Nov. 1, 1966 R. E. FRINK 3,283,100

VACUUM CIRCUIT INTERRUPTER WITH CONDENSING SHIELD SERVING AS ONE OF THE MAIN CONTACTS

Filed Nov. 16, 1964 3 Sheets-Sheet 1

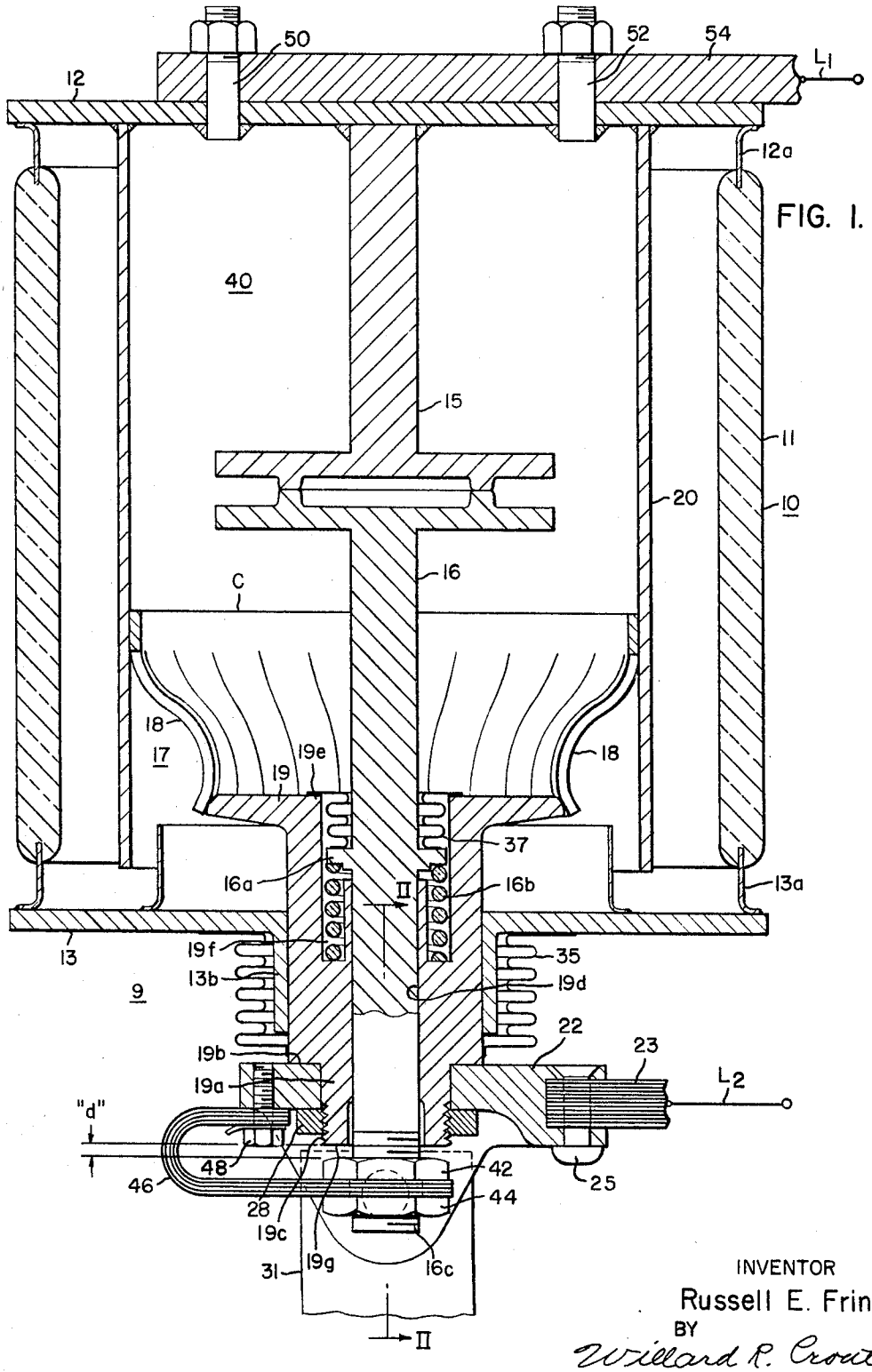


FIG. 1.

INVENTOR
Russell E. Frink
BY
Willard R. Crout
ATTORNEY

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3 Sheets-Sheet 2

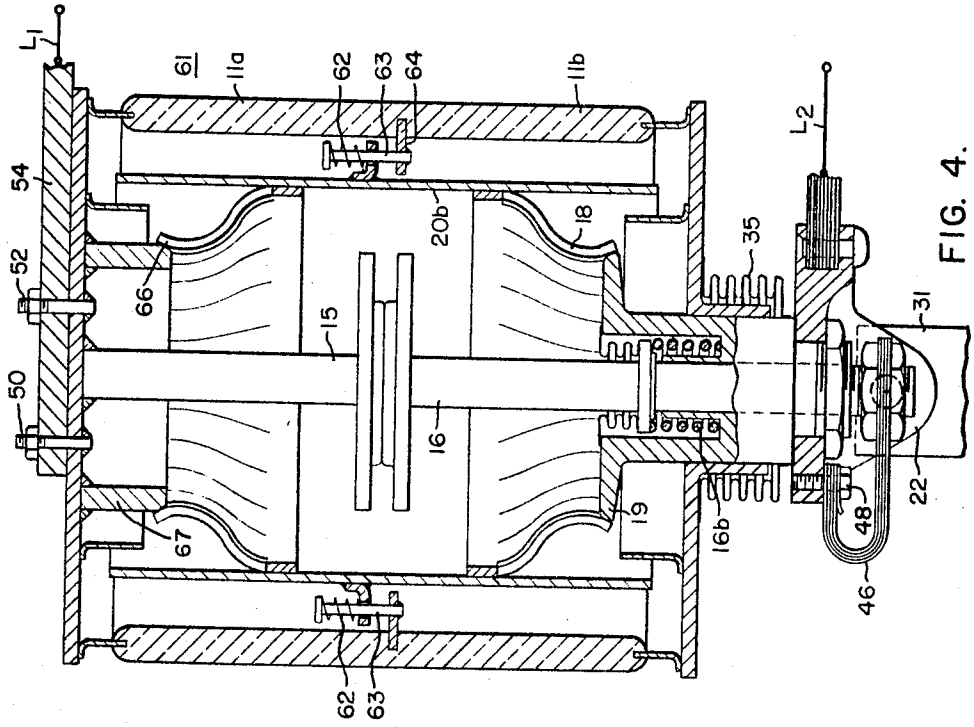


FIG. 4.

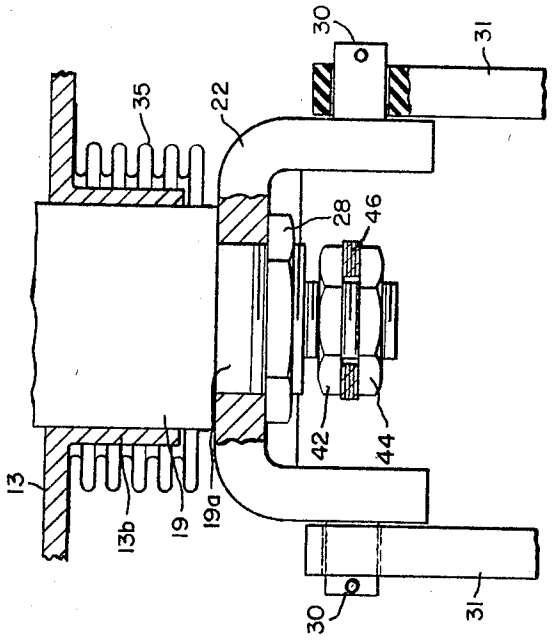


FIG. 2.

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VACUUM CIRCUIT INTERRUPTER WITH CONDENSING SHIELD
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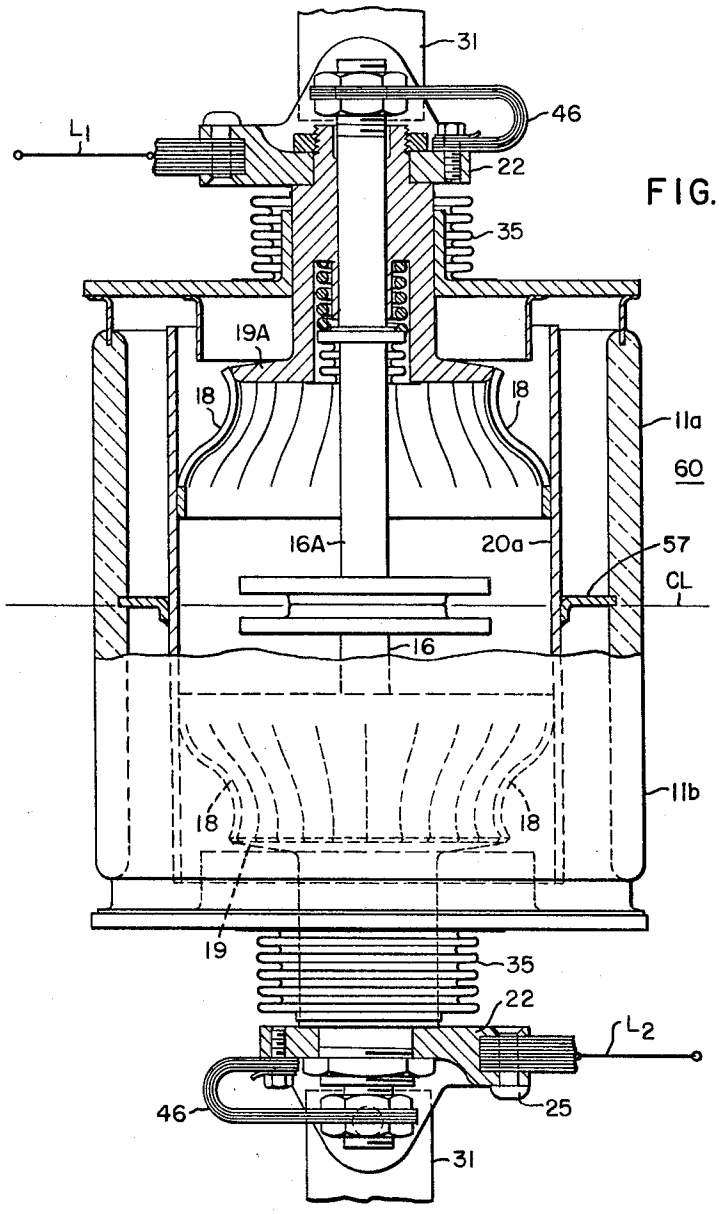


FIG. 3.

United States Patent Office

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Patented Nov. 1, 1966

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VACUUM CIRCUIT INTERRUPTER WITH CONDENSING SHIELD SERVING AS ONE OF THE MAIN CONTACTS

Russell E. Frink, Forest Hills, Pa., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Filed Nov. 16, 1964, Ser. No. 411,259
11 Claims. (Cl. 200—144)

This invention relates generally to vacuum-type circuit interrupters having condensing-shield structures and, more particularly, to a vacuum-type circuit interrupter in which the condensing-shield structure serves as a component part of a main-contact structure, which electrically shunts the separable arcing contacts.

A general object of the present invention is to provide an improved vacuum-type circuit interrupter capable of carrying continuously a high-value load current.

A more specific object of the present invention is the provision of an improved vacuum-type circuit interrupter having a condensing shield which serves as a support for main contact fingers.

Still another object of the present invention is the provision of an improved vacuum-type circuit interrupter in which the condensing shield is at a floating potential, and in which said condensing shield provides a component part of a shunting main contact structure.

Still a further object of the present invention is the provision of high-capacity vacuum-type circuit interrupter in which a pair of main contacts is arranged to open before the arcing contacts open during the opening operation, and to close after the arcing contacts close during the closing operation, and in which the condensing-shield structure serves as a supporting means for the main contact structure.

Another object of the present invention is to provide an improved vacuum-type circuit interrupter in which the condensing-shield structure carries practically all of the load current in the closed-circuit position of the device.

An ancillary object of the present invention is the provision of an improved vacuum-type circuit interrupter having a condensing-shield structure, in which the condensing-shield structure provides a support for main contact fingers, and, additionally, provides a large-area radiating surface, which can readily radiate generated heat through the surrounding glass envelope.

In carrying out my invention in one form, I provide a condensing tubular shield with a plurality of circumferentially-disposed flexible main contact fingers, which cooperate with a moving main contact, which is arranged to open prior to the opening movement of the movable arcing contact. In another form of my invention, I utilize a condensing-shield structure having two sets of resilient main contact fingers at the opposite ends thereof, and employ two oppositely-movable main contacts, which respectively engage with the main contact fingers supported by the condensing-shield structure. In such a device, the two oppositely-disposed main movable contact structures separate from their cooperable main contact fingers prior to the separation of the two arcing electrodes, a lost-motion connection being provided, associated with each movable contact structure.

In still a third form of my invention, I provide a resiliently-mounted movable condensing-shield structure associated with a vacuum-type circuit interrupter, in which the condensing-shield structure has two sets of main contact fingers disposed at the opposite ends thereof; and the entire condensing-shield structure is adapted to move with the main movable contact during the closing operation, until it engages the stationary serially-arranged main

contact structure. Such an arrangement has the advantage that the condensing-shield structure is at a floating potential, so that voltage stress is minimized in the open-circuit position of the device.

Further objects and advantages will readily become apparent upon reading the following specification, taken in conjunction with the drawings, in which:

FIGURE 1 is a vertical cross-sectional view taken through a vacuum-type circuit interrupter employing the principles of the present invention, the contact structure being illustrated in the closed-circuit position;

FIG. 2 is a fragmentary enlarged sectional view taken through the actuating mechanism substantially along the line II—II of FIG. 1, again the contact structure being illustrated in the closed-circuit position;

FIG. 3 illustrates a modified form of the invention in which two movable main contact structures are utilized, the view being taken generally sectionally through the device, the contact structure being illustrated in the closed-circuit position; and,

FIG. 4 is a vertical sectional view taken through another form of the present invention, the contact structure being illustrated in the closed-circuit position.

Referring now to the circuit interrupter **9** of FIG. 1, there is shown a highly-evacuated envelope **10** comprising a casing **11** of suitable insulating material, for example glass, and a pair of end plates **12, 13** closing off the ends of the casing. Suitable seals **12***a*, **13***a* are provided between the end plates **12, 13** and the glass casing **11** to provide vacuum-tight joints at these points.

Located within the envelope **10** is a pair of separable arcing contacts **15, 16**, which are electrically shunted by a main contact structure, generally designated by the reference numeral **17**, and comprising a plurality of circumferentially-disposed flexible contact fingers **18** and a main contact member **19**.

As shown in FIG. 1, the set of resilient main contact fingers **18** is supported by a metallic cylindrical condensing shield **20**, the latter being secured, as by brazing, to the upper end plate **12**. For certain applications, it may be desirable to form the main stationary resilient contact fingers **18** by slotting a metallic cylinder C, and bending the resulting fingers inwardly, as shown in FIG. 1. The slotted cylinder C may then serve as a contact ring, and be suitably affixed to the inner surface of the condensing shield **20**, as shown.

As well known by those skilled in the art, in a vacuum circuit interrupter, the metallic vapors that are produced by arcing tend to condense on the insulating surfaces of the interrupter and, tend to form metallic coatings which impair the insulating properties of such surfaces. For protecting these insulating surfaces against such metal deposition, a condensing-shielding structure is utilized. Generally, such shielding structure comprises a generally tubular metallic shield surrounding the arcing gap between the usual arcing electrodes of the interrupter, and electrically isolated from one or both end plates of the device. The electrically-isolated shield is physically located between the arcing gap and the internal surface of the usual insulating casing for the interrupter, and acts to intercept and condense those metallic vapors traveling toward the insulating surface from the arcing gap.

As shown in FIG. 1, the lower end plate **13** has a downwardly-extending cylindrical guide-flange portion **13***b*, which guides the reciprocal vertical opening and closing movement of the main contact member **19**, which engages the stationary resilient main contact fingers **18** in the closed-circuit position of the device, as shown in FIG. 1.

The main contact member **19** has a reduced portion **19***a* forming a shoulder **19***b*, which accommodates a line-terminal connector **22** having a flexible strap-like main

line connector **23** fixedly secured thereto, as by a rivet **25**. A locking nut **28** is threaded upon a threaded portion **19***c* of the reduced stem portion **19***a*, and securely fixes the line connector **22** to the movable main contact member **19**.

As shown in FIG. 2, the movable line connector **22** is of generally a U-shape having outwardly-projecting trunnion studs **30**, which are pivotally connected to insulating operating links **31**. Thus, each vacuum-type circuit-interrupting unit **9** has a pair of cooperable actuating links **31**, preferably composed of insulating material, which effect reciprocal opening and closing movement of the U-shaped line connector **22**, and hence the main movable contact member **19**.

To prevent leakage of gas between the downwardly-extending flange portion **13***b* of the end plate **13** and the reciprocally-movable main contact member **19**, there is provided a flexible metallic bellows **35**. The upper end of the bellows **35**, as viewed in FIG. 1, is secured by means of suitable sealed joints to the end plate **13**. The lower end of the bellows **35** is secured by suitable means to the lower external side surface of the main movable contact **19**, as shown.

A bore **19***d* is provided longitudinally through the main movable contact member **19**, and accommodates reciprocal opening and closing motion of the arcing contact **16**. A second flexible metallic bellows **37** is secured between an outwardly-extending flange portion **16***a* and an upper planar portion **19***e* of the main movable contact **19** to prevent leakage of gas along the bore **19***d* into the interior **40** of the evacuated envelope **10**. A compression spring **16***b* is interposed between flange **16***a* and the bottom of a spring bore **19***f* of the main movable contact member **19** to bias the movable arcing contact **16** upwardly against the stationary arcing contact **15**.

A pair of retaining nuts **42**, **44** fixedly secure a flexible conducting strap **46** to a lower threaded portion **16***c* of the movable arcing electrode **16**. The other end of the flexible strap-like lead **46** is connected, by an attachment bolt **48**, to the movable line connector **22**, as shown in FIG. 1. Thus, the two movable arcing and main contacts **16**, **19** are electrically connected together at all times.

As illustrated in FIG. 1, the upper end plate **12** has fixedly secured thereto, as by bolts **50**, **52**, a line bus bar **54**, to which the line connection L_1 may be connected by any suitable means.

As pointed out hereinbefore, in a vacuum-type circuit interrupter, the metallic vapors that are produced during arcing tend to condense on the insulating surfaces of the interrupter casing, and hence to form metallic coatings which impair the insulating properties of such surfaces. For protecting the surfaces against such metal deposition, a condensing shield **20** has been found particularly effective. Generally, such a condensing shield **20** comprises a tubular metallic member surrounding the arcing gap between the usual electrodes of the interrupter, and electrically isolated from both electrodes and from ground. This electrically-isolated shield is physically located between the arcing gap and the internal surface of the usual insulating casing **11** for the interrupter, and acts to intercept and condense those metallic vapors traveling toward the insulating surface from the arcing gap.

As provided herein, the condensing shield **20** constitutes a component part of the main contact structure **17** which shunts the arcing contact structure, and enables the circuit interrupter to carry higher load currents without heating.

The condensing-shield structure **20**, as shown, constitutes an integral part of the main current path in the closed-circuit position of the interrupter, as illustrated in FIG. 1.

During the opening operation, the pair of insulating links **31** are moved downwardly by any suitable actuating mechanism. Such action causes the U-shaped line connector **22** to also move down, which, in turn, causes downward opening movement of the main movable contact **19**, causing a separation thereof from the flexible main stationary contact fingers **18**. The current flowing through the interrupter **9** is then forced to flow through the arcing electrodes **15**, **16** still in engagement, which open at a later period of time due to the lost-motion connection, as afforded by the gap distance "*d*" and the biasing spring **16***b*. In other words, first the main movable contact **19** moves downwardly and, following abutting engagement between the lower extremity **19***g* and the retainer bolt **42**, the movable arcing contact **16** is forced to move downwardly with the main movable contact **19**, drawing an arc between the arcing contacts **15**, **16**, which is extinguished in the usual manner. It will be noted, therefore, that the main movable contacts **18**, **19** separate before separation of the arcing contacts **15**, **16**, so that no arc erosion occurs at the contact structure **18**, **19**.

During the closing operation, the insulating links **31** move upwardly to first cause re-engagement between the separable arcing contacts **15**, **16**, and further upward movement, as caused by the insulating links **31**, ultimately effects re-engagement between the main movable contact **19** and the flexible contact fingers **18** to thereby shunt the arcing contacts **15**, **16**. As a result, in the closed-circuit position of the interrupter, as illustrated in FIG. 1, the main contact structure **18**, **19** electrically parallels the current path between the arcing contacts **15**, **16**, and due to the lower resistance carries practically all of the current.

From the foregoing description it will be apparent that the usual metallic condensing shield **20** has an important additional function, namely of providing a component part of the main contact structure **18**, **19** shunting the arcing electrodes, and enabling the current to be increased without excessive heating. Due to the fact that the condensing shield **20** "sees" through the glass envelope **11**, heat may be readily radiated by the condensing shield **20** through the glass envelope **11** to be quickly dissipated.

FIG. 3 shows a modified-type of interrupting arrangement **60**, wherein the movable arcing and main contact structure **16**, **19** of FIG. 1 is duplicated so that in effect a mirror image structure about the center line CL is provided on the top and bottom of the interrupter **60**. As a result, two main contact breaks are provided before the establishment of an arcing gap, and support of the condensing shield **20***a* is provided between the envelope sections **11***a*, **11***b* by a support ring **57**. The shield **20***a* being electrically isolated in the open-circuit position reduces the voltage stress between the shield **20***a* and the movable main contacts **19**, **19**A.

During the opening operation of the modified-type of circuit interrupter **60**, the main movable contact structure **19** moves downwardly, whereas the cooperating main movable contact structure **19**A moves upwardly. Thus, two simultaneous main breaks are obtained, and subsequently the two movable arcing contacts **16**, **16**A are separated to bring about circuit interruption.

During the closing operation, the oppositely-disposed main and movable arcing contacts **16**, **19** are moved toward each other and make closing engagement, as illustrated in FIG. 3 of the drawings.

FIG. 4 illustrates a modified-type of interrupting arrangement **61** in which the condensing shield **20***b* is resiliently mounted by a plurality of compression springs **62** encircling spring bolts **63**, the latter being disposed circumferentially around a supporting ring **64**, which is sealed between two casing sections **11***a*, **11***b* of the interrupter **61**. During the closing operation, the movable condensing shield **20***b* is moved upwardly by the lower main movable contact structure **19**, until contact engagement is made at the upper set of main contact fingers **66** with a stationary main contact ring **67**.

During the opening operation, downward opening movement of the lower main movable contact **19** causes the condensing shield **20***b* to move therewith until separation is made at the upper main contact fingers **66**, **67**. Subsequently, the second set of main contact fingers **18**,

19 separate, and, finally, the arcing contacts 15, 16 separate in the same manner as illustrated in FIG. 1 of the drawings.

From the foregoing description, it will be apparent that I have provided an improved condensing-shield structure which not only provides its usual function, but, additionally, provides a main-current breaking function to increase the load-current-carrying capacity of the interrupter without excessive heating.

Although there have been illustrated and described specific structures, it is to be clearly understood that the same were merely for the purpose of illustration, and that changes and modifications may readily be made therein by those skilled in the art, without departing from the spirit and scope of the invention.

I claim as my invention:

1. A vacuum-type circuit interrupter including a tubular envelope of insulating material, a tubular metallic condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope for protecting said envelope from being coated with metallic particles, a pair of separable arcing contacts disposed within said condensing shield, a pair of separable main contacts within said envelope in electrically parallel relationship with respect to said separable arcing contacts, means separating the main contacts during the opening operation before separation of the arcing contacts, the condensing shield being electrically connected to one of the separable arcing contacts in the closed-circuit position, and said tubular metallic condensing shield comprising a component part of one of said separable main contacts to assist in carrying the continuous current through the interrupter.

2. A vacuum-type circuit interrupter including a tubular envelope of insulating material, a tubular metallic condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope for protecting said envelope from being coated with metallic particles, a pair of separable arcing contacts disposed within said condensing shield, a pair of separable main contacts within said envelope in electrically parallel relationship with respect to said separable arcing contacts, means separating the main contacts during the opening operation before separation of the arcing contacts, said main contacts comprising a circumferential set of resilient stationary main contact fingers and a movable main contact, the condensing shield being electrically connected to one of the separable arcing contacts in the closed-circuit position, and the condensing shield supporting said circumferential set of resilient stationary main contact fingers to assist in carrying the continuous current through the interrupter.

3. In combination, a vacuum-type circuit interrupter including a pair of separable arcing contacts, an electrically parallel pair of main separable contacts to assist in carrying load current through the interrupter, an evacuated envelope within which all said contacts are disposed, a tubular metallic condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope and surrounding said arcing contacts for protecting said envelope from being coated with metallic particles, means mounting one main contact upon said tubular metallic condensing shield so that main current flows through the condensing shield, means electrically connecting said condensing shield with one of the arcing contacts in the closed-circuit position, and means opening the main contacts before the arcing contacts during the opening operation.

4. A vacuum-type circuit interrupter including a tubular envelope of insulating material, a tubular metallic condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope for protecting said envelope from being coated with metallic particles, a pair of separable arcing contacts disposed within said shield, separable main contact means within said envelope in electrically parallel relationship with respect to said separable arcing contact means and comprising two sets of separable main contacts, said condensing shield being movable and in series circuit with said main contact means, means electrically connecting said condensing shield with one of the arcing contacts in the closed-circuit position, and said condensing shield carrying two sets of movable main contacts.

5. The combination of claim 1, wherein a lost-motion connection is provided between the main and arcing contacts.

6. A vacuum-type circuit interrupter including a tubular envelope of insulating material, a tubular metallic condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope for protecting said envelope from being coated with metallic particles, separable arcing contact means disposed within said shield, separable main contact means within said envelope in electrically parallel relationship with respect to said separable arcing contact means and including two sets of separable main contacts, means separating the main contact means during the opening operation before separation of the arcing contact means, said condensing shield being electrically connected with the arcing contact means in the closed-circuit position, and said tubular metallic condensing shield supporting one contact of the two separable sets of main contacts adjacent opposite ends thereof.

7. The combination according to claim 6, wherein the condensing shield is movable and provides sequentially-acting main contact gaps.

8. A vacuum-type circuit interrupter including a tubular envelope of insulating material, a tubular metallic condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope for protecting said envelope from being coated with metallic particles, separable arcing contact means disposed within said shield and comprising two oppositely movable arcing contacts, main contacts adjacent opposite ends of the condensing shield, said condensing shield being electrically connected with the arcing contacts in the closed-circuit position, and a pair of oppositely-movable main contacts engageable with said main contacts supported by the condensing shield.

9. A vacuum-type circuit interrupter including a tubular envelope of insulating material, a tubular metallic condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope for protecting said envelope from being coated with metallic particles, separable arcing contact means disposed within said shield, separable main contact means within said envelope in electrically parallel relationship with respect to said separable arcing contact means and including two sets of movable main contacts disposed adjacent opposite ends of the condensing shield, a stationary main contact supported by an end plate of the interrupter and making engagement with one movable main contact supported by the condensing shield, and another movable main contact disposed adjacent the other end of the envelope making engagement with the other movable main contact supported by the condensing shield.

10. A vacuum-type circuit interrupter including an evacuated envelope, a resiliently-mounted movable condensing shield disposed internally of said envelope in generally concentric relationship with respect to said envelope for protecting said envelope from being coated with metallic particles, movable main contacts carried adjacent opposite ends of the condensing shield, a pair of separable arcing contacts disposed within the shield, and first stationary and second movable main contacts respectively sequentially engageable with the two main movable contacts carried by the condensing shield.

11. A vacuum-type circuit interrupter including a generally cylindrically-shaped insulating envelope, an internally-disposed generally cylindrically-shaped conducting condensing shield in generally concentric relationship

therewith, a pair of separable arcing contacts disposed internally of said condensing shield, main contact means for increasing the current-carrying capacity including at least portions of the walls of said condensing shield in electrically parallel relationship with respect to the arcing contacts, means opening the main contact means prior to opening the arcing contacts during a circuit opening operation, and means closing the arcing contacts prior to closing the main contacts during a closing operation of the interrupter.

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ROBERT K. SCHAEFER, *Primary Examiner.*

ROBERT S. MACON, *Examiner.*