

Aug. 7, 1945.

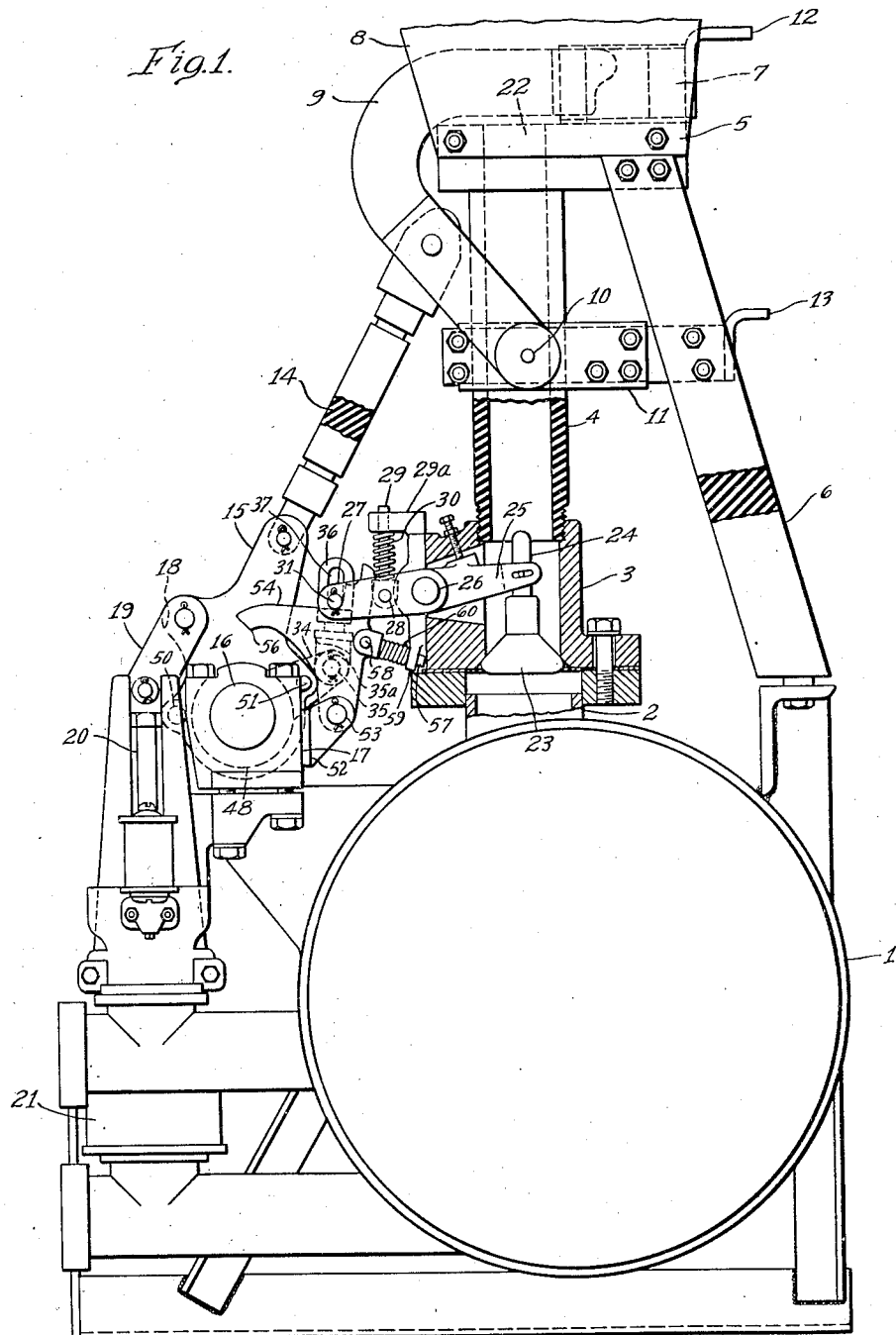
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2,381,353

CIRCUIT INTERRUPTER

Filed Jan. 28, 1943

4 Sheets-Sheet 1



WITNESSES:

C. J. Weller.
W. R. Croft

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Aug. 7, 1945.

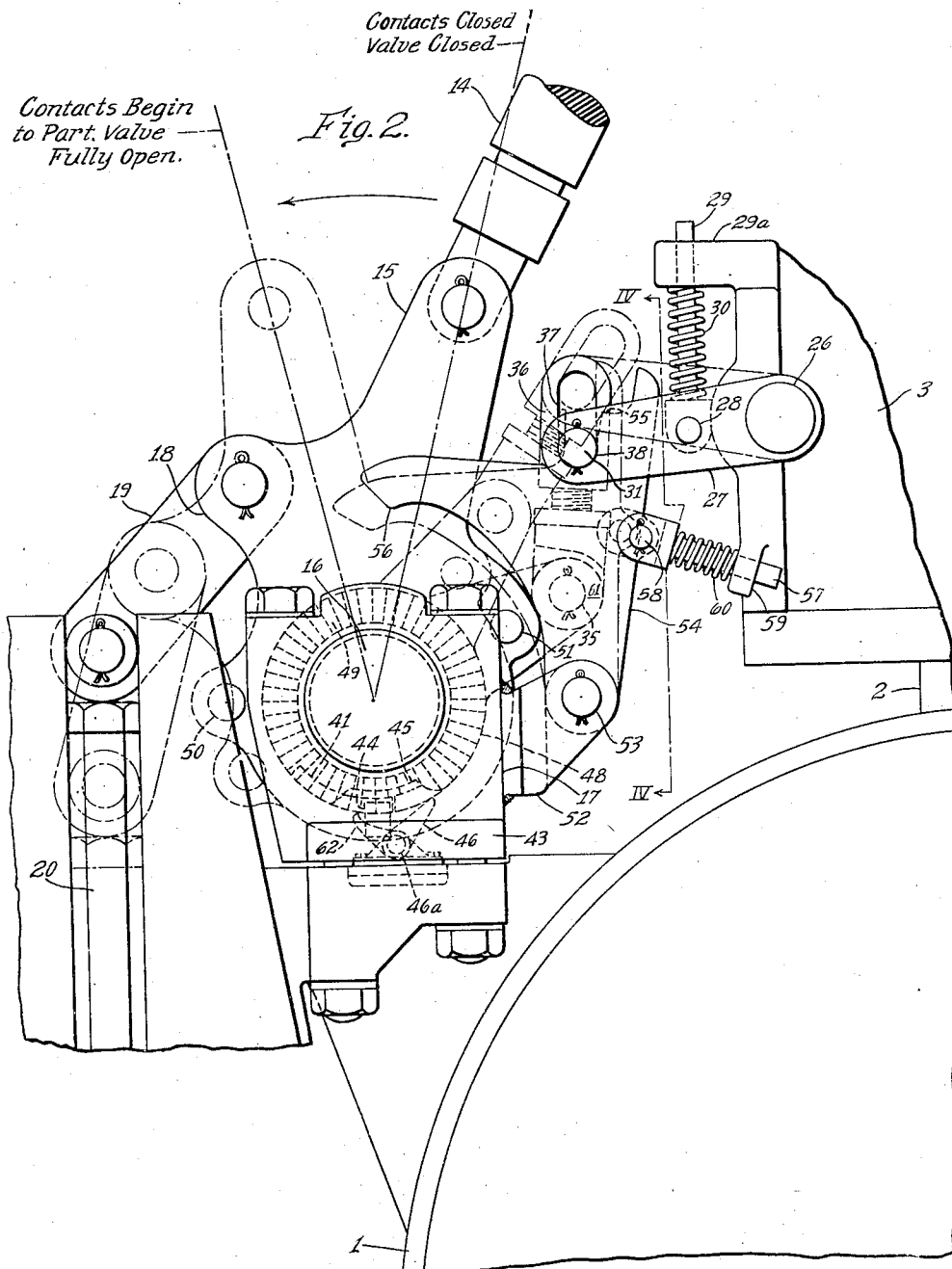
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CIRCUIT INTERRUPTER

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4 Sheets-Sheet 2



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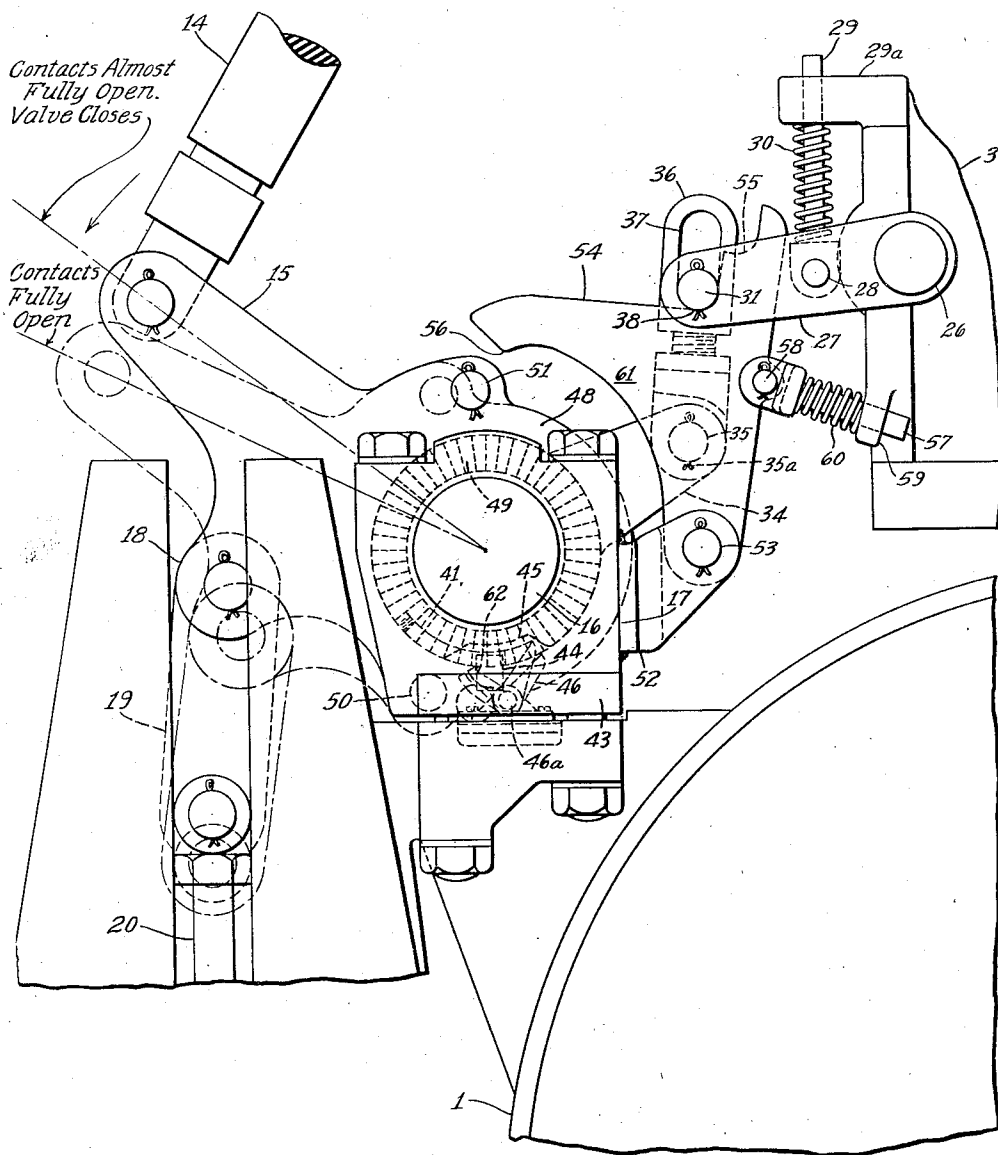
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CIRCUIT INTERRUPTER

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4 Sheets-Sheet 3

Fig. 3.



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4 Sheets-Sheet 4

Fig. 4.

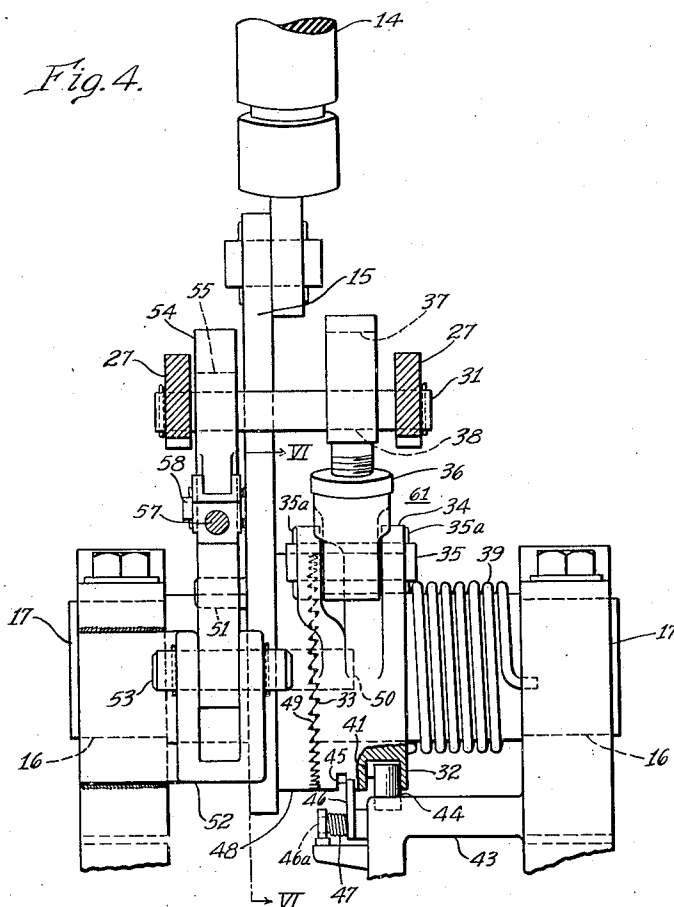


Fig. 7.

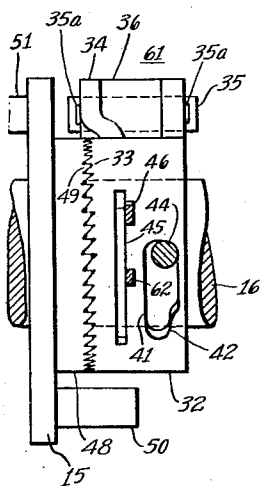


Fig. 5.

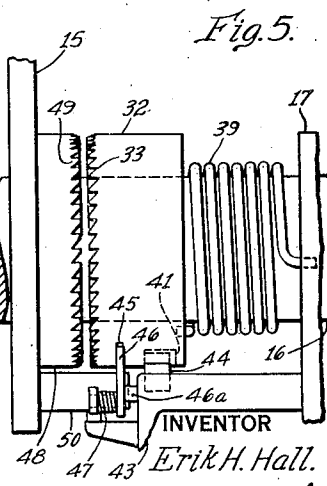
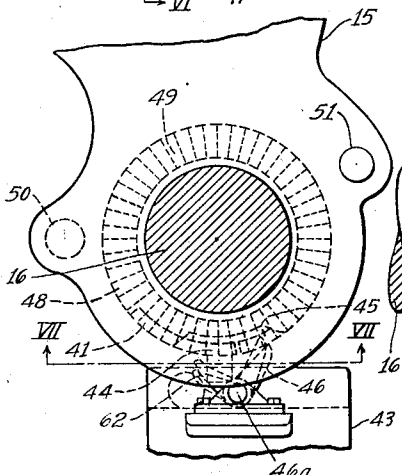


Fig. 6.



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2,381,353

CIRCUIT INTERRUPTER

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Application January 28, 1943, Serial No. 473,823

18 Claims. (Cl. 200—148)

This invention relates to circuit interrupters in general, and, more particularly, to gas blast type circuit interrupters.

More specifically it is an object of my invention to provide an improved operating mechanism for actuating the gas blast valve of a gas blast type of circuit interrupter.

Another object is to provide an improved mechanism which opens the blast valve only during a portion of the opening operation, and which maintains the blast valve closed during a closing operation to conserve the supply of gas.

Another object is to provide an improved valve mechanism which also functions to open the valve immediately upon a reversal of contact motion during a closing operation. Such a reversal of contact motion will occur when the interrupter is attempted to be closed during the existence of overload conditions in the electrical circuit controlled by the interrupter. An arc, carrying the overload current, will then jump between the contacts even before they touch each other, and this arc will trip the breaker mechanism to cause the reversal of contact motion during such a closing operation.

Another object is to provide an improved valve mechanism which utilizes ratchet means to relate the contact motion to the valve motion.

A further object is to provide an improved valve actuating mechanism which employs linkage means to interrelate contact motion with valve motion.

Another object is to provide an improved valve mechanism in which a ratchet coupling rotates in accordance with the contact movement. I provide a cooperable ratchet linked to the valve to positively open the valve during the initial portion of the opening operation of the interrupter. Preferably latching means are provided to maintain the valve open after the cooperable ratchet is disengaged from the ratchet coupling. Near the end of the opening operation I trip the latching means to close the valve.

In a patent application by R. C. Cunningham and B. P. Baker, Serial No. 357,686, filed September 21, 1940, now Patent No. 2,294,824, issued September 1, 1942, and in a patent application by E. H. Hall and R. H. Leitzel, Serial No. 416,360, filed October 24, 1941, now Patent No. 2,310,779, issued February 9, 1943, both of said applications being assigned to the assignee of this application, there are shown and described gas blast valve operating mechanisms which function to open the blast valve during the opening operation of the interrupter and which keep the blast

valve closed during the closing operation of the interrupter to conserve the supply of compressed gas. In the mechanisms described in both the foregoing applications, means are provided to open the blast valve during a closing operation of the interrupter when a reversal of contact mechanism takes place because of an attempt to close the interrupter during the existence of overload conditions in the circuit controlled by the interrupter.

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

Figure 1 is a side elevational view, partly in section, of a gas blast type circuit interrupter embodying my invention and being shown in the closed circuit position;

Fig. 2 is an enlarged side elevational view of the blast valve operating mechanism shown in Fig. 1;

Fig. 3 is an enlarged side elevational view of the blast valve operating mechanism but showing the position of the parts near the end of the opening operation;

Fig. 4 is an enlarged elevational view, partly in section, taken substantially on the line IV—IV of Fig. 2;

Fig. 5 is an enlarged fragmentary elevational view similar to the view shown in Fig. 4, but showing the disposition of the parts when the ratchet collar has disengaged from the ratchet coupling;

Fig. 6 is a fragmentary side elevational view, partly in section, taken substantially on the line VI—VI of Fig. 4; and

Fig. 7 is a fragmentary view taken substantially on the line VII—VII of Fig. 6.

Referring to the drawings, and in particular to Fig. 1, the reference numeral 1 designates a storage tank for storing gas, such as air, under pressure. Extending from the upper end of the storage tank 1 is a relatively short flanged conduit 2 which, in turn, carries a valve casing 3. Secured to the upper end of the valve casing 3 is a tubular insulator 4 which has secured to its upper end an insulating support 5. The insulating support 5 may be given additional support by an insulating member 6. The support 5 carries a stationary contact assembly 7 which, in this instance, is enclosed within an arc extinguishing structure 8, only a portion of which is shown. The arc extinguishing structure 8 may be of conventional form and does not concern the present invention.

Coacting with the stationary contact assembly 7 is a movable contact 9 which is preferably of blade-like construction and generally C-shaped, and mounted for swinging movement about a pivot 10 carried by a conducting bracket 11. External circuit connections to the interrupter are made through a pair of terminal members 12 and 13, the first of which is secured to the stationary contact assembly 7 and the second one of which is connected to the conducting bracket 11. Thus, when the interrupter is in the closed circuit position as shown in Fig. 1, an electrical circuit is established between the terminals 12 and 13 through the stationary contact assembly 7, the movable contact 9 and the conducting bracket 11.

The movable contact 9 is actuated to open and closed circuit positions by an insulating operating rod 14 actuated by a crank plate member 15, in this instance an integral part of the shaft 16. The shaft 16 is journaled in suitable brackets 17. The shaft 16 is actuated by a crank portion 18 of the plate member 15 which is coupled by suitable linkage 19 to a connecting rod 20 of an air actuated piston operated within the cylinder 21. The connecting rod 20 may be moved up and down to effect respective closing and opening movements of the movable contact 9 by the admission of compressed gas from the storage tank 1 to the operating cylinder 21 by suitable valves well known in the art.

The tubular insulator 4, in addition to serving as a support, also provided a passage for conducting an arc extinguishing blast of gas from the storage tank 1 to the space between the contacts 7 and 9. This gas blast passage proceeds through the short conduit 2 through the valve casing 3, through the tubular insulator 4 and opening 22 provided through the insulating support 5 which is preferably coextensive with the passage within the tubular insulator 4.

In the event the movable contact 9 is moved to the open circuit position while the circuit interrupter is carrying load, an arc will be drawn across the upper end of the passage 22 and will be subjected to a blast of arc extinguishing gas caused to flow through the tubular insulator 4, whereby the arc will be extinguished. Control of the blast of gas to the arc in this instance may be obtained by a valve 23 disposed in the lower end of the valve casing 3. The valve 23 has a stem 24 operatively coupled to one end of an actuating member 25. In this instance the actuating member 25 is rigidly secured to a rock shaft 26 journaled in the side of the valve casing 3. The shaft 26 extends exteriorly of the valve casing 3, and has a pair of rocker arms 27 secured to the opposite ends thereof.

Referring more particularly to Fig. 3 it will be observed that the rocker arms 27 have secured thereto a pin 28 upon which is pivotally mounted a spring guide rod 29, the upper end of which is slidably guided in a fixed guide bracket 29a, in this instance an integral portion of the valve casing 3. A compression spring 30 is disposed between the fixed guide bracket 29a and the lower portion of the spring guide rod 29 to bias the rocker arms 27 in a counterclockwise direction about the rock shaft 26 to bias the valve 23 to its closed position. Referring more particularly to Fig. 4, it will be noted that a pin 31 is rigidly supported at the lefthand end of the rocker arms 27 as viewed in Fig. 3, the purpose for which will appear more clearly hereinafter.

Referring to Fig. 4 it will be observed that a ratchet collar 32 is slidably mounted on the shaft

16 having teeth 33. A bifurcated bracket 34, in this instance an integral portion of the ratchet collar 32 supports a knee pin 35 as more clearly shown in Fig. 4. Cotter pins 35a hold the knee pin 35 in the bifurcated bracket 34. An adjustable link member 36 is pivotally supported on the knee pin 35. At the upper end of the link member 36, as viewed in Fig. 4 there is provided an elongated slot 37. The pin 31 passes through the elongated slot 37, and in the closed circuit position of the interrupter as shown by the full lines in Fig. 2, the pin 31 is disposed at the lower end 38 of the elongated slot 37.

A helically wound retrieving spring 39 is supported on the shaft 16 as more clearly shown in Fig. 4. The lefthand end of the retrieving spring 39, as viewed in Fig. 4, is rigidly secured to the ratchet collar 32. The righthand end of the retrieving spring 39 is rigidly secured to the bracket 17. It will, therefore, be apparent that the retrieving spring 39 biases the ratchet collar 32 in a clockwise direction about the shaft 16 as viewed in Fig. 2.

A cam slot 41 is provided at the lower end of the ratchet collar 32 as viewed in Fig. 4. The cam slot 41 has a configuration more clearly shown in Fig. 7. Referring to Fig. 7 it will be noted that the cam slot 41 has a cam portion 42. The righthand bracket 17 as viewed in Fig. 4 supports a bracket 43 in which is rigidly secured a follower pin 44. The follower pin 44 is inserted into the cam slot 41 as more clearly shown in Fig. 4. Disposed adjacent to the cam slot 41 is a straight slot 45 more clearly shown in Fig. 7. The support bracket 43 also pivotally supports a latch 46 on a pivot pin 46a, a helical spring 47 encircling the pivot pin 46a serving to bias the latch 46 in a counterclockwise direction about the pivot pin 46a as viewed in Fig. 6.

Cooperating with the ratchet collar 32 is a rotatable ratchet coupling, in this instance an integral portion of the shaft 16. The ratchet coupling 48 has teeth 49 which cooperate with the teeth 33 of the ratchet collar 32 as clearly shown in Figs. 4 and 5. Rigidly secured to the crank plate member 15 is a latch disengaging pin 50 as shown more clearly in Figs. 6 and 7, the purpose for which will appear more clearly hereinafter. Also rigidly secured to the crank plate member 15 is a valve latch disengaging pin 51 more clearly shown in Fig. 6, the purpose for which will also appear more clearly hereinafter.

Rigidly secured to the lefthand bracket 17 as viewed in Fig. 4 is an offstanding bracket 52 having a bifurcated portion which supports a pivot pin 53. The pivot pin 53 pivotally supports a valve latch 54 having a configuration more clearly shown in Figs. 2 and 3. It will be observed that the valve latch 54 has a latch portion 55 and a tripping portion 56 (see Fig. 3). Referring to Fig. 3 it will be observed that a spring guide rod 57 is pivotally supported to the valve latch 54 by a pivot pin 58. The righthand end of the spring guide rod 57 as viewed in Fig. 3, is slidably guided by a fixed guide bracket 59 in this instance an integral portion of the valve casing 3. A compression spring 60 encircles the spring guide rod 57 to bias the valve latch 54 in a counterclockwise direction about the pivot pin 53 as viewed in Fig. 3.

The operation of the blast valve mechanism will now be explained. In the closed circuit position of the interrupter as shown by the full lines in Fig. 2, it will be observed that the pin 31 is disposed at the lower end 38 of the elongated slot

37, the compression spring 39 maintaining the valve 23 in the closed position. It is, therefore, readily apparent that the contacts are closed and the valve 23 is also closed. Fig. 4 shows an elevational view taken along the line IV—IV of Fig. 2 with the parts shown in the closed circuit position, and Fig. 7 shows the disposition of the follower pin 44 in the cam slot 41 at this time, the latch 46 being out of the straight slot 45 (see Fig. 7) and the retrieving spring 39 forcing the teeth 33 of the ratchet collar 32 against the teeth 49 of the ratchet coupling 48.

When it is desired to open the electrical circuit passing through the interrupter, or as a result of the tripping of the breaker mechanism, suitable mechanism not shown operates to move the connecting rod 20 downward (see Fig. 1). This downward movement of the connecting rod 20 rotates the crank plate member 15 and hence the shaft 16 in a counterclockwise direction as viewed in Fig. 1. The rotation of the shaft 16 also rotates the ratchet coupling 48. The rotation of the ratchet coupling 48 causes the ratchet collar 32 to also rotate, the follower pin 44 meanwhile sliding in the cam slot 41. It will be observed that counterclockwise rotation of the ratchet collar 32 as viewed in Fig. 2 will serve to also rotate the knee pin 35 in a counterclockwise direction about the shaft 16 to straighten the adjustable link member 36 as shown by the dotted lines in Fig. 2. Consequently, it will be apparent that the bifurcated bracket 34, the knee pin 35 and the adjustable link member 36 constitute a valve actuating toggle generally designated by the reference numeral 61. The dotted lines in Fig. 2 show the disposition of the parts during the initial portion of the opening operation when the valve actuating toggle 61 is straightened by the initial rotation of the ratchet collar 32 with the ratchet coupling 48. It will be observed, however, that the straightening of the valve actuating toggle 61 will cause the pin 31 to move upward and hence to cause the valve 23 to open against the biasing action exerted by the compression spring 30.

The dotted lines in Fig. 2 show the disposition of the parts of the mechanism at a time when the contacts 7, 9 first began to part and at a time when the valve 23 is fully open to admit an arc extinguishing blast of gas upward through the tubular insulator 4 to extinguish the arc drawn between the contacts 7 and 9. However, when the valve actuating toggle 61 is straightened as shown by the dotted lines in Fig. 2, the valve latch 54 biased by the compression spring 60 in a counterclockwise direction about the pivot pin 53, latches under the pin 31. During this portion of the opening operation the latch 46 is out of the straight slot 45 and the follower pin 44 is moving in the straight portion of the cam slot 41, not yet having contacted the cam portion 42.

Further counterclockwise rotation of the crank plate member 15 about the shaft 16 causes the valve actuating toggle 61 to break, the valve latch 54 meanwhile holding the pin 31 in its raised position in the latch portion 55 of the valve latch 54. Consequently, it is readily apparent that the valve latch 54 serves to maintain the valve 23 open at a time when the valve actuating toggle 61 is broken by the continued counterclockwise rotation of the ratchet collar 32. However, when the valve actuating toggle 61 breaks, the follower pin 44 rides up on the cam portion 42 of the cam slot 41 to force the ratchet collar 32 to the right as viewed in Fig. 4 and hence to cause

the disengagement of the teeth 33 of ratchet collar 32 from the teeth 49 of the ratchet coupling 48 as shown more clearly in Fig. 5. When the teeth 33 and 49 disengage, the latch 46 snaps into the straight slot 45 and serves to maintain the teeth 33, 49 out of engagement while the retrieving spring 39 rotates the ratchet collar 32 in a clockwise direction about the shaft 16 as viewed in Figs. 2 and 3 to return the ratchet collar 32 to its initial position. When the ratchet collar 32 has returned to its initial position the latch 46 remains in the straight slot 45 to maintain the teeth 33 of the ratchet collar 32 out of engagement with the teeth 49 of the ratchet coupling 48 which meanwhile are continuing to rotate in a counterclockwise direction about the shaft 16.

It will, therefore, be apparent that if the latch 46 were not provided the teeth 33 of the ratchet collar 32 would tend, due to the compressive spring action exerted by the retrieving spring 39, to engage with the teeth 49 of the ratchet coupling 48 to be again rotated with the ratchet coupling 48.

As was stated previously, the valve latch 54 maintains the pin 31 in its raised position on the latch portion 55 to cause the valve 23 to remain open after the valve actuating toggle 61 has broken and the ratchet collar 32 has returned to its initial position. Meanwhile, the gas blast passing through the tubular insulator 4 has served to extinguish the arc drawn between the contacts 7 and 9. It is, therefore, desirable to close the valve 23, and the valve latch disengaging pin 51 serves this purpose. It will be observed that the full lines in Fig. 3 show the position of the parts just after the valve latch disengaging pin 51 has struck the tripping portion 56 of the valve latch 54 to cause a slight clockwise rotation of the valve latch 54 about the pivot pin 53. This slight clockwise rotation of the valve latch 54 about the pivot pin 53 caused by the valve latch disengaging pin 51 striking the tripping portion 56 of the valve latch 54 is sufficient to permit the pin 31 to drop off the latch portion 55 down to the bottom 38 of the slot 37 in the adjustable link member 36, which at this time has been returned to its lower position by the previous return of the ratchet collar 32. The disposition of the parts after the valve latch disengaging pin 51 has tripped the valve latch 54 to cause closing of the valve 23 is shown by the full lines in Fig. 3.

Further movement of the movable contact 9 to cause increased contact separation is desirable to prevent voltage surges on the line from breaking down the contact separation to result in re-striking of the extinguished arc. This increased contact separation is caused by the continued rotation of the crank plate member 15 as shown by the dotted lines in Fig. 3. The dotted lines in Fig. 3 show the disposition of the parts when the contacts are in their fully open position. However, the latch disengaging pin 50 serves at the extreme end of the opening operation to strike the tail 62 of the latch 46 to cause the latch 46 to be forced out of the straight slot 45 and hence to permit the compressive force exerted by the retrieving spring 39 to force the teeth 33, 49 into engagement. Consequently, in the full open circuit position of the interrupter, as shown by the dotted lines in Fig. 3, the contacts 7, 9 are widely separated, the valve 23 is closed and the teeth 33, 49 are in engagement, the latch 46 having been forced out of the straight slot 45 by the latch disengaging pin 50.

During the closing operation of the interrupter the crank plate member 15 rotates in a clockwise direction about the shaft 16 and during this closing movement the teeth 49 of the ratchet coupling 48 merely ratchet on the teeth 33 of the ratchet collar 32. This ratcheting action between the teeth 49, 33 will continue until the crank plate member 15 has rotated in a clockwise direction about the shaft 16 to the fully closed position of the interrupter shown by the full lines of Fig. 2. A subsequent opening operation will cause the valve mechanism to operate in a manner previously described and, therefore, a further description is not deemed necessary.

Occasionally, it may occur that overload conditions exist in the electric circuit controlled by the interrupter when the interrupter is in the open circuit position. In this event when it is attempted to close the interrupter during the existence of overload conditions in the electrical circuit controlled by the interrupter an arc will jump across the contacts 7, 9 because of the high voltage even before the movable contact 9 engages the stationary contact 7. The arc which jumps between the contacts 7, 9 before they have engaged will carry an overload current which will trip the breaker mechanism and will cause an immediate opening operation of the interrupter even before the interrupter has been completely closed. Consequently, the net result is a reversal of contact movement during a closing operation before the contacts 7, 9 have engaged.

It will be observed that in the blast valve mechanism which I have provided should a reversal of contact movement take place during a closing operation due to the aforesaid state of conditions, the reversal of movement of the ratchet coupling 48 will immediately serve to carry with it the ratchet collar 32 and hence to open the blast valve 23 in the same manner as would have occurred during a normal opening operation. I use the term normal opening operation to indicate an opening operation from the completely closed position of the interrupter.

It will, therefore, be apparent that the mechanism which I have provided serves to immediately open the blast valve 23 due to a reversal of contact movement during a closing operation at any intermediate position during the closing operation. The opening of the blast valve 23 will, of course, serve to deliver an arc extinguishing blast of gas upward through the tubular insulator 4 between the contacts 7, 9 to extinguish the arc thus drawn when it was attempted to close the interrupter during the existence of overload conditions in the electrical circuit.

From the above description it is apparent that I have provided a novel blast valve mechanism for use in circuit interrupters which functions to open the blast valve during a predetermined portion of the opening operation, and which also functions to maintain the valve closed during the closing operation to conserve the supply of compressed gas. It will be apparent that the position of the valve latch disengaging pin 51 determines when the valve latch 54 will be tripped open to close the blast valve 23. It will also be observed that when the contacts 7, 9 begin to separate the blast valve 23 is at this time fully open. Consequently, when the arc between the contacts 7, 9 is first drawn, it is subjected to an arc extinguishing blast of gas which at this time has its highest velocity due to the fact that the blast valve 23 at this time is fully open.

It will also be apparent that I have provided a blast valve operating mechanism which functions to immediately open the blast valve upon a reversal of contact motion at any intermediate position during a closing operation as a result of closing the interrupter during the existence of overload conditions in the electrical circuit controlled by the interrupter.

Although I have shown and described a specific embodiment of my invention, it is to be clearly understood that the same was merely for purposes of illustration and that changes and modifications may be made by those skilled in the art without departing from the spirit and scope of the invention.

I claim as my invention:

1. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, operating means for actuating the contacts to open and to closed circuit positions, a valve arranged to be supplied with gas under pressure, an actuating member for operating said valve to establish an arc extinguishing blast of gas, said contact operating means including a member movable in accordance with the opening and closing movements of the contacts, ratchet means interengaging said member with said actuating member to open the valve during an opening operation of the interrupter, and means rendering the ratchet means inoperable before the end of the opening operation of the interrupter.

2. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, operating means for actuating the contacts to open and to closed circuit positions, a valve arranged to be supplied with gas under pressure, an actuating member for operating said valve to establish an arc extinguishing blast of gas, said contact operating means including a member movable in accordance with the opening and closing movements of the contacts, ratchet means interengaging said member with said actuating member to open the valve during an opening operation of the interrupter, means rendering the ratchet means inoperable before the end of the opening operation of the interrupter, and valve latching means operable to hold the valve open after the ratchet means has been rendered inoperative.

3. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, operating means for actuating the contacts to open and to closed circuit positions, a valve arranged to be supplied with gas under pressure, an actuating member for operating said valve to establish an arc extinguishing blast of gas, said contact operating means including a member movable in accordance with the opening and closing movements of the contacts, ratchet means interengaging said member with said actuating member to open the valve during an opening operation of the interrupter, means rendering the ratchet means inoperable before the end of the opening operation of the interrupter, valve latching means operable to hold the valve open after the ratchet means has been rendered inoperative, and means movable with the operating means for tripping the valve latching means to close the valve before the operating means comes to rest at the end of an opening operation.

4. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, operating means for actuating the contacts to open and to closed circuit positions, a valve arranged to be supplied with gas under pressure, an actuating member for operating said valve to estab-

lish an arc extinguishing blast of gas, said contact operating means including a first member movable in accordance with the opening and closing movements of the contacts, linkage means communicating motion from the first member to the actuating member to open the valve during an opening operation, and means rendering the linkage means inoperative before the end of the opening operation to prevent the communication of motion from the first member to the actuating member.

5. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, operating means for actuating the contacts to open and to closed circuit positions, a valve arranged to be supplied with gas under pressure, an actuating member for operating said valve to establish an arc extinguishing blast of gas, said contact operating means including a first member movable in accordance with the opening and closing movements of the contacts, linkage means communicating motion from the first member to the actuating member to open the valve during an opening operation, means rendering the linkage means inoperative before the end of the opening operation to prevent the communication of motion from the first member to the actuating member, and valve latching means to maintain the valve open after the linkage means has been rendered inoperative.

6. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, operating means for actuating the contacts to open and to closed circuit positions, a valve arranged to be supplied with gas under pressure, an actuating member for operating said valve to establish an arc extinguishing blast of gas, said contact operating means including a first member movable in accordance with the opening and closing movements of the contacts, linkage means communicating motion from the first member to the actuating member to open the valve during an opening operation, means rendering the linkage means inoperative before the end of the opening operation to prevent the communication of motion from the first member to the actuating member, valve latching means to maintain the valve open after the linkage means has been rendered inoperative, and means tripping the latching means to close the valve before the end of the opening operation.

7. In a circuit interrupter of the gas blast type, separable contacts cooperable to establish an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, means rotatable in accordance with contact motion, a ratchet coupling fixed to and rotatable with the means, and a ratchet collar slidably mounted on the means and arranged to operate the valve.

8. In a circuit interrupter of the gas blast type, separable contacts cooperable to establish an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, disengageable means relating the opening contact motion with the valve to cause opening of the valve during at least a portion of the opening operation of the interrupter, means operable to cause the disengagement of the first-mentioned means, and latching means operable to maintain the valve open after the disengagement of the first-mentioned means.

9. In a circuit interrupter of the gas blast type, separable contacts cooperable to establish an arc, a valve controlling a supply of gas under pressure,

the valve being operable to deliver an arc extinguishing blast of gas, disengageable means relating the opening contact motion with the valve to cause opening of the valve during at least a portion of the opening operation of the interrupter, means operable to cause the disengagement of the first-mentioned means, latching means operable to maintain the valve open after the disengagement of the first-mentioned means, and means movable in accordance with the contact motion for tripping the latching means to close the valve before the end of the opening operation of the interrupter.

10. In a circuit interrupter of the gas blast type, separable contacts cooperable to establish an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, disengageable ratchet means relating the opening contact motion with the valve to cause opening of the valve during at least a portion of the opening operation of the interrupter, means operable to cause the disengagement of the first-mentioned means, and latching means operable to maintain the valve open after the disengagement of the first-mentioned means.

11. In a circuit interrupter of the gas blast type, separable contacts cooperable to establish an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, a shaft rotatable in accordance with contact motion, a ratchet coupling fixed to and rotatable with the shaft, a ratchet collar slidably mounted on the shaft, means for causing the opening of the valve in response to rotation of the ratchet collar, and means for disengaging the ratchet collar from the ratchet coupling at a predetermined time in the opening operation of the interrupter.

12. In a circuit interrupter of the gas blast type, separable contacts cooperable to establish an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, a shaft rotatable in accordance with contact motion, a ratchet coupling fixed to and rotatable with the shaft, a ratchet collar slidably mounted on the shaft, means for causing the opening of the valve in response to rotation of the ratchet collar, means for disengaging the ratchet collar from the ratchet coupling at a predetermined time in the opening operation of the interrupter, and latching means for maintaining the valve open after the disengagement of the ratchet collar from the ratchet coupling.

13. In a circuit interrupter of the gas blast type, separable contacts cooperable to establish an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, a shaft rotatable in accordance with contact motion, a ratchet coupling fixed to and rotatable with the shaft, a ratchet collar slidably mounted on the shaft, means for causing the opening of the valve in response to rotation of the ratchet collar, means for disengaging the ratchet collar from the ratchet coupling at a predetermined time in the opening operation of the interrupter, latching means for maintaining the valve open after the disengagement of the ratchet collar from the ratchet coupling, and means movable in accordance with the contact motion to trip the latching means and thus close the valve at a predetermined time in the opening operation of the interrupter.

14. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc,

a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, a shaft movable in response to contact motion, a ratchet coupling fixed to and rotatable with the shaft, a ratchet collar slidably mounted on the shaft, the valve being opened in response to rotation of the ratchet collar, means biasing the ratchet collar into engagement with the ratchet coupling, and cam means for causing the disengagement of the ratchet collar from the ratchet coupling at a predetermined time in the opening operation of the interrupter.

15. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, a shaft movable in response to contact motion, a ratchet coupling fixed to and rotatable with the shaft, a ratchet collar slidably mounted on the shaft, the valve being opened in response to rotation of the ratchet collar, means biasing the ratchet collar into engagement with the ratchet coupling, cam means for causing the disengagement of the ratchet collar from the ratchet coupling at a predetermined time in the opening operation of the interrupter, and means for maintaining the ratchet collar out of engagement with the ratchet coupling until substantially the end of the opening operation of the interrupter.

16. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, rotatable means rotatable in accordance with the contact motion, a first ratchet means rotatable with said means, a second cooperable ratchet means engageable

with the first ratchet means during a portion of the opening operation of the interrupter, and means operable in response to rotation of the second ratchet means to open the valve.

17. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, rotatable means rotatable in accordance with the contact motion, a first ratchet means rotatable with said means, a second cooperable ratchet means engageable with the first ratchet means during a portion of the opening operation of the interrupter, means operable in response to rotation of the second ratchet means to open the valve, and means for disengaging the second ratchet means from the first ratchet means at a predetermined time in the opening operation.

18. In a circuit interrupter of the gas blast type, separable contacts for establishing an arc, a valve controlling a supply of gas under pressure, the valve being operable to deliver an arc extinguishing blast of gas, rotatable means rotatable in accordance with the contact motion, a first ratchet means rotatable with said means, a second cooperable ratchet means engageable with the first ratchet means during a portion of the opening operation of the interrupter, means operable in response to rotation of the second ratchet means to open the valve, means for disengaging the second ratchet means from the first ratchet means at a predetermined time in the opening operation, and valve latching means to maintain the valve open after the second ratchet means has become disengaged from the first ratchet means.

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