Jan. 27, 1953 B. P. BAKER ET AL 2,627,005

INTERRUPTER PART OF COMPRESSED-AIR BREAKERS

Filed Feb. 3, 1949 2 SHEETS—SHEET 1

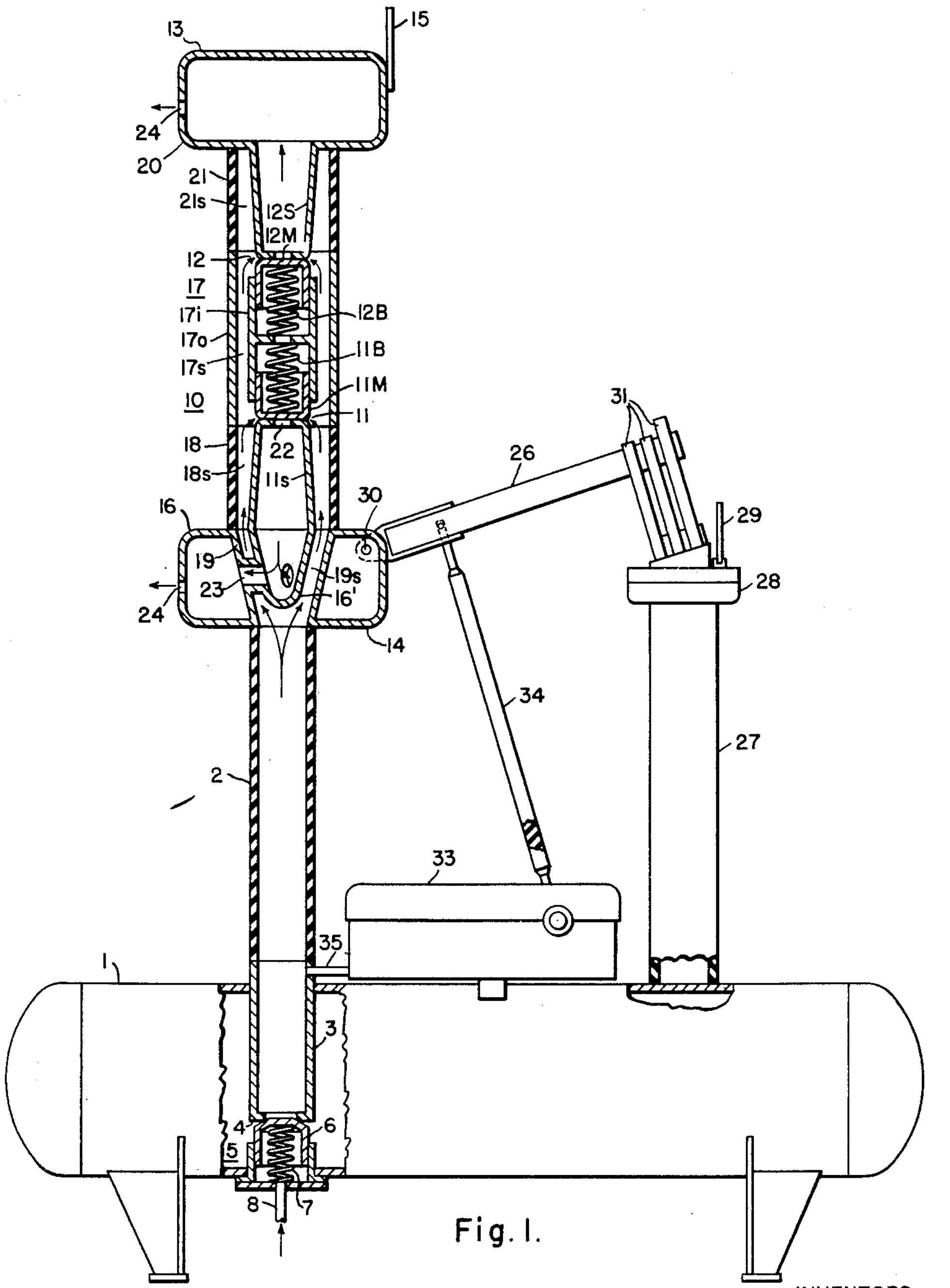

Fig. 1.

WITNESSES:
Edward Michaels
Robert C. Baird

INVENTORS
Benjamin P. Baker, Erling Frisch,
Wayne S. Aspey & John B. MacNeill.
BY O. B. Buchanan
ATTORNEY

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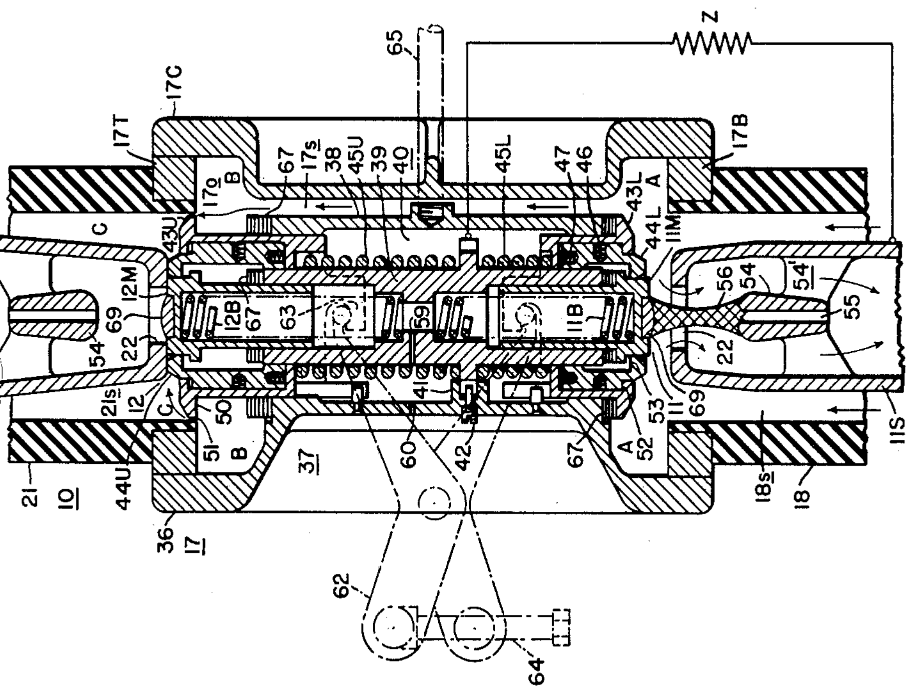

Fig. 3.

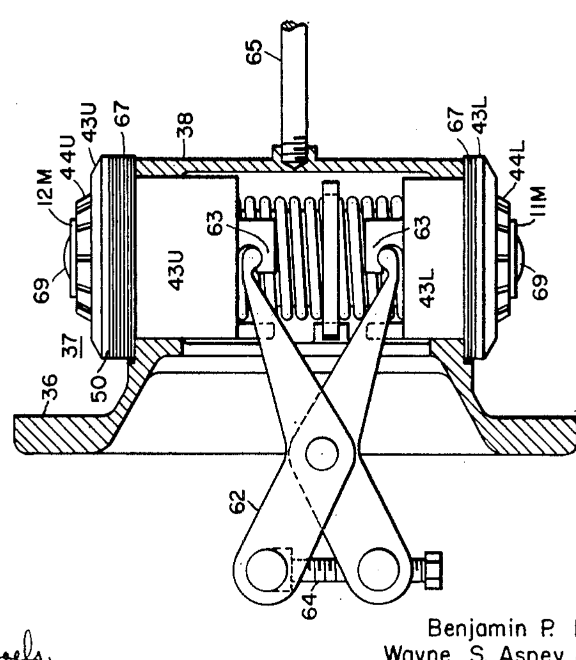

Fig. 2.

WITNESSES:

Edward Michaels

Wm. C. Groome

INVENTORS

Benjamin P. Baker, Erling Frisch,

Wayne S. Aspey & John B. MacNeill.

BY O. B. Buchanan

ATTORNEY

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INTERRUPTER PART OF COMPRESSED-AIR BREAKERS

Benjamin P. Baker, Turtle Creek, Erling Frisch, Pittsburgh, Wayne S. Aspey, Turtle Creek, and John B. MacNeill, Pittsburgh, Pa., assignors to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application February 3, 1949, Serial No. 74,406

16 Claims. (Cl. 200—148)

Our invention relates to compressed-air cir-circuit-breakers, and it has particular relation to the interrupter part of a self-opening, single-column, longitudinal-blast circuit-breaker having two contacts in series.

Heretofore, various types of compressed-air circuit-breakers have given an excellent account of themselves, both in this country and abroad, by reason of considerations of their safety, continuity of service, and reduced maintenance. These breakers, in the past, have been very greatly handicapped, however, by reason of their relatively high cost, and a considerable complexity of construction.

Our invention is the culmination of a design-development in which we have produced an extremely simple, practical, and inexpensive form of interrupter-assembly, which constitutes a specific detail or improvement of the subject matter of a copending application, of Benjamin P. Baker and Howard M. Wilcox, Serial No. 73,515, filed January 29, 1949, and now abandoned, which covers the general assembly of a compressed-air breaker which is mounted with an insulating blast-tube extending up from the top of a compressed-air reservoir, and having an extension of the blast-tube extending down inside of the tank and terminating in a blast-valve disposed at the bottom of the tank, and having a single-column multi-gap air-blast arrester-assembly mounted at the top of the insulating tube.

Our present invention relates to a practical form of the interrupter-assembly, for this combination, in which a novel, removable, double-ended, moving-contact assembly carries not only the moving arcing contacts, but also the cluster of segmental contact-fingers which constitute the main contacts. Our invention relates to an assembly in which these main and arcing contacts can be compressed or retracted toward each other, and in that state moved laterally out of a box-like holder, thereby exposing the tips of the two stationary contacts between which the double-ended moving-contact assembly is normally inserted. This makes it possible to service both the stationary contacts and the moving contacts. The use of the cluster of main contact-segments, in addition to the arcing contacts, makes possible the design of our assembly for a full-load line-current in excess of 2000 amperes.

Another object of our invention is to provide a special design of breaker, with two gaps, or sets of contacts, in series with each other, one gap being shunted by a shunting impedance, and the other gap being designed so that there is a

delay in the time at which this second gap receives a sufficient compressed-air pressure for separating the gap-contacts, so that the fault-current is first partially interrupted by the first-acting gap, and thereby transferred to the shunting impedance, which very considerably reduces the magnitude of the current which has to be finally interrupted by the second-operating gap. The two gaps are preferably differently designed, so as to advantageously handle the different circuit-interrupting duties which are imposed thereon, as will be subsequently described. By this means, we are enabled to interrupt currents up to 37,000 amperes at 44,000 volts, corresponding to 4.9 million-kilovolt amperes on a 3-pole, 69-kilovolt breaker, with a total circuit-interrupting time, from the first energizing of the trip-coil to the final interruption of the current flowing through the shunting impedance, ranging from 2.3 to 3.3 cycles, on a 60-cycle line.

A further object of our invention is to provide a novel double-gap interrupter-assembly of the class described, having two exhaust-chambers which materially contribute to the success of the functional operation of the device, as will be subsequently explained.

A more specific object of our invention is to provide a novel structure of the hollow longitudinal-blast stationary-electrode, having a special perforated arc-terminal device supported centrally therein at a point spaced slightly back from the orifice in the tip of said stationary electrode.

With the foregoing and other objects in view, our invention consists in the combinations, assemblies, systems, structures, parts, and methods of design and operation, hereinafter described and claimed, and illustrated in the accompanying drawing, wherein Figure 1 is a side elevational view, partly in section, and largely diagrammatic, not to scale, indicating the general principles of our invention as applied to a single-pole assembly, Fig. 2 is a side elevational view of the moving-contact assembly, removed from the circuit-breaker, and Fig. 3 is a longitudinal sectional view of the interrupter-assembly, showing the impedance-shunted contacts in their open, arcing condition, while the other contacts are still closed, with a diagrammatic indication of the shunting impedance.

Figure 1 shows a single pole of a compressed-air breaker-assembly embodying our invention. It is to be understood, however, that our invention is often or usually applied to a three-phase power-system, in which case each pole would consist of the structure as shown in Fig. 1, except that a single operating-mechanism may be used for gang-operation of all three poles, and possibly also a single compressed-air tank might be used for supporting the blast-tubes of all three poles.

Each pole of the breaker preferably has its own compressed-air tank or reservoir 1, which is made of steel, and which serves also as a supporting-structure for the rest of the assembly. We provide a vertically disposed, insulating, blast-tube 2 which extends upwardly above the top of the tank and is supported by the tank. Inside of the tank, there is a vertically disposed tube-means 3, which is in alignment, and air-flow communication, with the bottom of the blast-tube 2, so that said internal tube-means 3 serves, in effect, as a blast-tube extension which extends downwardly, within the tank, to a point near, but spaced from, the bottom of the tank, as indicated at 4. Physically, this blast-tube extension, inside of the tank, could be a part of the insulating blast-tube 2, which could be made long enough to extend down to the point 4 near the bottom of the tank, but actually, it is more convenient to make the internal tube-means 3 out of iron or steel which is welded or otherwise properly secured within the tank 1. Also, in a practical construction, it would be possible for the internal tube-means 3 to comprise the top part of an internal tube which physically extends from the top of the tank all the way down to the bottom of the tank, but which is provided with side-openings at the effective tube-bottom 4, so that said tube-means would be intact, as a tube, only above the point 4.

Disposed within the tank 1, under the bottom 4 of the tube-means 3, is a blast-valve 5, which is accessible and operable from the bottom of the tank. The blast-valve 5 is preferably a differential-pressure valve, having a vertically movable inverted-cup member 6, which is pressed up, by a compression-spring 7, into tight seating-engagement with the bottom end 4 of the tube-means 3, as claimed in the aforementioned Baker-Wilcox application. The compression-spring 7 acts as a weak closing-spring, which does not exert enough pressure to close the valve against the air-pressure in the tank 1, which may be at something of the order of 250 pounds per square inch. Normally, the blast-valve 5 is held closed by being supplied, from underneath, with air at the same pressure as the air in the tank 1, as by means of a valve-controlling pipe 8, which is in communication with the underside of the movable inverted cup 6, so that the valve is thus held closed. The valve is opened by releasing the air-pressure which is applied by the valve-controlling pipe 8, thus permitting the air-pressure within the tank to push down the inverted cup 6, thus permitting air to rush, in large quantities, upwardly through the internal tube-means 3 and through the insulating blast-tube 2.

On top of the insulating blast-tube 2, we mount a single-column interrupter-assembly 10, which is preferably supported in a vertical position, in alignment with the blast-tube 2, and which is physically supported solely, or substantially entirely, by the blast-tube, so as to be electrically insulated from ground by said blast-tube. This single-column interrupter-assembly comprises a plurality of vertically aligned, self-opening, longitudinal-blast interrupter-gap devices 11 and 12, two such gap-devices being used on a 69-kilovolt breaker as illustrated. These gap-devices 11 and 12 are electrically connected in series, so that the current-flow, in the normal closed position of the breaker, is from the top 13 of the interrupter-assembly 10 to the bottom 14 thereof, a suitable line-terminal 15 being provided at the top 13. Each interrupter-gap device 11 and 12 comprises a stationary contact-member 11S or 12S, as the case may be, and a vertically movable contact-member 11M or 12M, as the case may be. The two movable contact-members 11M and 12M are normally biased toward closed position by means of biasing-springs 11B and 12B respectively.

In the construction which is very much preferred, the first stationary contact-member 11S is at the bottom 14 of the interrupter-assembly 10, and is integrally or electrically united with a lower exhaust-chamber 16, which is made of metal. The stationary contact-member 11S is hollow, and extends down into the lower exhaust-chamber 16, as shown at 16'.

In the preferred construction, the two movable contact-members 11M and 12M are mounted within a metallic moving-contact assembly or housing 17 which is in the form of two concentric cylinders, namely an inner cylinder 17*i* and an outer cylinder 17*o*, so as to provide an annular space or an enclosed interrupting chamber 17*s* between these cylinders, through which the air-blast may pass.

The moving-contact housing 17 is vertically spaced from the lower exhaust-chamber 16 by means of an insulating tube 18, which supports the outer cylinder 17*o*, and which is larger than the lower stationary contact-member 11S, so as to provide an annular space 18*s* therearound, through which the air-blast may pass. In order to guide the air-blast from the blast-tube 2 into the annular space 18*s*, the lower exhaust-chamber 16 is provided with a funnel-like air-guiding duct 19, which is spaced from the lower end 16' of the lower stationary contact-member 11S, so as to provide an annular space 19*s* through which the air-blast may pass, in moving upwardly from the blast-tube 2 into the annular space 18*s*.

The upper stationary contact-member 12S is integrally or electrically united with an upper exhaust-chamber 20, which is similar to the lower exhaust-chamber 16, except that it lacks the funnel or duct 19 for carrying the blast-air upwardly on through the upper exhaust-chamber 20. The upper stationary contact-member 12S is likewise of hollow construction, and its upper end is in communication with the space within the upper exhaust-chamber 20. This upper exhaust-chamber 20 is supported on the top end of an insulating tube 21, which is similar to the tube 18, except that the lower end of the top insulating tube 21 rests on top of the outer cylinder 17*o* of the moving-contact housing 17. This upper insulating tube 21 is also larger than the upper stationary contact-member 12S, so as to provide an annular space 21*s* which forms a closed upper end for the blast-air, as this blast initially moves upwardly through the interrupter-assembly 10.

In the construction which is very much preferred, as illustrated, the upper end of the lower stationary contact-member 11S, and the lower end of the upper stationary contact-member 12S are each provided with a centrally disposed orifice 22, which is normally closed by the cooperating movable contact-member 11M or 12M, as the case may be. The configuration of these movable contact-members 11M and 12M is such that the pressure of the blast-air operates on these movable contact-members 11M and 12M to press them back away from their respective stationary contact-members 11S and 12S, thus making the gap-devices 11 and 12 self-opening, that is, making them open automatically, by themselves, as soon as a sufficient gas-pressure is built up in the spaces around them, without requiring any other device, not a part of the moving-contact assembly 17, for causing a separating-movement of the movable contact-members 11M or 12M. This opening-movement of the movable contact-members 11M and 12M draws arcs between said members and their associated stationary contact-members 11S and 12S, respectively, thus initiating a circuit-interrupting operation of the breaker.

As soon as each movable contact-member 11M or 12M moves away from its normal contact-making engagement with the end of its associated stationary contact-member 11S or 12S, as the case may be, it uncovers the orifice 22 in the hollow stationary contact-member 11S or 12S, thus permitting a blast of air to move longitudinally, or in a vertical direction, through the orifice 22 and thence through the hollow stationary contact-member 11S or 12S, and thus acting powerfully to extinguish the arc between the movable and stationary contact-members. The upper end of the hollow upper stationary contact-member 12S dumps its air directly into the upper exhaust-chamber 20, and the lower end of the lower hollow stationary contact-member 11S exhausts its blast of air into the lower exhaust-chamber 16 by means of a plurality of tubular openings 23, which pass through the lower end 16′ of the hollow lower stationary contact-member 11S, and also through the funnel or duct 19 in the lower exhaust-chamber 16.

These upper and lower exhaust-chambers 20 and 16 thus provide an expansion-space in which the longitudinally moving air-blasts within the two stationary contact-members 11S and 12S may accumulate during the brief time which is required for a complete circuit-interruption. It may take the blast something like ¼ cycle, (assuming a 60-cycle line), before the arcing-contacts begin to separate, and then a time something like ¾ cycle for the maximum contact-separation to be achieved. Then the arc may hang on for an additional time which may be slightly longer than the longest current-flow period or half-cycle which could be expected under asymmetric-wave conditions. It is desirable for the arc to be interrupted at or before the first important current-zero, (or sometimes possibly the second one), after full contact-separation has been achieved, disregarding, (as unimportant from an arc-interrupting standpoint), any current-zero which may occur very soon after full contact-separation is obtained. Then it is desirable to prevent a restriking of the arc on the next half-cycle, and to this end it is necessary to have a large quantity of air-movement, a high air-velocity, high turbulence, and cooling, or a combination of these factors. And then, in subsequent half-cycles, it is desirable to continue to have a sufficient dielectric strength of the air in the arcing-gap, so as to prevent any subsequent arc-restriking, and for this purpose, the air-pressure of the once-deionized and cooled gap-air is of service in providing dielectric strength to prevent a later breakdown of the gap.

Our upper and lower exhaust-chambers 20 and 16 provide the gas-pressure in the gap-space. The initial blast must be maintained until at least the first (or second) important current-

zero after full gap-separation has been reached, but when the back-pressure in these exhaust-chambers reaches as much as something like 50% of the pressure at the high-pressure side of the orifice or arcing-gap, the blast no longer travels at approximately the speed of sound, but begins to slow down. The size of the exhaust-chambers 16 and 20 should be such, therefore, that this 50% air-pressure should not be built up therein until after the above-mentioned important current-zero. To provide a reasonable factor of safety, we prefer to have this 50% pressure occur within about 2½ cycles after the opening of the blast-valve 5.

However, it is important that these exhaust-chambers 16 and 20 should be present, and that they should develop an important back-pressure after said period of 2½ cycles or the like, and it is important that these exhaust-chambers should be able to hold their back-pressures for a few half-cycles, or until a serially connected isolating-switch 26 can be opened, as will subsequently be described. During this time, when a substantial back-pressure is being held in the exhaust-chambers 16 and 20, the blast-valve 5 must be kept open, as will readily be understood.

The air which accumulates in the two exhaust-chambers 16 and 20 is cooled, in these chambers, and is slowly dissipated to the atmosphere, through suitable exhaust-openings 24, which are provided in each of the exhaust-chambers 16 and 20, and which may be provided with any desirable muffling or sound-deadening or flame-extinguishing means (not shown), as is well understood in the compressed-air circuit-breaker art.

Since the movable contact-members 11M and 12M are opened by the air-pressure which is exerted by a large body of fast-moving air, in a blast which moves at a velocity approximating the velocity of sound, it is impractical to sustain such a large movement or blast of air for any considerable length of time. It is necessary, therefore, to close the blast-valve 5 very quickly after it is opened, so as to conserve the high-pressure air or gas which is stored in the tank or reservoir 1. Consequently, after a circuit-interrupting operation by the isolating-switch 26, the blast-valve 5 is reclosed, and therefore the two movable contact-members 11M and 12M close again into contact with their respective stationary contact-members 11S and 12S, so that these contact-members thereafter remain closed throughout the time when the circuit should remain interrupted. It is necessary, therefore, as in the case of previously known self-opening, longitudinal-blast, orifice-type circuit-breakers, to provide the previously mentioned isolating-switch 26 which is electrically connected in series with the interrupter-assembly 10.

We also provide a second vertically disposed insulating column 27, which is spaced from the blast-tube 2, and which also extends upwardly above the top of the tank 1, so that it is supported by the tank, although it is not in pneumatic communication with the air within the tank 1. This second insulating column 27 is surmounted by a metal terminal-member 28, which is provided with a line-terminal 29, so as to provide the second line-terminal of the breaker-assembly, the first line-terminal being the terminal 15 at the top of the interrupter-assembly 10. The isolating-switch 26 is movable so as to close or open an electrical circuit between this metal terminal-member 28 at the top of the second insulating column 27, and the bottom 14 or 16 of the interrupter-assembly 10 which is mounted at the top of the insulating blast-tube 2. In the illustrated construction, the isolating switch 26 is pivotally connected to the lower exhaust-chamber 16, as indicated at 30, and its free end is movable into and out of contact with suitable contact-fingers 31 carried by the metal terminal-member 28.

It is also a feature of the type of breaker to which our invention is applicable, that an operating-mechanism is provided, as diagrammatically indicated at 33, in a location which is on, or close to, the tank 1, and which is at substantially the same electrical potential as the tank, which would normally be grounded. Thus, this operating-mechanism 33 is physically and electrically at the ground-level, which is of considerable advantage from the standpoint of the amount and size of the equipment which must be insulatedly supported, up in the air, as by the two insulating supporting-columns 2 and 27. The operating-mechanism 33 is operatively joined to the switch 26 through an insulating switch-operating rod 34, for opening and closing the isolating-switch 26.

The operating-mechanism 33 may be controlled in any desired manner, so that it will open the isolating-switch 26, and lock it open, after the completion of the arc-interruption during the opening-operation of the interrupter-assembly 10, and before the two movable contact-members 11M and 12M are spring-closed again, after a reclosure of the blast-valve 5. In the particular design illustrated, the operating-force, and the timing, for the operating-mechanism 33 are both provided by a small tube or pipe 35, which is in communication with the lower end of the insulating blast-tube 2, or the upper end of the internal tube-means 3 in the tank 1. When the blast-valve 5 first opens, the air or blast is moving upwardly very rapidly in the blast-tube 2, so that its static air-pressure is relatively small. This blast travels upwardly, at a velocity approximating the velocity of sound, until its upward movement is halted, by the top of the upper annular space 21*s*, or otherwise, and then pressure begins to be built up in this blast-air space, serving first to open the two movable contact-members 11M and 12M, after which said air-pressure builds back downwardly, until the level of the top of the tank 1 is reached, at which time a sufficient air-pressure is applied, through the tube 35, to begin to initiate the operation of the operating-mechanism 33. The inertia of the operating-mechanism 33, the insulating connecting rod 34, and the isolating switch 26 is such that the isolating-switch 26 breaks its contact with the contact-fingers 31 after the arcs have been interrupted by the longitudinally flowing gas-blast in the two interrupter-gap devices 11 and 12.

The specific construction of our novel double-gap single-column interrupter-assembly 10 is shown in Fig. 3, which represents a preferred form of embodiment, for illustrative purposes. The outer cylinder 17*o* of the moving-contact assembly or housing 17, which was shown in Fig. 1, is shown, in Fig. 3, as a stationary open-sided, open-ended box-like housing-member having integrally cast, ring-shaped, top and bottom members 17T and 17B, which provide the abutment-members for the upper and lower insulating-tubes 21 and 18, respectively. Two opposite sides, or quadrants, of the cylindrical part 17*o* of this housing 17 are open, as shown in Fig. 3, the right-hand open side being closed by a cover 17C, while the left-hand open side is closed by a flange 36 of a removable contact-supporting casting 37 which has a cylindrical part 38 which is substantially coaxial with respect to the insulating tubes 18 and 21 of the interrupter-assembly. This cylinder part 38 corresponds to the outer surface of the inner cylinder 17*i* in Fig. 1.

Fixedly but removably secured, in coaxial spaced relation within the cylindrical part 38 of the removable contact-supporting casting 37, is a copper-alloy contact-carrying sleeve or cylinder 39, which corresponds to the inner surface of the inner cylinder 17*i* in Fig. 1. Thus, the space outside of the cylindrical part 38 of the removable casting 37, is the annular air-blast space or enclosed interrupting chamber 17*s*, as described in connection with Fig. 1, while the space inside of the contact-carrying sleeve 39 is occupied by the upper and lower movable arcing-contact members 12M and 11M, and their biasing-springs 12B and 11B, respectively. The copper-alloy contact-carrying sleeve 39 thus carries the current between the upper and lower moving arcing-contacts 12M and 11M. The contact-carrying sleeve 39 is smaller, in diameter, than the cylindrical part 38 of the removable casting 37, so that there is a space 40 therebetween. The contact-carrying sleeve 39 is held fixedly in position, by means of a sort of flanged and grooved bayonet-joint 41, which is held, in assembled position, by a suitable set-screw 42.

Disposed within the space 40 between the two cylindrical parts 38 and 39 of the removable moving-contact assembly, we show upper and lower annular finger-cases or contact-holders 43U and 43L, respectively, which house upper and lower main moving contacts 44U and 44L, respectively, which consist of clusters of copper-alloy segments which are held in said contact-holders so as to form self-contained units. These contact-holders 43U and 43L are pressed outwardly or away from each other, by means of springs 45U and 45L, respectively, which normally cause the tips of the main contact-fingers 44U and 44L to be pressed into engagement with the ends of the respective stationary contact-members 12S and 11S.

Each of the main contact-fingers 44U and 44L is provided with two springs, namely a radially operating spring 46 and a longitudinally operating spring 47. The radially operating spring 46 presses a side of the front end of the finger into good contact-making, sliding, engagement against the outer cylindrical surface of the movable arcing-contact member 12M or 11M, as the case may be. At the same time, said radial spring 46 also presses a side of the rear end of the contact-finger against the outer surface of the contact-carrying sleeve 39. The longitudinally operating spring 47 is mounted in the rear end of each of the contact-fingers 44U and 44L, so as to individually press each finger longitudinally or axially toward the end of the corresponding stationary contact-member 12S or 11S, as the case may be, so that each finger makes an individual spring-pressed contact-engagement with the associated stationary contact-member, regardless of any irregularity or lack of parallelism in either the contact-surface of the stationary contact-member 12S or 11S, or the finger-case 43U or 43L.

The top or upper finger-case or contact holder 43U has an outwardly extending flange 50 which extends partway into the lower part or mouth of the upper insulating tube 21, or into the opening in the top plate 17T of the moving-contact housing 17, so as to provide a restricted annular space 51, when the upper contacts are in their closed position, as shown in Fig. 3. Thus, when the blast-valve 5 (Fig. 1) opens, compressed air rapidly fills the annular space A around the bottom contacts 44L, in Fig. 3, and also the space B under the flange 50 of the top contact-holder 43U. Air-flow to the space C surrounding the upper contacts 44U is restricted by this flange 50, so that the air-pressure in this upper space C builds up more slowly than the air-pressure in the intermediate space B. As a result, the top contact-holder 43U is initially forced upwardly, by the inrushing air, so that the upper contacts 44U remain tightly closed.

When the upward inrush of air, resulting from the opening of the blast-valve 5 in Fig. 1, is halted by the flange 50, the air-pressure begins to build up, starting with the intermediate space B under this flange, and backing on downwardly to the space A which surrounds the lower contacts 44L. This air-pressure in the space A quickly reaches a value sufficient to force the lower finger-case or contact-holder 43L upwardly against the force of its spring 45L. When the lower contact-holder 43L has moved but a short distance, it makes a hook-connection with its cluster of contact-fingers 44L, as shown at 52, and begins to raise these main contact-fingers 44L away from the stationary contact-member 11S, leaving the current to be carried momentarily by the moving arcing-contact member 11M, which is still in contact with the stationary contact-member 11S. As the main contact-fingers 43L continue to move upwardly, however, under the influence of the air-pressure in the space A, they soon make a hook-connection, at 53, with the movable arcing-contact member 11M, thus beginning to move this movable arcing-contact member 11M upwardly away from contact with the tip of the associated contact-member 11S.

This draws an arc, which bridges the gap separating the tip of the stationary contact-member 11S and the upwardly moving lower movable arcing-contact 11M. The air-blast immediately rushes radially inwardly across this arcing gap, under the influence of the air-pressure in the space A, and this blast of air then moves downwardly through the orifice 22 in the lower stationary contact-member 11S, and escapes longitudinally downwardly through the hollow stationary contact-member 11S, to finally exhaust itself, first into the lower exhaust-chamber 16, and thence, through the exhaust-openings 24, into the surrounding atmosphere, as has been explained in connection with Fig. 1.

In accordance with our invention, each of the stationary contact-members 11S and 12S is provided with a concentrically disposed arc-terminal 54 which is centrally held, by a suitable spider-construction 54′, inside of the hollow stationary contact-member 11S or 12S, as the case may be, so as to provide a suitable, fairly uniform, air-blast space for the passage of the air-blast between the arcing tip of the arc-terminal 54 and the orificed tip of the hollow stationary contact-member, and also between the sides of the arc-terminal 54 and the hollow inner sides of the stationary contact-member. The blast of air, rushing radially inwardly across the tip of the lower stationary contact-member 11S, and then longitudinally downwardly through the orifice 22 in this member, carries the arc downwardly and causes it to become affixed to the top of the arc-terminal 54, as shown in Fig. 3.

This arc-terminal 54 is provided with a central, longitudinally extending hole 55, the top end of which is preferably enlarged or rounded, so as to cause the arc 56 to play for a short distance within this hole 55, thus causing the end of the arc to remain centrally fixed over the hole 55, instead of playing over to one side of the arc-terminal 54, and thus causing excessive burning and asymmetrical air-flow, which would interfere with the proper arc-extinguishing functions. The longitudinal hole 55 through the arc-terminal 54 permits a small amount of air to flow longitudinally through this hole, enough to hold the arc centered on the hole, thus permitting the longitudinally flowing air-blast to flow equally on all sides of the lower end of the arc 56, and thus exercising a maximum amount of cooling, and deionizing, and arc-extinguishing influence on the arc.

The design of the restricted annular space 51 which surrounds the upper contact-holder 43U is such that the air which escapes upwardly through this restricted space, from the space B to the space C, requires about 0.8 cycle before it builds up sufficient air-pressure, in the space C, to overcome the combined upward thrusts of the air-pressure in the space B and the spring 45U of the upper contact-holder 43U. Consequently, this upper contact-holder begins to move downwardly, in a contact-opening direction, approximately 0.8 cycle after the lower contact-holder 43L began to move upwardly, in its contact-opening movement, or say between ½ cycle and 1 cycle thereafter. Thereafter the order of movement of the parts, in the opening of the upper movable arcing-contact 12M, is essentially the same, in principle, as has been described for the lower movable arcing-contact 11M, and the description need not be repeated. The upper stationary contact-member 12S is also provided with an arc-terminal 54 which is essentially similar to the arc-terminal 54 which has already been described in connection with the lower stationary contact-member 11S.

It should be noted that the throttling opening, or restricted annular space 51, between the flange 50 of the upper contact-holder 43U, and the mouth of the upper insulating tube 21, is enlarged as soon as there is movement of the upper contact-holder 43U, thus removing all restrictions to the free flow of air. This construction has the important advantage that the opening of the second set of contacts, that is, the upper movable contacts, is definite, very fast, and independent of the length of the time-delay.

The reason for the provision of a construction which causes a time-delay in the opening of one of the two serially connected gaps of our breaker-assembly, is because it was found impossible to satisfactorily interrupt an arcing-current of more than 15,000 to 20,000 amperes at 44,000 volts, if both of the gaps were opened simultaneously. It is an important feature of our invention, that the two gaps are opened sequentially, and that the first-opening gap shall be shunted by a suitable shunting-impedance Z, which is diagrammatically indicated in Fig. 3. This shunting-impedance Z makes it possible for the lower gap to interrupt arcing-currents as high as 37,000 amperes at 44,000 volts, even when the current is supplied by a line (not shown) having considerable charging-current, or having considerable transformer-magnetizing current therein. The effect of the shunting impedance is to delay the rate of recovery-voltage across the impedance-shunted, first-opening gap, after a current-zero, so that, in general, the arc will not restrike, in this impedance-shunted gap, in the half-cycle following the first current-zero after full gap-separation has been attained. As a result of this construction, the first-opening gap 11 will have substantially interrupted its arc before the second-opening gap 12 will be called upon to begin to extinguish its arc.

Thus, when the arc is extinguished in the first-opening gap 11, within from 0.5 to 0.8 cycle after full contact-separation has been attained, the fault-current is caused to flow through the shunting-impedance Z, thus reducing the value of the fault-current to a relatively small value which can easily be handled by the second-opening gap 12, even without any shunting-impedance around the second-opening gap. Because the current to be interrupted in this second-opening gap 12 is always of a low order, it is possible to increase the length of the gap-opening of this second-opening gap, without deleteriously affecting its current-interrupting ability. This is of great importance, when interrupting either line-charging currents, or magnetizing currents, when the value of the recovery-voltage may reach very high peaks, so that the air-gap dielectric-strength must be increased to a maximum, in order to prevent restriking of the arc in this second-opening gap 12, after a current-zero.

In our preferred design, as shown, our lower gaps 11, or high-current-interrupting arcing-contacts 11M, separate approximately ⅝ inch, while our upper gaps 12, or our upper movable arcing contacts 12M, separate approximately 1⅜ inch. The corresponding orifice-openings, for the orifice 22 in the stationary contact-members 11S and 12S, are approximately 1¾ inch diameter for the orifice 22 in the lower stationary contact-member 11S, and approximately 1½ inch diameter for the orifice 22 in the upper stationary contact-member 12S.

Since the air-passage to the upper space C is initially substantially shut off, by the restricted annular space 51, the total initial air-flow is concentrated on the interruption of the high-current arc which plays on the bottom contacts. By the time the top contacts open, the lower exhaust-chamber 16 (Fig. 1) is partly filled, so that the velocity of air-flow in the lower gap begins to decrease, thus making available an increasingly large amount of air-flow which is directed toward the upper contacts and the interruption of the current which flows through the shunting impedance Z. This has the combined effect of improving the interrupting capacity of the breaker, and conserving the compressed air.

In order to prevent the accumulation of internal air-pressures, inside of the moving-contact assembly, which might interfere with the uniform operation of the device, the internal space within the contact-carrying sleeve 39, may be vented by a radial vent 59 through the wall of this contact-sleeve, as indicated; while the space 40 between the contact-sleeve 39 and the cylindrical part 38 may be vented to the outer atmosphere, through a suitable vent 60 in the removable contact-supporting casting 37, as indicated in Fig. 3.

The removable moving-contact assembly can be removed by unfastening the flange 36 of the removable contact-supporting casting 37 from the side of the box-like stationary contact-support 17, after a suitable tong-shaped tool 62 has been inserted in an opening which is provided in the flange 36, and used to force the moving contacts to their open-circuit positions. This tool 62 may fit in, on either side, or on both sides, of the cylindrical part 38 of the removable casting 37, so as to engage hooks 63 which are provided on the upper and lower contact-holders 43U and 43L. The necessary pressure for the compression of the several springs within the moving contact-assembly is provided by a screw 64, in the handle of the tool 62, which makes it possible to contract the movable parts into their full-open position.

It will be noted that the tips of the two stationary contact-members 11S and 12S are spaced back, a slight distance, behind the ends of the corresponding insulating tubes 18 and 21, and that the main and arcing moving-contacts normally project out beyond the respective ends of their guiding-sleeves, so as to make contact with these back-set tips of the respective stationary contacts. Consquently, when the moving contacts are compressed to their open positions, the entire moving-contact assembly, which is carried by the removable contact-supporting casting 37, can be moved laterally out of the box-like housing 17.

As this movable contact-assembly is somewhat heavy for one man to handle, the cover 17C has been provided, for the other side of the box-like housing 17, not only for inspection-purposes, but also so that, when this cover 17C is removed, a rod or handle 65 may be attached to that side of the removable casting 37, so that two men may easily remove the removable assembly.

The destructive swaging of the abutment-parts, which limit the movement of the fast-moving parts of our breaker, has heretofore been quite a problem, resulting in excessive deformation of the parts, as well as undesirable noise. These difficulties have been avoided by the use of suitable damping-means or shock-absorbers, interposed between the abutments which limit the opening-movements of the various parts, and the most suitable damping-means, for this purpose, has been found to be a large number of extremely thin metal damping-washers 67, a suitable stack of which is interposed between each of the abutment-surfaces which limit the opening-movements of the contact-holders 43U and 43L, and also the opening movements of the two movable arcing-contacts 11M and 12M.

The movable arcing-contacts 11M and 12M are provided with centrally disposed arcing-tips 69, made of a suitable arc-terminal metal, such as a mechanical mixture of tungsten and silver or a mechanical mixture of tungsten and copper, as is known in the art. These metal inserts carry the arc-terminal during most of the arcing time, that is, during most of the time before the current-zero at which the arc is interrupted, as indicated in the lower gap in Fig. 3.

The operation of the device has been indicated as the description has proceeded. It will be observed that the main contact-fingers 44U and 44L are disposed in shielding-relationship with respect to the movable arcing-members 12M and 11M, so as to shield the latter from receiving the effects of the air-pressure until the main contacts have separated. This prevents an arc from being drawn on the tips of the main contacts, which would roughen them and destroy their ability to carry large currents without overheating, in the closed position of the breaker. If, however, for any reason, an arc should form on the main contacts, it will be noted that these contacts are in the air-stream, which will immediately blow such an arc off of the main contacts, and transfer it onto the movable arcing-contacts, where it belongs.

In the closing movement of the breaker, the same construction which causes the main contacts to open first, causes the arcing-contacts to close first, so that the main contacts are protected against the arcs which might be formed as the zero-gap point approaches, near the end of the closing-movement, particularly when our invention is applied to a quick-reclosing breaker.

It is believed that the other features of our invention have been sufficiently well described as the description has proceeded.

Various details of the breaker-assembly, which is herein generically or broadly described and claimed, are described and claimed in more detail in other copending applications. Thus, the general combination, including the blast-valve **5**, is claimed in the previously mentioned Baker-Wilcox application. Certain improvements and novel features of the pneumatic operating assembly, including the operating mechanism **33**, insulating switch-operating rod **34**, isolating-switch **26**, pneumatic controlling-means including the tube **35**, and an interlocking-means (not here shown) for automatically reclosing the blast-valve **5** when the isolating-switch **26** has completed enough of its opening-movement, are shown and claimed in a copending application, Serial No. 73,516, filed January 29, 1949, by Baker and Wilcox. And finally, certain structural details of the interrupter-assembly **10**, for mechanically holding the parts of this assembly together, are shown in more detail, and specifically claimed, in a copending application, Serial No. 74,407, filed February 3, 1949, now U. S. Patent 2,602,868, issued July 8, 1952, to Benjamin P. Baker, Erling Frisch, and Howard M. Wilcox.

While we have described and illustrated our invention in but a single illustrative form, which is shown somewhat diagrammatically or ideally, we wish it to be understood that we are not limited to the precise form which is illustrated, as those skilled in the art could readily make various changes of substitution, omission or addition, without departing from the essential spirit of our invention. We desire, therefore, that the appended claims shall be accorded the broadest construction consistent with their language.

We claim as our invention:

1. An interrupter-assembly for a compressed-air circuit-breaker comprising: an enclosed interrupting chamber, a hollow elongated stationary contact-member disposed within said chamber having an orifice in its front end; a substantially closed exhaust-chamber at the rear end of said stationary contact-member in air-communication with its hollow interior; a moving-contact assembly comprising a spring-closed, longitudinally movable contact-member normally abutting against the front end of said stationary contact-member and in such position substantially covering said orifice; and means for, at times, supplying a blast of compressed air to the enclosed interrupting chamber surrounding the abutting ends of the two contact-members; said exhaust-chamber having means for permitting a slow air-exhaustion therefrom and thereby preventing free venting of the enclosed interrupting chamber to atmosphere during the time of contact separation and having a capacity such as to build up, in said exhaust-chamber, a pressure equal to about 50 percent of the pressure in the enclosed interrupting chamber surrounding the normally abutting ends of the two contact-members in a time not much longer than the time necessary for the moving member to move back to full contact-gap-separation under the influence of the air-pressure of the applied air-blast and for the longitudinally flowing air-blast in the orifice to extinguish the resulting arc.

2. A multigap breaker comprising at least two interrupter-assemblies, each interrupter-assembly comprising: an enclosed interrupting chamber, a hollow elongated stationary contact-member disposed within said chamber having an orifice in its front end; a substantially closed exhaust-chamber at the rear end of said stationary contact-member in air-communication with its hollow interior; a moving-contact assembly comprising a spring-closed, longitudinally movable contact-member normally abutting against the front end of said stationary contact-member and in such position substantially covering said orifice; and means for, at times, supplying a blast of compressed air to the enclosed interrupting chamber surrounding the abutting ends of the two contact-members; said exhaust-chamber having means for permitting a slow air-exhaustion therefrom and thereby preventing free venting of the enclosed interrupting chamber to atmosphere during the time of contact separation and having a capacity such as to build up, in said exhaust-chamber, a pressure equal to about 50 percent of the pressure in the enclosed interrupting chamber surrounding the normally abutting ends of the two contact-members in a time not much longer than the time necessary for the moving member to move back to full contact-gap-separation under the influence of the air-pressure of the applied air-blast and for the longitudinally flowing air-blast in the orifice to extinguish the resulting arc, the blast-supplying means being such as to apply an effective contact-separating air-pressure to one of the interrupter assemblies early enough before the other interrupter-assembly so that the first-opening gap will have substantially interrupted its arc before the second-opening gap will be called upon to begin to extinguish its arc, said two interrupter assemblies being electrically connected in series circuit relation, in combination with a shunting-impedance electrically connected in shunt around the first-opening gap.

3. A multigap breaker comprising an enclosed interrupting chamber, at least two interrupter-assemblies disposed within said chamber; each comprising a hollow elongated stationary contact-member having an orifice in its front end, a moving-contact assembly comprising a contact-carrying sleeve, a spring-closed, longitudinally movable contact-member carried by said sleeve, said stationary contact-member and said sleeve being in substantial alignment, the movable contact-member normally abutting against the front end of said stationary contact-member and in such position substantially covering said orifice, said two interrupter assemblies being electrically connected in series circuit relation; in combination with means for, at times, supplying a blast of compressed air to said enclosed interrupting chamber, the blast-supplying means being such as to apply an effective contact-separating air-pressure to one of the interrupter

assemblies early enough before the other interrupter-assembly so that the first-opening gap will have substantially interrupted its arc before the second-opening gap will be called upon to begin to extinguish its arc, a substantially enclosed exhaust chamber in pneumatic communication with at least one of the hollow stationary contact members and thereby preventing free venting of the gas blast to atmosphere during the time the contacts are separated, and a shunting-impedance electrically connected in shunt around the first-opening gap.

4. A multigap breaker comprising at least two interrupter-assemblies, each interrupter-assembly comprising: an enclosed interrupter chamber, a hollow elongated stationary contact-member disposed within said chamber having an orifice in its front end; a substantially closed exhaust-chamber at the rear end of said stationary contact-member in air-communication with its hollow interior; a moving-contact assembly comprising a spring-closed, longitudinally movable contact-member normally abutting against the front end of said stationary contact-member and in such position substantially covering said orifice; and means for, at times, supplying a blast of compressed air to the enclosed interrupting chamber surrounding the abutting ends of the two contact-members; said exhaust-chamber having means for permitting a slow air-exhaustion therefrom and thereby preventing free venting of the enclosed interrupting chamber to atmosphere during the time of contact separation and having a capacity such as to build up, in said exhaust-chamber, a pressure equal to about 50 percent of the pressure in the enclosed interrupting chamber surrounding the normally abutting ends of the two contact-members in a time not much longer than the time necessary for the moving member to move back to full contact-gap-separation under the influence of the air-pressure of the applied air-blast and for the longitudinally flowing air-blast in the orifice to extinguish the resulting arc, the blast-supplying means being such as to apply an effective contact-separating air-pressure to one of the interrupter assemblies early enough before the other interrupter-assembly so that the first-opening gap will have substantially interrupted its arc before the second-opening gap will be called upon to begin to extinguish its arc, said two interrupter assemblies being electrically connected in series circuit relation, in combination with a shunting-impedance electrically connected in shunt around the first-opening gap, the second-opening moving contact-member having a materially longer gap-separation than the first.

5. A multigap breaker comprising an enclosed interrupting chamber, at least two interrupter-assemblies disposed within said chamber, each comprising a hollow elongated stationary contact-member having an orifice in its front end, a moving-contact assembly comprising a contact-carrying sleeve, a spring-closed, longitudinally movable contact-member carried by said sleeve, said stationary contact-member and said sleeve being in substantial alignment, the movable contact-member normally abutting against the front end of said stationary contact member and in such position substantially covering said orifice, said two interrupter assemblies being electrically connected in series circuit relation; in combination with means for, at times, supplying a blast of compressed air to said enclosed interrupting chamber, the blast-supplying means being such as to apply an effective contact-separating air-pressure to one of the interrupter assemblies early enough before the other interrupter-assembly so that the first-opening gap will have substantially interrupted its arc before the second-opening gap will be called upon to begin to extinguish its arc, a substantially enclosed exhaust chamber in pneumatic communication with at least one of the hollow stationary contact members and thereby preventing free venting of the gas blast to atmosphere during the time the contacts are separated, and a shunting-impedance electrically connected in shunt around the first-opening gap, characterized by the second-opening moving contact-member having a materially longer gap-separation than the first.

6. A single-column, double-gap, interrupter-assembly for a compressed-air circuit-breaker, comprising, at each end of the assembly, an inwardly extending hollow elongated stationary contact-member having its arcing-end toward the center of the assembly and having an orifice in said arcing-end, an insulating tube surrounding each stationary contact-member in spaced relation thereto to provide an air-space therearound, an open-sided open-ended moving-contact housing disposed in abutting engagement with the inner ends of the respective insulating tubes, a removable contact-supporting member having a flange which closes the open side of said housing and having a contact-carrying sleeve which is disposed substantially coaxially with respect to said insulating tubes, a longitudinally movable contact-member carried by each end of said contact-carrying sleeve, a biasing-spring tending to press each movable contact-member out of said sleeve and normally holding each movable contact-member in contact with the arcing-end of the associated stationary contact-member, and air-blast means for, at times, supplying a contact-opening and arc-extinguishing blast of compressed air to the space between one of said insulating tubes and its associated stationary contact-member.

7. An interrupter-assembly for a compressed-air circuit-breaker, comprising a hollow elongated stationary contact-member having an orifice in its front end, a moving-contact assembly comprising, in effect, two spaced concentric cylinders, a movable arcing-contact member longitudinally slidable within the inner cylinder and extending beyond the end thereof, a biasing-spring tending to press said movable arcing-contact member out of said inner cylinder and normally holding said movable arcing-contact member in orifice-closing contact with the front end of said stationary contact-member, a cluster of main contact-fingers surrounding said movable arcing-contact member, each contact-finger having lateral abutting-contact against the outer surface of said inner cylinder, a contact-holder surrounding said cluster of main contact-fingers, said contact-holder being longitudinally slidable within the outer cylinder and extending beyond the end of said outer cylinder, spring-means for yieldably pressing each contact-finger laterally inwardly, a biasing-spring tending to press the contact-holder out of said outer cylinder, enclosure-means for providing a gap-surrounding air-space surrounding the abutting ends of the contact-fingers and the stationary contact-member, and means

for, at times, supplying a blast of compressed air to said gap-surrounding space.

8. An interrupter-assembly for a compressed-air circuit-breaker, comprising a hollow elongated stationary contact-member having an orifice in its front end, a moving-contact assembly comprising, in effect, two spaced concentric cylinders, a movable arcing-contact member longitudinally slidable within the inner cylinder and extending beyond the end thereof, a biasing-spring tending to press said movable arcing-contact member out of said inner cylinder and normally holding said movable arcing-contact member in orifice-closing contact with the front end of said stationary contact-member, a cluster of main contact-fingers surrounding said movable arcing-contact member, each contact-finger having lateral abutting-contact against the outer surface of said inner cylinder, a contact-holder surrounding said cluster of main contact-fingers, said contact-holder being longitudinally slidable within the outer cylinder and extending beyond the end of said outer cylinder, spring-means for yieldably pressing each contact-finger laterally inwardly, a biasing-spring tending to press the contact-holder out of said outer cylinder, enclosure-means for providing a gap-surrounding air-space surrounding the abutting ends of the contact-fingers and the stationary contact-member, and means for, at times, supplying a blast of compressed air to said gap-surrounding space, characterized by said main contact-fingers, when they have moved slightly away from the stationary contact-member, under the influence of the air-blast pressure, having means for making a contact for carrying along the movable arcing-contact member.

9. An interrupter-assembly for a compressed-air circuit-breaker, comprising a hollow elongated stationary contact-member having an orifice in its front end, a moving-contact assembly comprising, in effect, two spaced concentric cylinders, a movable arcing-contact member longitudinally slidable within the inner cylinder and extending beyond the end thereof, a biasing-spring tending to press said movable arcing-contact member out of said inner cylinder and normally holding said movable arcing-contact member in orifice-closing contact with the front end of said stationary contact-member, a cluster of main contact-fingers, each having lateral abutting-contact against the outer surface of said inner cylinder and another lateral abutting-contact with an outer surface of the projecting end of said movable arcing-contact member, beyond the end of said inner cylinder, a contact-holder surrounding said cluster of main contact-fingers, said contact-holder being longitudinally slidable within the outer cylinder and extending beyond the end of said outer cylinder, spring-means for pressing laterally inwardly against the contact-fingers, a separate longitudinally acting spring-means interposed between the rear end of each contact-finger and the contact-holder, another biasing-spring tending to press the contact-holder out of said outer cylinder and normally holding the front ends of said contact-fingers in contact with the front end of said stationary contact-member, enclosure-means for providing a gap-surrounding air-space surrounding the abutting ends of the contact-fingers and the stationary contact-member, and means for, at times, supplying a blast of compressed air to said gap-surrounding space.

10. An interrupter-assembly for a compressed-air circuit-breaker, comprising a hollow elongated stationary contact-member having an orifice in its front end, a moving-contact assembly comprising, in effect, two spaced concentric cylinders, a movable arcing-contact member longitudinally slidable within the inner cylinder and extending beyond the end thereof, a biasing-spring tending to press said movable arcing-contact member out of said inner cylinder and normally holding said movable arcing-contact member in orifice-closing contact with the front end of said stationary contact-member, a cluster of main contact-fingers, each having lateral abutting-contact against the outer surface of said inner cylinder and another lateral abutting-contact with an outer surface of the projecting end of said movable arcing-contact member, beyond the end of said inner cylinder, a contact-holder surrounding said cluster of main contact-fingers, said contact-holder being longitudinally slidable within the outer cylinder and extending beyond the end of said outer cylinder, spring-means for pressing laterally inwardly against the contact-fingers, a separate longitudinally acting spring-means interposed between the rear end of each contact-finger and the contact-holder, another biasing-spring tending to press the contact-holder out of said outer cylinder and normally holding the front ends of said contact-fingers in contact with the front end of said stationary contact-member, enclosure-means for providing a gap-surrounding air-space surrounding the abutting ends of the contact-fingers and the stationary contact-member, and means for, at times, supplying a blast of compressed air to said gap-surrounding space, characterized by said main contact-fingers, when they have moved slightly away from the stationary contact-member, under the influence of the air-blast pressure, having means for making a contact for carrying along the movable arcing-contact member.

11. A single-column, double-gap, interrupter-assembly for a compressed-air circuit-breaker, comprising, at each end of the assembly, an inwardly extending hollow elongated stationary contact-member having its arcing-end toward the center of the assembly and having an orifice in said arcing-end, an insulating tube surrounding each stationary contact-member in spaced relation thereto to provide an air-space therearound, an open-sided open-ended moving-contact housing disposed in abutting engagement with the inner ends of the respective insulating tubes, a removable contact-supporting member having a flange which closes the open side of said housing, said removable contact-supporting member also having, in effect, two spaced concentric cylinders which are disposed substantially coaxially with respect to said insulating tubes, a longitudinally movable arcing-contact member carried by each end of the inner cylinder of said removable contact-supporting member, each movable arcing-contact member being longitudinally slidable within the inner cylinder and extending beyond the end thereof, a biasing-spring tending to press each movable arcing-contact member out of said inner cylinder and normally holding said movable arcing-contact member in orifice-closing contact with the front end of the corresponding stationary contact-member, a cluster of main contact-fingers as-

sociated with each movable arcing-contact member, each contact-finger having a lateral abutting-contact against the outer surface of said inner cylinder, a separate contact-holder surrounding each of said clusters of main contact-fingers, each contact-holder being longitudinally slidable within the outer cylinder and extending beyond the end of said outer cylinder, spring-means for pressing each contact-finger laterally inwardly, a biasing-spring tending to press each contact-holder out of said outer cylinder, air-blast means for, at times, supplying a contact-opening and arc-extinguishing blast of compressed air to the space between one of said insulating tubes and its associated stationary contact-member, each of said contact-holders, when it has moved slightly axially inwardly against the pressure of its biasing-spring, having means for making contact for carrying along its cluster of contact-fingers, each cluster of contact-fingers, when it has moved slightly away from the associated stationary contact-finger, having means for carrying along the associated movable arcing-contact member, and means whereby the two contact-holders may, at times, be squeezed together against the forces of the several biasing-springs, whereby said removable contact-supporting member, with its associated moving contact-members, may be removed as a self-contained unit from said moving-contact housing.

12. A single-column, double-gap, interrupter-assembly for a compressed-air circuit-breaker, comprising, at each end of the assembly, an inwardly extending hollow elongated stationary contact-member having its arcing-end toward the center of the assembly and having an orifice in said arcing-end, an insulating tube surrounding each stationary contact-member in spaced relation thereto to provide an air-space therearound, a moving-contact assembly disposed in abutting engagement with the inner ends of the respective insulating tubes, said moving-contact assembly including a contact-carrying sleeve which is disposed substantially coaxially with respect to said insulating tubes, a longitudinally movable contact-member carried by each end of said contact-carrying sleeve, a biasing-spring tending to press each movable contact-member out of said sleeve and normally holding each movable contact-member in contact with the arcing-end of the associated stationary contact-member, and air-blast means for, at times, supplying a contact-opening and arc-extinguishing blast of compressed air to the space between one of said insulating tubes and its associated stationary contact-member, the entrance to the inner end of the insulating tube opposite to the tube through which the air-blast is supplied being normally, in the closed-contact position, closed to a restricted space by a portion of the movable contact-member at that end of the assembly, whereby said restricted space causes that movable contact-member to receive an adequate contact-separating air-pressure only after the other contact-member has been opened, said second-opening contact-member, when it first begins to open, moving out of said entrance to its associated insulating tube, so that said second-opening movable contact-member thereafter receives a substantially unrestricted air-blast to cause a rapid and positive contact-opening movement and an adequate arc-extinguishing blast.

13. A single-column, double-gap, interrupter-assembly for a compressed-air circuit-breaker, comprising, at each end of the assembly, an inwardly extending hollow elongated stationary contact-member having its arcing-end toward the center of the assembly and having an orifice in said arcing-end, an insulating tube surrounding each stationary contact-member in spaced relation thereto to provide an air-space therearound, an open-sided open-ended moving-contact housing disposed in abutting engagement with the inner ends of the respective insulating tubes, a removable contact-supporting member having a flange which closes the open side of said housing and having a contact-carrying sleeve which is disposed substantially coaxially with respect to said insulating tubes, a longitudinally movable contact-member carried by each end of said contact-carrying sleeve, a biasing-spring tending to press each movable contact-member out of said sleeve and normally holding each movable contact-member in contact with the arcing-end of the associated stationary contact-member, and air-blast means for, at times, supplying a contact-opening and arc-extinguishing blast of compressed air to the space between one of said insulating tubes and its associated stationary contact-member, characterized by the entrance to the inner end of the insulating tube opposite to the tube through which the air-blast is supplied being normally, in the closed-contact position, closed to a restricted space by a portion of the movable contact-member at that end of the assembly, whereby said restricted space causes that movable contact-member to receive an adequate contact-separating air-pressure only after the other contact-member has been opened, said second-opening contact-member, when it first begins to open, moving out of said entrance to its associated insulating tube, so that said second-opening movable contact-member thereafter receives a substantially unrestricted air-blast to cause a rapid and positive contact-opening movement and an adequate arc-extinguishing blast.

14. A single-column, double-gap interrupter-assembly for a compressed-air circuit-breaker, comprising, at each end of the assembly, an inwardly extending hollow elongated stationary contact-member having its arcing-end toward the center of the assembly and having an orifice in said arcing-end, an insulating tube surrounding each stationary contact-member in spaced relation thereto to provide an air-space therearound, an open-sided open-ended moving-contact housing disposed in abutting engagement with the inner ends of the respective insulating tubes, a removable contact-supporting member having a flange which closes the open side of said housing, said removable contact-supporting member also having a cylindrical part which is fixedly united with said flange, said removable contact-supporting member being further provided with a separable contact-carrying sleeve having a sort of removably locked bayonet-joint connection for holding it in spaced coaxial relation within said cylindrical part, said cylindrical part and said contact-carrying sleeve being disposed substantially coaxially with respect to said insulating tubes, a longitudinally movable contact-member carried by each end of said contact-carrying sleeve, spring-means for yieldably pressing each movable contact-member into its normal contact-making position, and air-blast means for, at times, supplying a

contact-opening and arc-extinguishing blast of compressed air to the space between one of said insulating tubes and its associated stationary contact-member.

15. A self-opening, orifice-type, air-blast circuit-interrupter assembly, comprising spring-closed, longitudinally separable arcing-contacts, at least one of which is provided with an orifice which is closed by the other contact in the normal closed position of the assembly, said orificed contact also having a longitudinal passage for the flow of an arc-extinguishing air-blast therein, and means for, at times, supplying a blast of compressed air to the space surrounding said contacts, whereby the air-pressure of said blast causes a contact-separation and then extinguishes the resulting arc, in combination with a cluster of main contact-fingers normally surrounding the space around the separable arcing-contacts so as to partially shield the arcing-contacts from the initial effects of the blast, means for biasing each contact-finger laterally toward a surface of one contact-member of the circuit-interrupter and longitudinally toward a surface of the other contact-member of the circuit-interrupter, the relations between the pneumatic pressure-surfaces and the longitudinally acting closure-springs being such that the main contact-fingers open first, in response to the air-blast, and then the arcing-contacts separate and the blast flows into said orifice and said longitudinal passage after first passing the opened contact-fingers.

16. A self-opening, orifice-type, air-blast circuit-interrupter assembly, comprising spring-closed, longitudinally separable arcing-contacts, at least one of which is provided with an orifice which is closed by the other contact in the normal closed position of the assembly, said orificed contact also having a longitudinal passage for the flow of an arc-extinguishing air-blast therein, and means for, at times, supplying a blast of compressed air to the space surrounding said contacts, whereby the air-pressure of said blast causes a contact-separation and then extinguishes the resulting arc, in combination with a cluster of main contact-fingers normally surrounding the space around the separable arcing-contact so as to partially shield the arcing-contacts from the initial effects of the blast, means for biasing each contact-finger laterally toward a surface of one contact-member of the circuit-interrupter and longitudinally toward a surface of the other contact-member of the circuit-interrupter, the relations between the pneumatic pressure-surfaces and the longitudinally acting closure-springs being such that the main contact-fingers open first, in response to the air-blast, and then the arcing-contacts separate and the blast flows into said orifice and said longitudinal passage after first passing the opened contact-fingers, in combination with a contact-holder surrounding said cluster of main contact-fingers and having a biasing-spring for normally biasing said holder longitudinally toward the closed position of said contact-fingers.

BENJAMIN P. BAKER.
ERLING FRISCH.
WAYNE S. ASPEY.
JOHN B. MACNEILL.

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2,458,240	Baskerville	Jan. 4, 1949
2,491,821	Lerstrup	Dec. 20, 1949