped configuration, said contact spring carrying a contact on the free leg of the U, second contacts mounted within said housing, each adapted to cooperate with one of said first contacts, three normally substantially straight bimetallic springs, each mounted at one end within said housing, a common rocking member having

a pair of opposite V-shaped recesses therein interposed between and receiving, respectively, the free ends of said free legs of said contact springs and the free ends of said bimetallic springs, said rocking member being adapted to be freely movable on said free ends within said recesses, said contact springs engaging under an initial tension into one of said recesses, each of said bimetallic springs when heated being adapted to bend and through said conmon rocking member to swing said contact springs and the contacts thereon to a connecting and disconnecting position relative to said second contacts.

10. A circuit breaker as defined in claim 9, further comprising a single arresting means mounted within said housing and adapted to engage with one of said contact springs, and a release key mounted in a wall of said housing and being adapted to be depressed from the outside of said housing for disengaging said arresting means from said contact spring.

11. A circuit breaker as defined in claim 1, further comprising a housing containing said circuit breaker and having at least one open side, and a perforated plate secured to said housing for closing said side while permitting dissipation of heat produced within said housing.

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