United States Patent [19]

Deno

[11] **3,858,015**

[45] **Dec. 31, 1974**

[54] **ELECTRIC CIRCUIT BREAKER OF THE GAS BLAST TYPE**

[75] Inventor: **Don W. Deno,** Berwyn, Pa.

[73] Assignee: **General Electric Company**

[22] Filed: **Sept. 15, 1972**

[21] Appl. No.: **289,579**

[52] **U.S. Cl.** ..... **200/148 B,** 200/148 R

[51] **Int. Cl.** **H01h 33/86**

[58] **Field of Search** ..... 200/148 B, 148 R

[56] **References Cited**

UNITED STATES PATENTS

3,471,666	10/1969	Barkan	200/148 B
3,538,282	11/1970	Leeds	200/148 B
3,604,871	9/1971	Kriechbaum	200/148 B

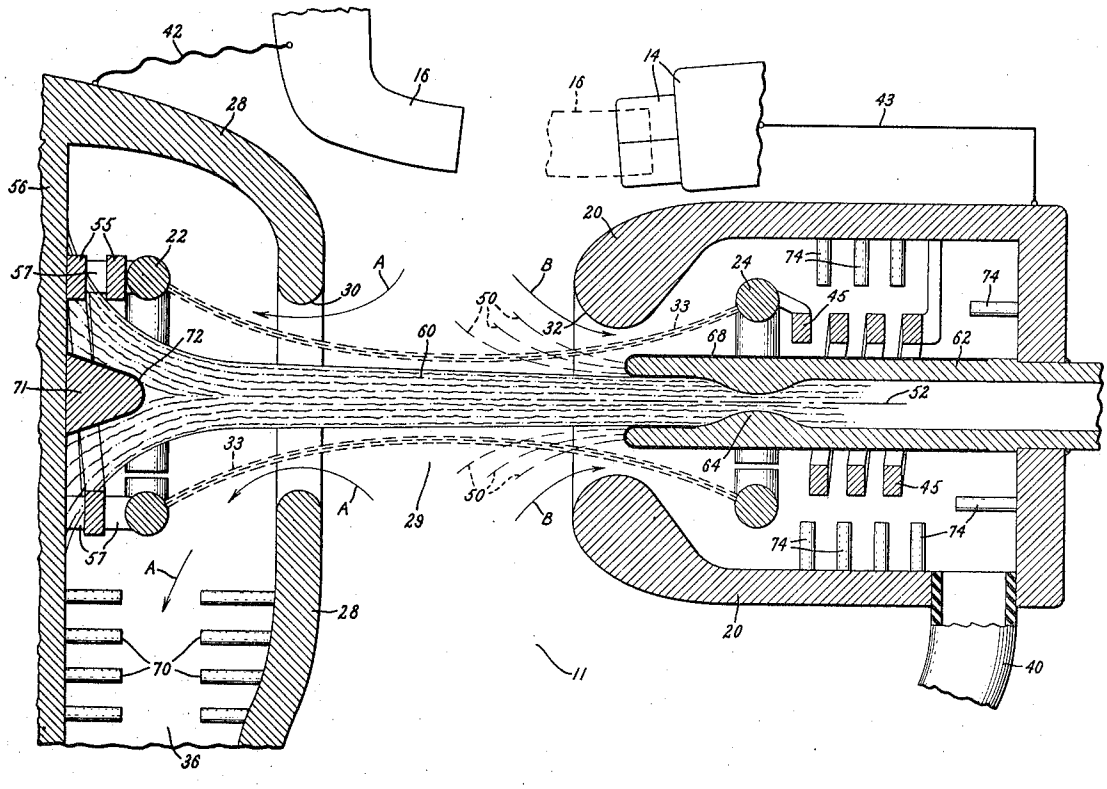
Primary Examiner—Robert S. Macon

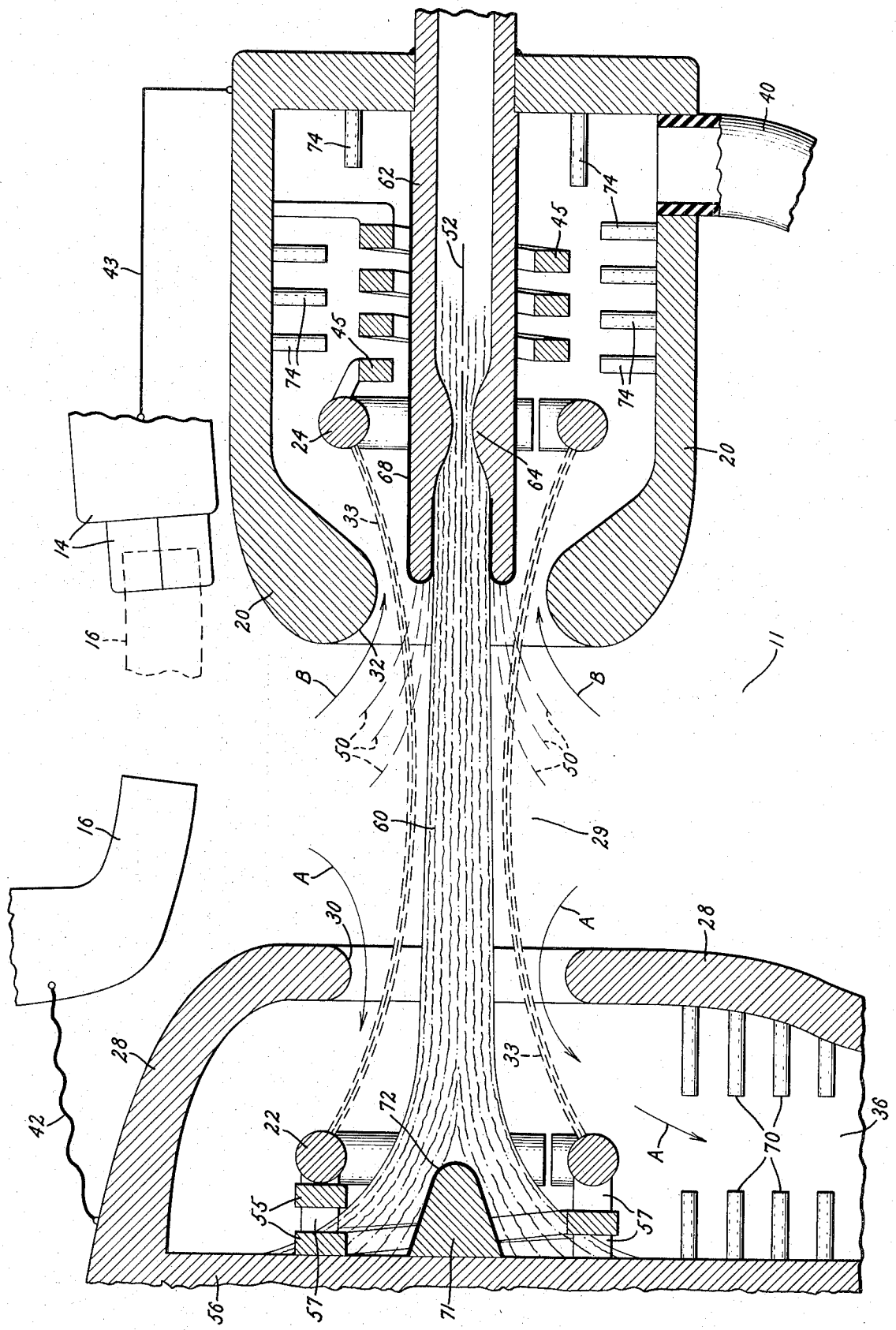
Attorney, Agent, or Firm—J. Wesley Haubner et al.

[57] **ABSTRACT**

A gas-blast circuit breaker comprises a pair of spaced-apart annular electrodes, to which are respectively electrically connected spaced-apart nozzles, each having an orifice opening positioned between the electrodes. During interruption, an arc is established between the electrodes with its column extending through the orifice openings; and two streams of gas are caused to flow in generally opposite directions from the space between the nozzles through said orifice openings, one stream flowing past one electrode and the other past the other electrode. Magnetic means forces one of the arc terminals to move in a generally circular path along its electrode, thus developing a hollow arc column. Along the longitudinal axis of this hollow arc column, a jet of gas is directed from one electrode toward the other electrode.

8 Claims, 1 Drawing Figure




40
74
62
52
45
43
74
24
68
64
20
14
16
33
32
B
50
11
60
29
A
30
28
42
22
72
55
57
36
70
56
71

ELECTRIC CIRCUIT BREAKER OF THE GAS BLAST TYPE

BACKGROUND

This invention relates to an electric circuit breaker of the gas blast type and, more particularly, to a circuit breaker of this type wherein the inter-electrode space across which arcing occurs is maintained exceptionally free of electrode vaporization products.

Prior patents of interest with respect to this circuit breaker are U.S. Pat. Nos. 3,471,666—Barkan; 3,538,282—Leeds; 3,549,841—McCloud et al.; 3,564,177—Birt et al.; and 2,969,446—Forwald.

In the circuit breaker that I am concerned with, one terminal of the arc is magnetically driven about an annular surface of one electrode so as to develop a generally hollow arc column in the region of the electrode; and along the longitudinal axis of this hollow arc column, a jet of cool gas is directed from the region of said one electrode toward the other electrode. A circuit breaker of this type is shown and claimed in the aforesaid U.S. Pat. No. 3,471,666—Barkan, assigned to the assignee of the present invention, which patent is incorporated by reference in the present application.

In the circuit breaker of the Barkan patent, a main gas blast flows in the same general direction as the jet of gas, flowing first past said one electrode and then past said other electrode. An undesirable feature of this prior circuit breaker is that both the jet and the main blast carry electrode vaporization products from said one electrode into the inter-electrode gap. This flow pattern results in an arc that has a high content of electrode vaporization products and, at current zero following arcing, an inter-electrode gap that is not freed as quickly as desired of electrode-vaporization products. These factors detract from the circuit breaker's ability to rapidly build up dielectric strength across the gap at current zero.

SUMMARY

An object of my invention is to construct a circuit breaker of the type comprising the above-described arc revolving means and jet cooling means in such a manner that reduced quantities of electrode vaporization products are carried into the inter-electrode gap during and immediately after arcing.

Another object is to increase the rate at which said inter-electrode gap recovers its dielectric strength immediately after arc extinction at a current zero.

In carrying out the invention in one form I provide a gas-blast circuit breaker comprising a first electrode of generally annular configuration and a second electrode spaced therefrom. Electrically connected to the first and second electrodes, respectively, are first and second spaced-apart nozzles, each having an orifice opening positioned between said electrodes. Means is provided for establishing between said electrodes an arc that has its opposed terminals on said electrodes and its column extending through said orifice openings. During an interrupting operation, two streams of gas are caused to flow in generally opposite directions from the space between said nozzles through said orifice openings, one stream flowing past said first electrode and the other flowing past said second electrode. Magnetic means forces the arc terminal on said first electrode to move therealong in a generally circular path so as to develop a generally hollow arc column in the region adjacent said first electrode. In one form of the invention, means is provided for directing along the longitudinal axis of said hollow arc column a jet of gas flowing from the region of said first electrode toward said second electrode.

BRIEF DESCRIPTION OF THE DRAWING

For a better understanding of the invention, reference may be had to the following description taken in conjunction with the accompanying drawing, wherein:

The single FIGURE is a cross-sectional view through a circuit interrupter embodying one form of my invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to the drawing, the circuit interrupter shown therein is of the sustained-pressure gas-blast type described and claimed in the aforesaid Barkan U.S. Pat. No. 3,471,666 and in U.S. Pat. No. 2,783,338—Beatty, both assigned to the assignee of the present invention. Only those parts of the interrupter that should be understood in order to understand the present invention have been shown in the drawing. As described in the above patents, the interrupter comprises a casing (not shown herein) that is normally filled with pressurized gas to define an interrupting chamber indicated at **11** in my drawing. Located within interrupting chamber **11** are two relatively-movable contacts **14** and **16** which can be separated to draw an arc within the pressurized gas within the chamber **11.** Contact **14** is relatively stationary, whereas the other contact **16** is suitably mounted for pivotal motion into and out of its dotted line position of engagement with contact **14.** In FIG. **1,** contact **16** is shown in a solid-line position through which it passes during a circuit interrupting operation after having established an arc.

The arc that is established between contacts **14** and **16** is quickly transferred off the contacts **14, 16** to a pair of spaced-apart conductive nozzle members **20** and **28** separated by a gap **29** and thereafter to a pair of annular electrodes **22** and **24** located within the nozzle members. For effecting this arc transfer, two streams of gas are caused to flow from chamber **11** through the nozzle members **28** and **20,** respectively. One of these gas streams (indicated by arrows A) flows through orifice opening **30** of nozzle member **28,** and the other (indicated by arrows B) flows through orifice opening **32** of nozzle member **20.**

The stream that flows through orifice opening **30** is controlled by a normally-closed blast valve (not shown) at the lower end of an exhaust passage **36** receiving the flow through orifice opening **30.** As described in the aforesaid Barkan patent, this blast valve is opened during the interruting operation, and this allows gas flow through the exhaust passage **36** to the surrounding atmosphere, thereby creating the above-described blast through orifice opening **30.** The blast valve and the movable contact **16** are jointly controlled by a suitable operating mechanism (not shown in the prsesent application but shown in the aforesaid Barkan and Beatty patents), which causes the blast valve to close at the end of an interrupting operation but holds the contact **16** in its open position so long as it is desired to maintain the circuit interrupter open.

The blast that flows through the other orifice opening **32** is preferably controlled by the same blast valve that controls the flow through the first orifice opening **30.** To this end, a tube **40** of insulating material extends across the gap **29,** communicating at its upstream end with the space inside nozzle member **20** and at its downstream end with exhaust passage **36** at a point (not shown) upstream from the blast valve therein. An arrangement of this type is disclosed in detail and claimed in application Ser. No. 267,945—Beatty, filed June 30, 1972, and assigned to the assignee of the present invention. Alternatively, a separate valve (not shown) located downstream from orifice opening **32** and suitably mechanically coupled to the main blast valve can be used for controlling the blast through orifice opening **32.**

The blast that flows through orifice opening **30** forces one terminal of the arc off the moving contact **16,** onto nozzle member **28,** then through the orifice opening **30** onto electrode **22.** The other blast that flows through orifice opening **32** transfers the other terminal of the arc off the stationary contact **14** onto the other orifice member **20,** then through orifice opening **32** onto electrode **24.** After such transfer of the arc terminals to electrodes **22** and **24,** the arc (shown at **33**) extends through the orifice openings **30** and **32** across the gap **29.** It is to be noted that the nozzle member **28** is electrically connected to movable contact **16** as schematically indicated at **42**; and the electrode **22** is electrically connected to the nozzle member through conductive means **55, 56** soon to be described. Similarly, the stationary contact **14** is electrically connected to the other nozzle member **20** as schematically shown at **43**; and the electrode **24** is electrically connected to the nozzle member **20** through conductive means **45** soon to be described.

Stationary contact **14** and nozzle member **20** are supported on the interrupter casing preferably by a lead-in bushing (not shown) that electrically insulates the stationary contact **14** and nozzle member **20** from the movable contact **16** and nozzle member **28** when the circuit interrupter is open. A preferred form of such a lead-in bushing is illustrated at **7** in the aforesaid Barkan patent.

Each of the electrodes **22** and **24** is of a generally annular configuration. Each does, however, contain a suitable split to reduce the eddy currents developed therein by the magnetic field from its associated coil (soon to be described). The material of electrodes **22** and **24** is preferably a sintered mixture of a refractory metal, such as tungsten, and silver or copper. In materials of this type, which are sold under the trademark Elkonite, the refractory metal component limits the extent that the material is vaporized by the arc terminal thereon.

For further reducing the amount of electrode vaporization produced by the arc, I revolve each of the arc terminals along a generally annular path on its associated electrode. This is accomplished on the electrode **24** by utilizing a coil **45** that is electrically connected in series with electrode **24** between electrode **24** and the orifice member **20.** Any current entering the arc through electrode **24** is forced to pass through coil **45.** This creates a radial magnetic field that has a configuration indicated by the dotted lines **50.** Such a field reacts in a known manner with the magnetic field around the arc to revolve or spin the arc about the central longitudinal axis **52** of electrode **24,** driving its terminal in an annular or circular path on electrode **24.**

For revolving the other arc terminal on its electrode **22,** a suitable coil **55** is connected between electrode **22** and conductive supporting structure **56** in series with electrode **22.** Suitable spacers **57** maintain the turns of coil **55** separated but allow air to flow between the turns. Any current entering the arc through electrode **22** is forced to pass through this coil **55.** This creates a radial magnetic field that reacts in a known manner with the adjacent portion of the arc to revolve this portion of the arc and its associated arc terminal about the central longitudinal axis of electrode **22.**

High speed motion of the two arc terminals in annular paths tends to force the arc column to have a generally tubular or hollow form, with its longitudinal axis generally coinciding with center line **52.** An additional feature tending to impose a hollow configuration on the arc is that I direct a high velocity jet **60** of cool air along the center line **52** from the region of electrode **24** toward the other electrode **22.** Jet **60** is directed in this manner by a tube **62** extending through the annular electrode **24** into a position well out in front of electrode **24.** Tube **62** communicates with a high pressure source (not shown) through a suitable auxiliary valve (not shown). When this auxiliary valve (which is normally closed) is opened, as by overcurrent responsive means, high pressure air flows from the source into the tube **62,** exhausting as the jet **60.** Reference may be had to the aforesaid Barkan patent for a detailed description of such a source and a current-responsive auxiliary valve operating to provide a jet such as **60.** For controlling the jet velocity, a suitable throat **64** is provided in the tube's internal passageway. Preferably, the source of jet **60** is at a much higher pressure than the air in chamber **11,** e.g., at 1500 p.s.i. as compared to 500 p.s.i. for air in chamber **11.**

In a preferred form of the invention, the jet-directing tube **62** is made of a high permeability material such as steel for controlling the shape of the magnetic field developed by current through coil **45.** The tube **62,** in effect, acts as a core within the coil **45,** distributing the radial magnetic field along the length of the arc, and preventing the radial field from concentrating immediately adjacent the end turn of coil **45.** This more uniform distribution of the radial component of the magnetic field, it is believed, makes the field more effective in producing high speed revolution of the arc.

For preventing substantial vaporization of the tube material by the surrounding arc plasma, I provide the exposed surface of the tube with a refractory insulating coating **68** that evolves very little gas when heated by the arc. Preferably, this coating is of fused silica applied by plasma-arc spraying. It is important that the refractory coating **68** be of an insulating material to prevent the arc terminal from rooting on the tube **62.**

For distributing the flow through jet **60** radially outward in all directions after it has passed across the arcing region, a generally conical deflector **71** is provided within the space surrounded by coil **55.** This conical deflector **71** is preferably of a magnetizable material in order to suitably control the shape of the magnetic field developed by current through coil **55.** The deflector **71** is also coated with a refractory insulating coating **72,** preferably of fused silica, to prevent the arc terminal from rooting thereon.

For cooling the gas flowing through orifice opening **30** after it has passed through the arcing region, I provide in a location downstream from electrode **22** heat sinks **70,** preferably in the form of metallic pins projecting into the flow path from the surrounding metal walls. These heat sinks, by vigorously cooling the gas flowing thereadjacent, act to increase the density of the gas in this region, thus permitting increased gas flow through a given blast valve area downstream from exhaust passage **36,** thereby reducing the back pressure opposing flow through the arcing region. For cooling the gas flowing through the other orifice opening **32** after it has passed the arcing region, similar heat-sink pins **74** are provided within the nozzle member **20.** These heat-sink pins **74** act in the same manner as pin **70** to reduce the back pressure opposing flow through orifice opening **32.**

As stated hereinabove, an object of my invention is to reduce the quantities of electrode vaporization products that are carried into the interelectrode gap **29** during and immediately following the arcing period. One feature that contributes toward attainment of this object is the double exhaust character of the main blast. By causing this blast to originate in the gap **29** and to be directed from the gap toward the two electrodes at opposite ends of the gap, most of the electrode vaporization products are forced by the two streams of the main blast in directions away from the gap **29.** Another feature contributing toward attainment of the above-stated object is that the tube **62** from which the jet **60** originates extends to a point well ahead of the electrode **24.** In the immediate region of electrode **24,** the jet stream is isolated from the electrode **24** by the walls of tube **62.** Accordingly, even though the jet is directed into the arcing gap (**29**) from one electrode, it does not sweep electrode-vaporization products from this electrode into the gap.

There are a number of features contributing to rapid dielectric recovery at current zero in my circuit breaker. One is the fact that the quantity of electrode-vaporization products entering gap **29** is severely limited by the two flow features set forth in the immediately preceding paragraph. Another is that the arc terminals are revolved at high speed on the electrodes, thus reducing the amount of electrode vaporization products that are developed. Still another feature is that near and during the current zero period, the two streams at A and B constituting the main blast are sweeping past the dielectrically-stressed surfaces of nozzle members **20** and **28** in a direction to carry any particles being emitted therefrom away from the stressed arcing gap **29** into low-stress regions behind the nozzle members. All of these features coact to drastically limit the quantity of dielectrically-weak products present within or entering the gap during the period around current zero.

Another feature contributing to improved dielectric properties during the period around current zero is that both the arcing electrodes **22** and **24** are located in regions of low electric stress. At current zero the nozzle members **20** and **28** are at the same potential as the electrodes, and thus there is essentially zero electric field behind the confronting faces of the nozzle members in the region where the electrodes are located. This relationship reduces the probability of the arc restriking between the electrodes **22, 24,** despite their high temperature and any surface irregulatities resulting from prior arcing.

Still another feature contributing to improved interrupting performance is the intense cooling action that the arc is subjected to in my circuit breaker. By forcing the arc into a generally hollow configuration, much more surface area of the arc is exposed. This larger surface area I sweep both with the high pressure jet **60** through the center of the arc along axis **52** and the two streams at A and B constituting the main blast. This intense cooling, by reducing arc-vaporization and more effectively deionizing the arcing products, contributes to more rapid dielectric recovery at current zero.

While I have shown and described particular embodiments of my invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from my invention in its broader aspects; and I, therefore, intend herein to cover all such changes and modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A gas blast circuit breaker comprising:

a. a first electrode of a generally annular configuration and a second electrode spaced therefrom,

b. first and second spaced-apart nozzles primarily of metal electrically connected to said first and second electrodes, respectively,

c. each of said nozzles having an orifice opening positioned between said electrodes,

d. means for establishing between said electrodes an arc that has its opposed terminals on said electrodes and its column extending through said orifice openings.

e. means for causing two streams of gas to flow in generally opposite directions from the space between said nozzles through said orifice openings, one stream flowing past said first electrode and the other flowing past said second electrode,

f. magnetic means for forcing the arc terminal on said first electrode to move along said first electrode in a generally circular path so as to develop a generally hollow arc column in the region adjacent said first electrode,

g. and means for directing along the longitudinal axis of said hollow arc column a jet of gas flowing from the region of said first electrode toward said second electrode.

2. The circuit breaker of claim **1** in which said jet-directing means comprises a pipe extending through said first electrode and terminating at a point between said two electrodes a substantial distance ahead of said first electrode.

3. The gas blast circuit breaker of claim **2** in which said pipe acts as a core for said magnetic means and is primarily of a magnetizable material so as to distribute more uniformly along the arc length the radial component of the magnetic field developed by said magnetic means.

4. The gas blast circuit breaker of claim **2** in which said pipe is primarily of a magnetizable metal and is coated with an insulating material to discourage the arc terminal from rooting on said pipe.

5. The gas blast circuit breaker of claim **1** in which:

a. said second electrode is of a generally annular configuration, and

b. additional magnetic means is provided in proximity to said second electrode for forcing the arc terminal on said second electrode to move therealong in a generally circular path.

6. The gas blast circuit breaker of claim **1** in which:

a. exhaust passages are provided downstream from said electrodes into which said streams flow after passing said electrodes, and

b. heat sinks are provided in said exhaust passages for cooling the gases flowing past said electrodes upon their entry into said exhaust passages, thereby reducing the back pressure opposing flow through said exhaust passages.

7. The gas blast circuit breaker of claim **6** in which: said jet-directing means comprises a pipe extending through said first electrode and terminating at a point between said two electrodes a substantial distance ahead of said first electrode.

8. A gas blast circuit breaker comprising:

a. a first electrode of a generally annular configuration and a second electrode spaced therefrom,

b. first and second spaced-apart nozzles primarily of metal electrically connected to said first and second electrodes, respectively,

c. each of said nozzles having an orifice opening positioned between said electrodes,

d. means for establishing between said electrodes an arc that has its opposed terminals on said electrodes and its column extending through said orifice openings,

e. means for causing two streams of gas to flow in generally opposite directions from the space between said nozzles through said orifice openings, one stream flowing past said first electrode and the other flowing past said second electrode,

f. and magnetic means for forcing the arc terminal on said first electrode to move along said first electrode in a generally circular path so as to develop a generally hollow arc column in the region adjacent said first electrode.

* * * * *