July 5, 1966 W. E. HARPER 3,259,725

ELECTRIC CIRCUIT BREAKER HAVING A MODULAR ARRANGEMENT OF INTERRUPTING ASSEMBLIES

Filed Oct. 16, 1963 2 Sheets-Sheet 1

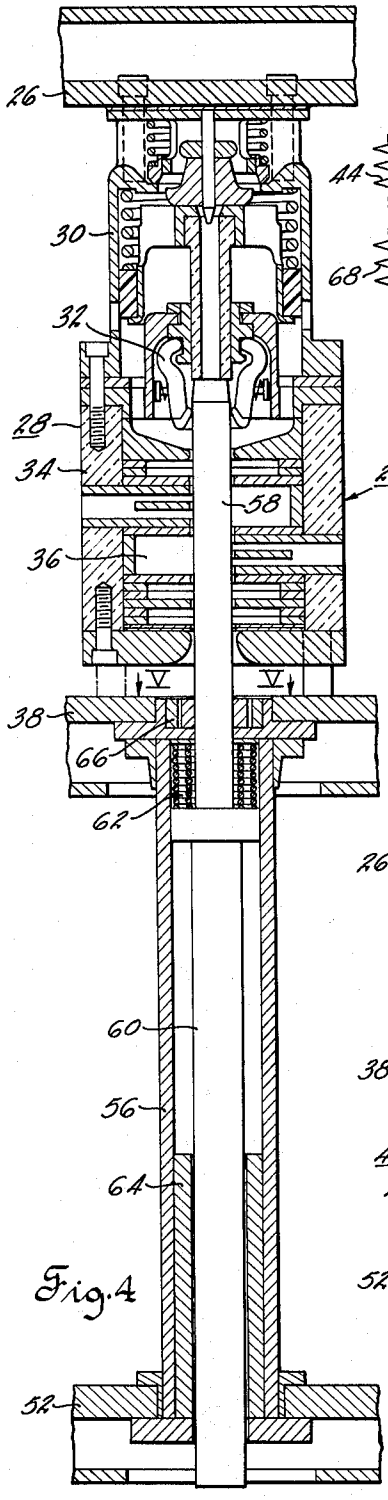


Fig. 4

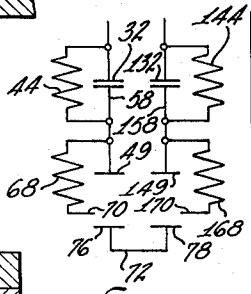


Fig. 6

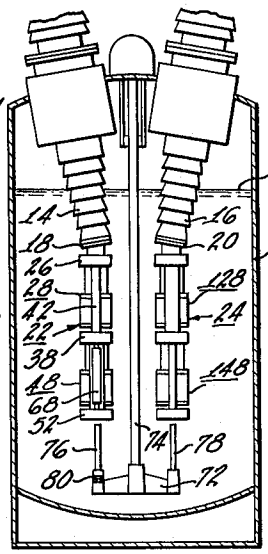


Fig. 1

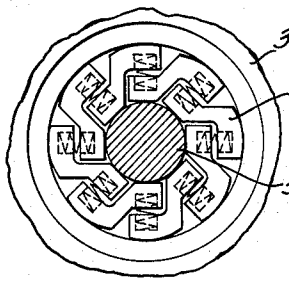


Fig. 5

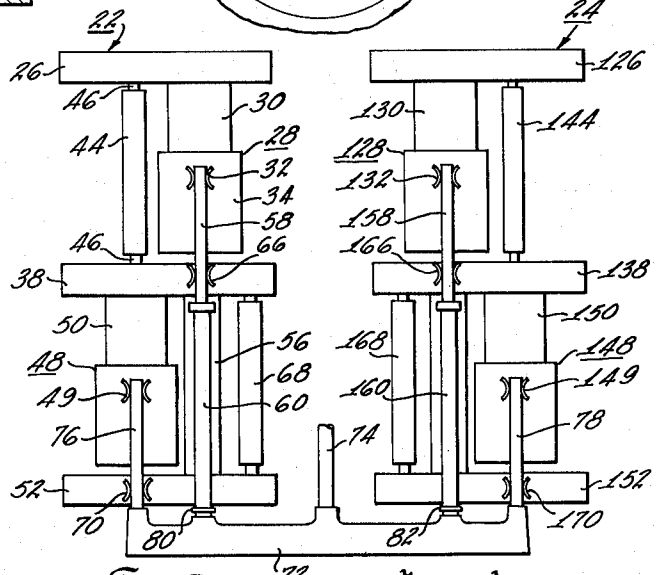


Fig. 2

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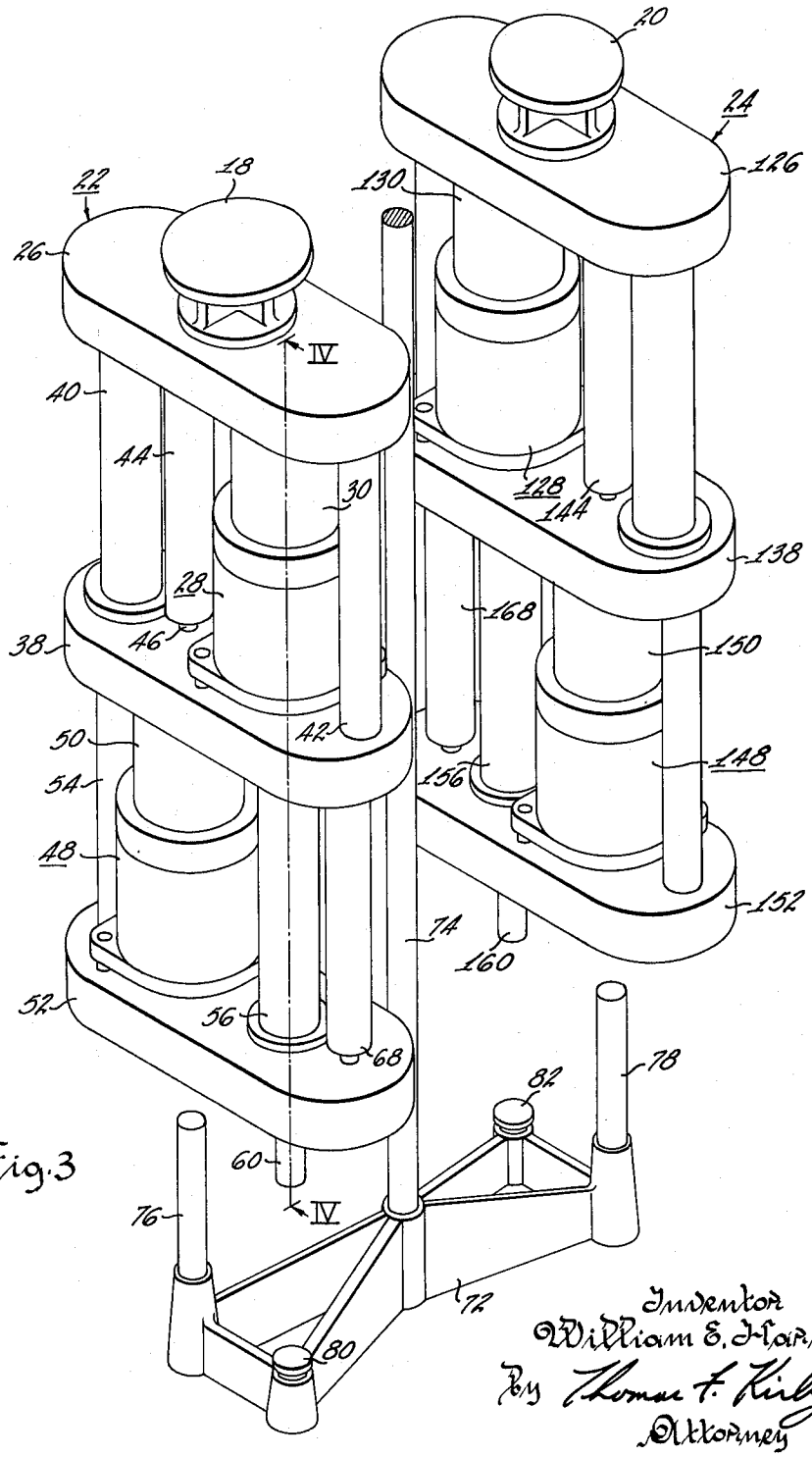


Fig. 3

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ELECTRIC CIRCUIT BREAKER HAVING A MODULAR ARRANGEMENT OF INTERRUPTING ASSEMBLIES

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5 Claims. (Cl. 200—150)

This invention relates generally to electric circuit breakers and particularly to high voltage type breakers having multiple breaks per phase and having impedance means, such as a resistor, connected across each break.

In high voltage oil type power circuit breakers, for example, it is known to provide multiple breaks per phase in order to increase the interrupting capacity of the circuit breaker. It is also known to place impedance means, such as a resistor or capacitor, across each break in parallel with the arc drawn when the break opens in order to equally divide the recovery voltage drop across the several breaks and to otherwise influence the interrupting performance of the circuit breaker. Heretofore, in carrying out the above practices, the means employed have been unduly costly, complicated and cumbersome. In some installations, for example, several breaks are provided for within a single arc extinguishing unit and this results in a very large and complicated extinguishing unit, particularly if the unit also employs oil pumping means to quench the arcs across each break therein. Such units are difficult to service because of their size and complexity and because of the manner in which the impedance devices, if such are employed, are associated therewith.

Accordingly, it is an object of the present invention to provide an improved circuit breaker having a plurality of series connected simultaneously operated interrupting devices per phase and wherein each interrupting device has an impedance device, such as a resistor, associated therewith.

Another object is to provide a circuit breaker of the aforesaid character wherein a modular concept is employed, i.e., wherein there are a pair of identically constructed arc extinguishing units for each phase and wherein each unit employs a plurality of substantially identical self-contained arc extinguishing devices, a plurality of substantially identical resistor devices and a plurality of substantially identical supporting and conducting members.

Another object is to provide a circuit breaker of the aforesaid character wherein the modular components employed are relatively small and easily handled and wherein they are assembled in an arrangement which provides for ease of assembly, reliability in use, and accessibility for inspection, servicing and repair.

Other objects and advantages of the invention will hereinafter appear.

The accompanying drawings illustrate a preferred embodiment of the invention, but it is to be understood that the embodiment illustrated is susceptible of modification with respect to details thereof without departing from the scope of the appended claims.

In the drawings:

FIG. 1 is an elevational view, partly in section, of an oil type circuit breaker embodying the present invention and shown in circuit open position;

FIG. 2 is an enlarged schematic view of a portion of the circuit breaker shown in FIG. 1, with certain components deleted to simplify the illustration of the electrical connection therein;

FIG. 3 is an enlarged perspective view of a portion of the circuit breaker shown in FIG. 1;

FIG. 4 is an enlarged sectional view taken along line IV—IV of FIG. 3;

FIG. 5 is an enlarged sectional view taken along line V—V of FIG. 4; and

FIG. 6 is a diagrammatic showing of the circuitry of the circuit breaker shown in FIG. 1 when the latter is in circuit open position.

Referring to FIG. 1, there is shown an oil circuit breaker of the high voltage type incorporating the invention and adapted for use in power transmission systems. The circuit breaker comprises a tank **10** which is filled with an arc extinguishing fluid, such as oil, to a line **12**. A pair of insulating bushings **14** and **16** extend through and are supported by the top of tank **10**. It is to be understood that in practice one pair of bushings is provided for each phase or line of the power system being protected. The bushings **14** and **16** house electrical conductors (not shown) which are electrically connected to terminal members **18** and **20**, respectively, on the ends of the bushings. An arc extinguishing assembly **22** is suspended from terminal member **18** on bushing **14** and a similar arc extinguishing assembly **24** is suspended from terminal member **20** of bushing **16**. Since assembly **24** is similar in all respects to assembly **22**, except for being reversely disposed as FIG. 3 shows, only the latter will hereinafter be described in detail.

FIGS. 1, 2 and 3 show that interrupting unit assembly **22** comprises a first or upper platform casting or member **26** which is mechanically and electrically connected to terminal member **18** on bushing **14**, as by bolting. Each platform casting described herein is to be understood to be a rigid, electrically conductive member.

As FIG. 3 shows, the platform castings are preferably oblong in shape to conserve space and are all of the same dimension and basic construction. As FIG. 4 shows, each platform casting is hollow to reduce weight. Besides serving as supports and conductors, the platform castings serve to dissipate heat from the interrupting devices and resistor devices to the surrounding oil, and to increase the dielectric strength of the breaker by serving as electrodes with large radii, thus reducing the voltage stress at the surfaces of the interrupting devices. The relatively large interelectrode capacitance between the platform castings also serves to aid in achieving uniform distribution of recovery voltage among the interrupting devices during interruption of the circuit. A first or upper interrupting device **28** is electrically and mechanically connected to upper platform casting **26**, as by bolting, and depends therefrom. Interrupting device **28** is also mechanically connected to a second or intermediate platform casting or member **38**. Interrupting device **28**, as FIG. 4 shows, comprises a metallic top section **30** having a stationary contact **32** therewithin and electrically connected thereto and further comprises an insulating lower section **34** having an arcing chamber **36** therewithin. Interrupting device **28** is understood to comprise means for pumping oil into its arc chamber to effect arc quenching during its operation. It is to be understood that interrupting device **28** is representative of each interrupting device described herein. Each interrupting device is an independent self-contained unit. Reference may be had to U.S. Patent No. 3,076,080, issued January 29, 1963, to J. M. Ramrath, for Fluid Blast Interrupting Device for Oil Circuit Breakers Employing Auxiliary Contact, for a full description of an interrupting device similar to the interrupting devices referred to herein.

Upper platform casting **26** is mechanically connected to intermediate platform casting **38** by a pair of rigid tubular insulating members or struts **40** and **42**, which are understood to be suitably secured to the platform castings. Although two supporting struts **40** and **42** are shown, it is to be understood that one or both could be omitted in an assembly wherein interrupting device **28** and a resistor

device, such as 44, afforded the mechanical support necessary.

Upper or first resistor device 44 is mechanically supported by and between the upper and intermediate platform castings 26 and 38 and is electrically connected to each of them. Resistor device 44 which is understood to be representative of each resistor device described herein comprises a tubular insulating casing having resistance material (not shown) therewithin and is provided with terminal members 46 at opposite ends which adapt it for mechanical and electrical connection to the platform castings.

A second or lower interrupting device 48 having a stationary contact 49 is electrically and mechanically connected by its metallic top portion 50 to intermediate platform casting 38, as by being bolted thereto, and depends therefrom. Interrupting device 48 is also mechanically connected to a third or lower platform casting 52. FIGS. 2 and 3 show that lower interrupting device 48 is axially offset from upper interrupting device 28.

Intermediate platform casting 38 is mechanically connected to lower platform casting 52 by a pair of tubular insulating members or struts 54 and 56. As hereinbefore explained, strut 54 could be omitted in certain installations if interrupting device 48 and a resistor device 68 afforded mechanical support. As FIGS. 2 and 4 show, strut 56 is hollow and is adapted to accommodate therein a movable sliding contact 58, preferably cylindrical in form, which is rigidly secured to a movable insulating push rod 60 and tends to be biased downwardly by bearing means such as a compression spring 62 out of engagement with stationary contact 32 and against a retainer 64 in strut 56. Movable sliding contact 58 is engaged by a stationary sliding contact 66, also shown in FIG. 5, which is mechanically supported by and electrically connected to intermediate platform casting 38.

Lower or second resistor device 68 is mechanically supported by and between the intermediate and lower platform casting 38 and 52 and is electrically connected to each of them. A stationary sliding contact 70, similar to stationary sliding contact 66 shown in FIG. 5, is mechanically supported by and electrically connected to lower platform casting 52.

It is to be understood that the other interrupting unit assembly 24 comprises upper, intermediate and lower platform castings 126, 138 and 152, respectively, upper and lower interrupting devices 128 and 148, respectively, having top sections 130 and 150, respectively, and having stationary contacts 132 and 149, respectively, an insulating push rod 160, and associated movable contact 158, stationary sliding contacts 166 and 170, upper and lower resistor devices 144 and 168, respectively, and suitable struts; all of which components are identical to their counterparts in interrupting unit assembly 22.

As FIG. 3 best shows, the modular components comprising each interrupting unit assembly are arranged to lie in the same vertical plane and these planes are spaced apart horizontally from each other and are parallel. Thus, not only is the arrangement compact but all of the modular components are accessible for servicing.

As FIGS. 1, 2 and 3 show, the circuit breaker described herein further comprises a cross bar or arm 72 which is reciprocally movable in the vertical direction by an insulating lift rod 74 to operate the circuit breaker. Cross bar 72 is provided at its opposite ends with upwardly projecting cross arm contact members 76 and 78 which are understood to be electrically connected to each other through the cross bars and which are adapted to extend through the stationary sliding contacts 70 and 170, respectively, in lower platform castings 52 and 152 into the lower interrupting devices 48 and 148, respectively. Cross bar 72 is further provided at its opposite ends with means such as push rod operators 80 and 82 for engagement with the lower ends of the insulating push rods 60 and 160, respectively, to effect operations of the movable contacts 58 and 158, respectively.

FIG. 6 shows diagrammatically the electrical connections within the oil circuit breaker when it is in circuit open position.

The circuit breaker hereinbefore described operates as follows.

Assume first that cross bar 72 has been moved downwardly by rod 74 to its lowest position so that the circuit breaker is in circuit open position, as shown in FIGS. 1, 3 and 6. In this position, the contact members 76 and 78 of cross bar 72 are completely withdrawn from the lower interrupting devices 48 and 148, respectively. Furthermore, the push rod operators 80 and 82 of cross bar 72 are disengaged from the lower ends of the insulating push rods 60 and 160, respectively. Thus, the insulating push rods 60 and 160 and their associated movable contacts 58 and 158, respectively, are biased downwardly within their struts by their respective springs so that the movable contacts are disengaged from the stationary contacts 32 and 132, respectively, in the upper interrupting devices 28 and 128, respectively. In this condition no current can flow through the circuit breaker.

Now assume that cross bar 72 is moved upwardly by rod 74 to circuit closed position. As this is done, the contact member 76 and 78 of cross bar 72 are first inserted into engagement with the stationary sliding contacts 70 and 170, respectively. At this point during the closing stroke a current path of low amperage is established through the circuit breaker. The current path therethrough for one phase is as follows: From terminal member 18 on bushing 14 through upper platform casting 26, through upper resistor device 44, through intermediate platform casting 38, through lower resistor device 68, through lower platform casting 52, through lower stationary sliding contact 70 to contact member 76; from this point current flows from contact member 78 through stationary sliding contact 170, through lower platform casting 152, through lower resistor device 168, through intermediate platform casting 138, through upper resistor device 144 to upper platform casting 126 to terminal member 20 on bushing 16. The conduction through the resistors divides the circuit voltage equally among the four interrupting devices thus minimizing prearcing during the closing operation. As cross bar 72 is moved further upwardly by rod 74 to the closed position, the contact members 76 and 78 of cross bar 72 are inserted into the lower interrupting devices 48 and 148, respectively, and make electrical contact with the stationary contacts 49 and 149, respectively, therein. Simultaneously, the push rod operators 80 and 82 of cross bar 72 engage the lower outwardly extending ends of the insulating push rods 60 and 160, respectively, and move the latter upwardly so that their associated movable contacts 58 and 158, respectively, make electrical contact with the stationary contacts 32 and 132, respectively, in the upper interrupting devices 28 and 128, respectively.

With the circuit breaker in circuit closed position the current path therethrough for one phase is as follows: from terminal member 18 on bushing 14 through upper platform casting 26, through top section 30 and stationary contact 32 of upper interrupting device 28, through movable contact 58, through stationary sliding contact 66, through intermediate platform casting 38, through top section 50 and stationary contact 49 of lower interrupting device 48, through contact member 76 on cross bar 72, through cross bar 72, through contact member 78 on cross bar 72, through stationary contact 149 and top section 150 of lower interrupting device 148, through intermediate platform casting 138, through stationary sliding contact 166, through movable contact 158, through stationary contact 132 and top section 130 of upper interrupting device 128, through upper platform casting 126, to terminal member 20 on bushing 16.

Finally assume that, with the circuit breaker energized so that current is flowing through the path described hereinbefore, cross bar 72 is moved downwardly by rod 74 toward circuit open position. As this downward move-

ment commences, electrical contact is broken simultaneously at four places in the circuit path described above and arcing occurs (1) between stationary contact **32** of upper interrupting device **28** and movable contact **58**, (2) between stationary contact **49** of lower interrupting device **48** and contact member **76** on cross bar **72**, (3) between contact member **78** on cross bar **72** and stationary contact **149** of lower interrupting device **148**, and (4) between movable contact **158** and stationary contact **132** of upper interrupting device **128**. Since the resistors **44**, **68**, **168** and **144**, respectively, are electrically connected across the contact gaps described, they have the effect of equalizing the voltage drop across the several contact gaps during the arc recovery period thus enhancing the interrupting performance of the circuit breaker.

As downward movement of cross bar **72** continues, the arcs become elongated. Since the movable contacts **58** and **158** are always electrically connected to the stationary sliding contacts **66** and **166**, respectively, on the intermediate platform castings **38** and **138**, respectively, the upper resistors **44** and **144**, respectively, are permanently connected across their respective arcs. However, as FIG. 6 shows, the resistors **68** and **168** are finally disconnected after they have performed their function when the contact members **76** and **78** on cross bar **72** finally disengage the sliding contacts **70** and **170**, respectively, on the lower platform castings **52** and **152**, respectively. In this way, complete interruption of the current path through the circuit breaker and isolation of the assemblies **22** and **24** is insured.

It is to be understood that in any particular installation a circuit breaker incorporating the present invention would be employed with its resistor devices omitted, if it were required to do so.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In an electric circuit breaker, in combination,
a pair of spaced apart arc extinguishing unit assemblies,
each assembly comprising an upper interrupting device having a vertical axis and a lower interrupting device having a vertical axis,
each of said interrupting devices having a stationary contact therein,
all of said devices in one of said assemblies having their axes lying in one vertical plane and all of said devices in the other of said assemblies having their axes lying in another vertical plane which is spaced from and parallel to said one vertical plane,
the lower interrupting device in each assembly having its axis offset from but parallel to the axis of the upper interrupting device,
and a movable cross bar for cooperation with said pair of arc extinguishing assemblies,
said cross bar having one cross bar contact in alignment with the axis of one of said devices in said one vertical plane,
said cross bar further having one movable contact operator in alignment with the axis of the other of said devices in said one vertical plane,
said cross bar having another cross bar contact in alignment with the axis of one of said devices in said other vertical plane,
said cross bar further having another movable contact operator in alignment with the axis of the other of said devices in said other vertical plane.

2. The combination according to claim **1** wherein in each vertical plane there is a hollow insulating member disposed below and in alignment with the axis of the upper interrupting device for housing a movable contact for cooperation with the stationary contact of said upper interrupting device and for housing a push rod therefor which is adapted to be operated by a respective movable contact operator on said cross bar.

3. In an electric circuit breaker, in combination,

a pair of spaced apart arc extinguishing unit assemblies,
each assembly comprising electrically conductive upper, intermediate and lower platform members,
a first interrupting device having a vertical axis and having a stationary contact therein,
said first device mounted between said upper and intermediate platform members and having its stationary contact electrically connected to said upper platform members,
insulating means for mechanically connecting said upper and intermediate platform members,
a movable contact electrically connected to said intermediate platform member and reciprocally movable into and out of engagement with the stationary contact of said first interrupting device,
a second interrupting device having a vertical axis and having a stationary contact therein,
said second device connected between said intermediate and lower platform members and having its stationary contact electrically connected to said intermediate and lower platform members,
both of said first and second interrupting devices in one of said assemblies having their axes lying in one vertical plane and both of said first and second interrupting devices in the other of said assemblies having their axes lying in another vertical plane which is spaced from and parallel to said one vertical plane,
and a reciprocally movable cross bar for cooperation with said pair of arc extinguishing assemblies,
said cross bar having a pair of electrically connected cross bar contacts thereon and a pair of movable contact operators,
said cross arm being movable to a closed position wherein each cross bar contact engages the stationary contact of the second interrupting device of one of said assemblies and wherein each movable contact operator effects engagement between its associated movable contact and the stationary contact of the first interrupting device of one of said assemblies.

4. The combination according to claim **3** wherein said insulating means for mechanically connecting said intermediate and lower platform members comprises a tubular member in alignment with the axis of said first interrupting device and which houses said movable contact and an insulating push rod for moving said movable contact,
said push rod being adapted for movement by said movable contact operator.

5. The combination according to claim **4** including a first resistor supported between and electrically connected to said upper and intermediate platform members,
and a second resistor supported between and electrically connected to said intermediate and lower platform members,
and wherein each cross bar contact on said cross arm makes electrical contact with its respective lower platform member when said cross is moved to closed position.

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