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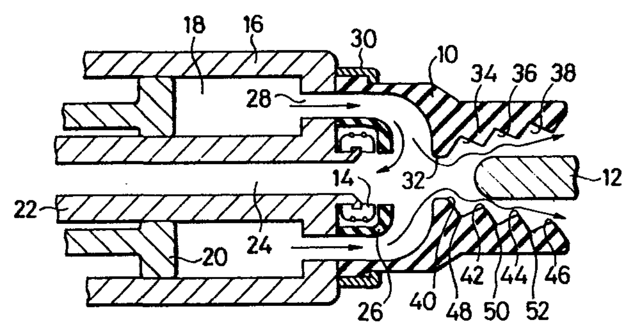
(54) **A puffer type gas blast circuit breaker.**

(57) An insulation nozzle (10) for the puffer type gas blast circuit breaker moves together with a movable arcing contact (14). A downstream divergent section of the insulation nozzle (10) includes a first annular triangular groove (34) and a second annular triangular groove (36). The first triangular groove (34) is disposed downstream to a intermediate throat section (32) of the insulation nozzle (10). The second annular triangular groove (36) is disposed downstream to the first annular triangular groove (34) and so dimensioned that an angle (P_2) of a line between the downstream edge (40) of the intermediate throat section (32) and downstream ridge (44) of the second annular triangular groove (36) is smaller than an angle (P_1) of a line between the downstream edge (40) of the intermediate throat section (32) and the downstream ridge (42) of the first annular triangular groove (34) to the axis of the insulation nozzle (10), whereby part of compressed blast gas is directed to the visinity of the front end portion of a stationary arcing contact (12) to apply a dynamic pressure thereat until the insulation nozzle (10) leaves the stationary arcing contact (12) to thereby prevent sudden pressure drops of the compressed blast gas thereat which causes an electrical breakdown between the arcing contacts (12, 14).



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TITLE OF THE INVENTION

A PUFFER TYPE GAS BLAST CIRCUIT BREAKER

Field of the Invention

The present invention relates to an improvement of an insulation nozzle for a puffer type gas blast circuit breaker.

Background of the Invention

An insulation nozzle for a puffer type gas blast circuit breaker essentially consists of three sections, an upstream and inlet convergent section surrounding a movable arcing contact being connect and disconnectable with a stationary arcing contact, a dwonstream and outlet divergent section and an intermediate throat section.

An insulation nozzle with a large downstream divergent angle, in other words a large vertex angle of the downstream divergent section, for example 60°, is known to be suitable for the circuit breaker of a large fault current interruption, because hot gas generated by an arc between arcing contacts is effectively exhausted through the insulation nozzle, but the interrupting voltage of the circuit breaker is limited, because a sudden pressure drop of the compressed blast gas takes place in the downstream divergent section of the insulation nozzle due to a sudden change of the sectional areas of the gas flow passage therein which causes a sudden transient decrease of a dielectric withstand voltage between the contacts, even with a continuous increase of the distance between the contacts during the interrupting operation so that an electrical breakdown between the contacts or reignition sometimes occurs. Particularly the circuit breaker is put under the most severe condition when the circuit breaker has to interrupt a small capacitive current, because a maximum recovery voltage, two or more times larger than the rated phase-to-ground voltage, is applied between the contacts at about 0.5 cycle after the initiation of the interrupting operation where the distance between the contacts is not necessarily enough to withstant the recovery voltage.

An insulation nozzle with a small downstream divergent angle, for example 20°, is also known to be suitable for the circuit breaker of a higher interrupting voltage, but the interrupting current thereof is limited, because the hot gas generated by an arc between the contacts is sometimes ineffectively exhausted though the insulation nozzle so that an electrical breakdwon between contacts takes place particularly during a large fault current interrupting operation of the circuit breaker.

U.S. Patent 3,816,684 is for improving a large fault current interrupting property of a compressed gas axial blast circuit breaker and discloses a nozzle assembly having a convergent inlet section, a divergent outlet section and an intermediate throat section. The outlet divergent section has a plurality of annular grooves formed downstream of the intermediate throat section, the diametral cross-section of the grooves being substantially triangular shaped with a vertx angle defined by the meeting of two surfaces, downhill surface and uphill surface, one of the surfaces being substantially perpendicular to the axis of the nozzle itself, and having an open base faced towards the outlet orifice of the nozzle, namely directed in way to favor the escape of the decomposition gases, which are generated from the wall of the divergent outlet section owing to the strong heating due to the electric arc, along a direction concomitant with the direction flow of the quenching gas stream. The dimensions of the substantially triangular diametral cross-section of each annular groove decrease little by little from the first groove, immediately downstream the intermediate throat section to the last groove closer to the nozzle outlet, with the distance between adjacent grooves increasing among successive grooves in the direction of the nozzle outlet.

EP Application No. 84109801.5 filed August 17, 1984, for "Gas insulated circuit breaker" assigned to the assignee of the present invention is for improving a small capacitive current interrupting property as well as large fault current interrupting property discloses an insulation nozzle, the outlet divergent section thereof has an annular triangular groove formed downstream of the intermediate throat section. The vertex angle and the height of the downstream ridge of the annular triangular groove are so selected that a part of the compressed gas flow are possitively directed by the annular trianguar groove to the visinity of the front end portion of the stationary arcing contact to prevent the transient decrease of a gas pressure thereat due to the sudden changes of the sectional area, which causes an eletrical breakdown between contacts, even with the continuous increase of the distance between the contacts during the current interrupting operation.

Summary of the Invention

An object of the present invention is to provide a puffer type gas blast breaker having an insulation nozzle with a relatively large downstream divergent angle of which a transient dielectric withstand voltage substantially continuously increases together with an increase of a distance between arcing contacts of the circuit breaker during the current interrupting operation thereof so that a small capacitive current as well as a large fault current interrupting properties of the circuit breaker is improved.

Another object of the present invention is to provide an insulation nozzle for a puffer type gas blast circuit breaker wherein a sudden drop of a blast gas pressure at the visinity of the front end of the stationary arcing contact in the downstream divergent section of the insulation nozzle is prevented during current interrupting operation.

A puffer type gas blast circuit breaker of the present invention comprises a stationary arcing contact, a movable arcing contact connect and disconnectable with the stationary arcing contact, and an insulation nozzle moving together with the movable contact and surrounding the movable contact so as to guide a compressed gas between the arcing contacts. The insulation nozzle is formed of an upstream convergent section surrounding the movable arcing contact, a downstream divergent section and an intermediate throat section. The downstream divergent section includes a first annular triangular groove and a second annular triangular groove. The first annular triangular groove is disposed downstream to the intermediate throat section. The second annular triangular groove is disposed downstream to the first annular triangular groove and so dimensioned that an angle of a line between the downstream edge of the intermediate throat section and the downstream ridge of the second annular triangular groove to the axis of the insulation nozzle is smaller than that of a line between the downstream edge of the intermediate throat section and the downstream ridge of the first annular triangular groove to the axis of the insulation nozzle whereby a part of the compressed blast gas is directed to the visinity of the front end portion, particularly 30^{o}-70^{o} position from the top, of the stationary arcing contact, where an electric field strength is also high, to apply a dynamic pressure thereat during substantially whole contact openning stroke of the circuit breaker, in other words until the insulation nozzle leaves the stationary arcing contact, and to thereby prevent the sudden drops of the blast gas pressure thereat which may cause an electrical breakdown between the contacts.

Brief Discription of the Drawings

Fig. 1 is an essential part cross-sectional view illustrating one embodiment of the puffer type gas blast circuit breaker of the present invention in one contact openning stroke.

Fig. 2 is the same essential part cross-sectional view as Fig. 1, but in another contact opening stroke.

Fig. 3 is an enlarged cross-sectional view of a part of the insulation nozzle illustrated in Figs. 1 and 2.

Fig. 4 is a graph illustrating electric field strengths, gas pressures and dielectric withstand voltages at respective front points of the stationary arcing contact shown in Fig. 2.

Preferred Embodiment of the Invention

Referring now to Figs. 1 and 2, Fig. 1 shows one stroke during circuit interrupting oepration and Fig. 2 shows another further proceeded stroke during circuit interrupting operation in that a separating distance between a stationary arcing contant 12 and a movable arcing contact 14 is further than that shown in Fig. 1. The movable arcing contact 14 is supported by a shaft 22 of a puffer cylinder 16 with which a stationary puffer piston 20 forms a puffer chamber 18, and wehrein a compressed gas is generated through the movement of the puffer cylinder 16 by an operating device (not shown) mechanically coupled to the cylinder shaft 22. An insulation nozzle 10 made of Tetrafluoroethylene fluorocarbon polymer is fixed to an end of the puffer cylinder 16 by a holder 30. A flow guide 26 is provided around the movable arcing contact 14. The compressed gas generated in the puffer chamber 18 is introduced through bores 28 in the puffer cylinder 16 into a passage formed between an upstream and inlet convergent section of the insulation nozzle 10 and the flow guide 6 as shown by arrows.

When the operating device receives a circuit interruption instruction, the device moves the puffer cylinder 16 to the left in the drawing. As a result, an arc extinguishing gas, preferably SF_6 gas, in the puffer chamber 18 begins to be compressed and the contact opening operation starts, before the intermediate throat section of the insulation nozzle 10 passes through the front end of the stationary arcing contact 12, the greater part of the compressed gas in the puffer chamber 18 flows through a center bore of the movable arcing contact 14 and a bore 24 formed in the cylinder shaft 22 as shown by arrows.

When the circuit openning operation further proceeds as shown in Fig. 1, in that, a first annular triangular groove 34 formed on the wall of the downstream outlet divergent section of the insulation nozzle 10 comes to the front end of the stationary arcing contact 12, the greater part of the compressed gas flows through the intermediate throat section 32 as shown by arrows and a part of which is forced by the first annular triangular groove 34 to flow to the front end of the stationary arcing contact 12, particularly 30^{o}-70^{o} position from the top thereof, wherein the sudden gas pressure drop and the intense electric field are taking place.

When the circuit openning operation further more proceeds as shown in Fig. 2, in that, a second annular triangular groove 36 formed downstream the first annular triangular groove 34 of the insulation nozzle 10 comes to the front end of the stationary arcing contact 12, a further gas flow is caused by the second annular triangular groove 36 which directs to the front end of the stationary arcing contact 12 and applies a dynamic pressure thereto to prevent the sudden pressure drops.

The same is true with a third annular triangular groove 38 disposed downstream the second annular triangular groove 36. Since the three annular triangular grooves 34, 36, and 38 are disposed over the substantially whole longitudinal length of the downstream divergent section of the insulation nozzle 10, the sudden pressure drops at the visinity of the front end of the stationary arcing contact 12 are prevented until the insulation nozzle 10 has passed through the stationary arcing contact 12 when the distance between the movable arcing contact 14 and the stationary arcing contact 12 is large enough to withstand a recovery voltage between the contacts and thus to prevent an electrical breakdown therebetween.

Now the dimension of the first, second and third annular triangular grooves 34, 36 and 38 in the downstream divergent section of the insulation nozzle 10 is explained with reference to Fig. 3.

An angle P_1, for example 15°, which is formed by a line between a dwonstream edge 40 of the intermediate throat section 32 and a downstream ridge 42 of the first annular triangular groove 34 to a line parallel to the axis of the insulation nozzle 10 is selected to be larger than an angle P_2, for example 10°, which is formed by a line between the downstream edge 40 and a downstream ridge 44 of the second annular triangular groove 36 to the line parallel to the axis of the insulation nozzle 10, further the angle P_2 is selected to be larger than an angle P_3, for example 7.5°, which is formed by a line between the downstrem edge 40 and a downstream ridge 46 of the third annular triangular groove 38 to the line parallel to the axis of the insulation nozzle 10.

Angles θ_1, and θ_2 in Fig. 3 relates to a generation of whirls of the blast gas, which has to be prevented, in a gas streams in the downstream divergent section of the insulation nozzle 10.

The angle θ_1 is defined by lines between respective upstream ridges 40, 42 and 44 to the respective bottoms 48, 50 and 52 of the first, second and third annular triangular grooves 34, 36 and 38 to the axis of the insulation nozzle 10, in other words, by downhill surfaces of the first, second and third annular triangular grooves 34, 36 and 38 to the axis of the insulation nozzle 10 and in the present embodiment is selected to be, for example 43°.

The angle θ_2 is defined by lines between respective bottoms 40, 42 and 44 to the respective downstream ridges 42, 44 and 46 of the first, second and third annular triangular grooves 34, 36 and 38 to the axis of the insulation nozzle 10, in other words, by uphill surfaces of the first, second and third annular triangular grooves 34, 36 and 38 to the axis of the insulation nozzle 10 and in the present embodiment is selectd to be, for example 28°.

Fig. 4 shows effects of the insulation nozzle as explained with reference to Figs. 1, 2 and 3.

Curve 60 shows dielectric withstand voltages of the present invention at respective front points of the stationary arcing contact wherein the insulation nozzle as explained above is employed, in that, $P_1 > P_2 > P_3$. The location of the insulation nozzle with respect to the stationary arcing contact is as shown in Fig. 2, in that, the distance between the stationary arcing contact and the movable arcing contact is about 80mm.

Curve 62 shows dielectric withstand voltages of a comparative circuit breaker at respective front points of the stationary contact wehrein a comparative insulation nozzle with angles $P_1 \leq P_2 \leq P_3$ is employed and the location of the insulation nozzle with respect to the stationary arcing contact is as same as the case of curve 60.

Curve 64 shows gas pressures of the present invention at respective front points of the stationary arcing contact wherein the conditions are as same as explained in connection with the curve 60.

Curve 66 shows gas pressures of the comparative circuit breaker at respective front points of the stationary arcing contact wherein the conditions are as same as explained in connection with the curve 62.

Curve 68 shows electric field strengths of the present invention and the comparative circuit breaker at respective front points of the stationary arcing contacts.

The respective points at front end of the stationary arcing contact 12 are schematically illustrated at the bottom of Fig. 4.

As will be seen from Fig. 4, the dielectric withstand voltages, and the gas pressures of the present invention at respective front points of the stationary arcing contact, particularly at the points of 30°-70° position from the top of the stationary arcing contact are greatly improved, accordingly, the small capacitive current interrupting property as well as a large fault current interrupting property are increased of the puffer type gas blast circuit breaker of the present invention.

Claims:

1. A puffer type gas blast circuit breaker comprising:

a movable cylinder (16) with a hollow cylinder shaft (22);

a stationary piston (20) coupled with said movable cylinder (16) so as to generate a compressed gas during circuit interrupting operation;

a stationary arcing contact (12);

a movable arcing contact (14) engageable and disengageable with said stationary arcing contact (12) and fixed to the hollow cylinder shaft (22) of said movable cylinder (16); and

an insulation nozzle (10) fixed to said movable cylinder (16) and surrounding said movable arcing contact (14) so as to guide the compressed gas between said stationary and movable arcing contacts (12, 14), said insulation nozzle (10) being formed of an upstream convergent section surrounding said movable arcing contact (14), a downstream divergent section and an intermediate throat section (32),

Characterized in that :

the downstream divergent section of said insulation nozzle (10) including a first annular triangular groove (34) disposed downstream to the intermediate throat section (32) and a second annular triangular groove (36) disposed downstream to said first annular triangular groove (34) and so dimensioned that an angle (P_2) of a line between the downstream edge (40) of the intermediate throat section (32) and the downstream ridge (44) of said second annular triangular groove (36) to the axis of said insulation nozzle (10) is smaller than that (P_1) of a line between the downstream edge (40) of the intermediate throat section (32) and the downstream ridge (42) of said first annular triangle groove (34) to the axis of said insulation nozzle (10).

2. A puffer type gas blast circuit bereaker according to claim 1 further characterized in that the divergent section of said insulation nozzle (10) including a third annular triangular groove (38) disposed downstream to said second annular triangular groove (36) and so dimensioned that an angle (P_3) of a line between the downstream edge (40) of the intermediate throat section (32) and the downstream ridge (46) of said third annular triangular groove (38) to the axis of said insulation nozzle (10) is smaller than that (P_2) of the line between the downstream edge (40) of the intermediate throat section (32) and the downstream ridge (44) of said second annular triangular groove (36) to the axis of said insulation nozzle (10).

3. A puffer type gas blast circuit breaker according to claims 1 or 2 further characterized in that an angle (θ_1) of the downhill surfaces and that (θ_2) of the uphill surfaces of said first, second and third annular triangular grooves (34, 36, 38) to the axis of said insulation nozzle (10) are so selected as not to cause whirls of the blast gas in the divergent section during circuit interrupting operation.

4. A puffer type gas blast circuit breaker according to claims 1 or 2 further characterized in that an angle (θ_1) of the downhill surfaces and that (θ_2) of the uphill surfaces of said first, second and third annular triangular grooves (34, 36, 38) to the axis of said insulation nozzle (10) are about 43° and 28° respectively.

FIG. 1

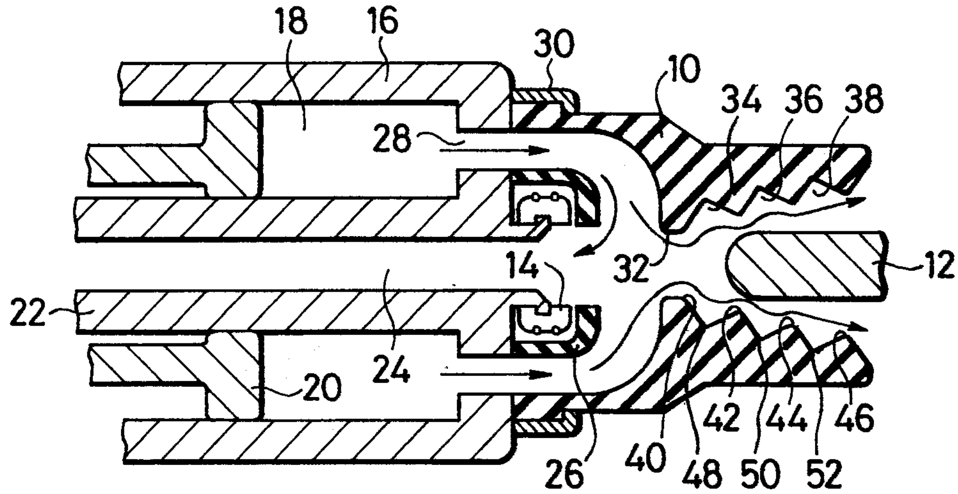


FIG. 2

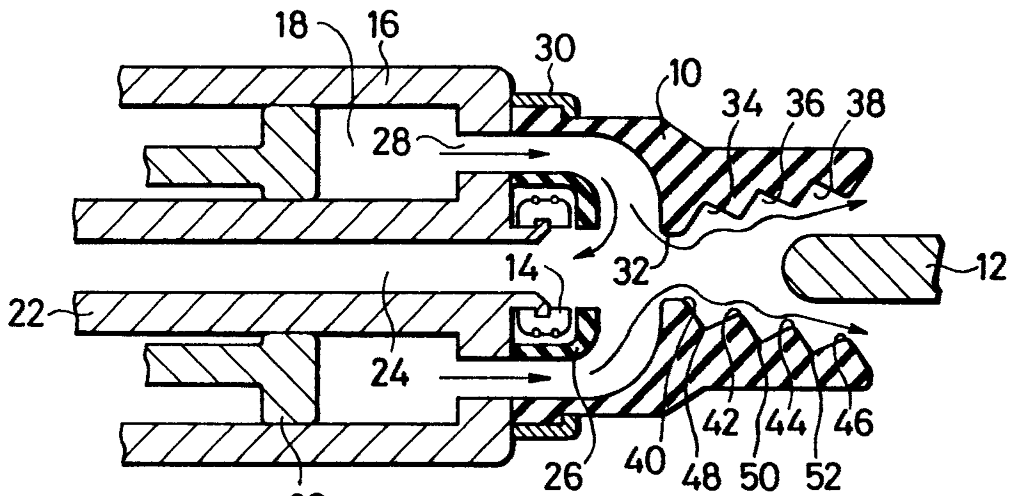


FIG. 3

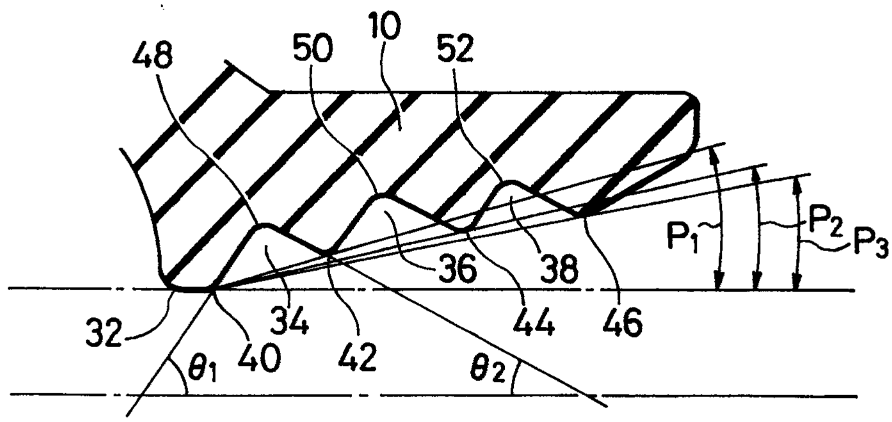
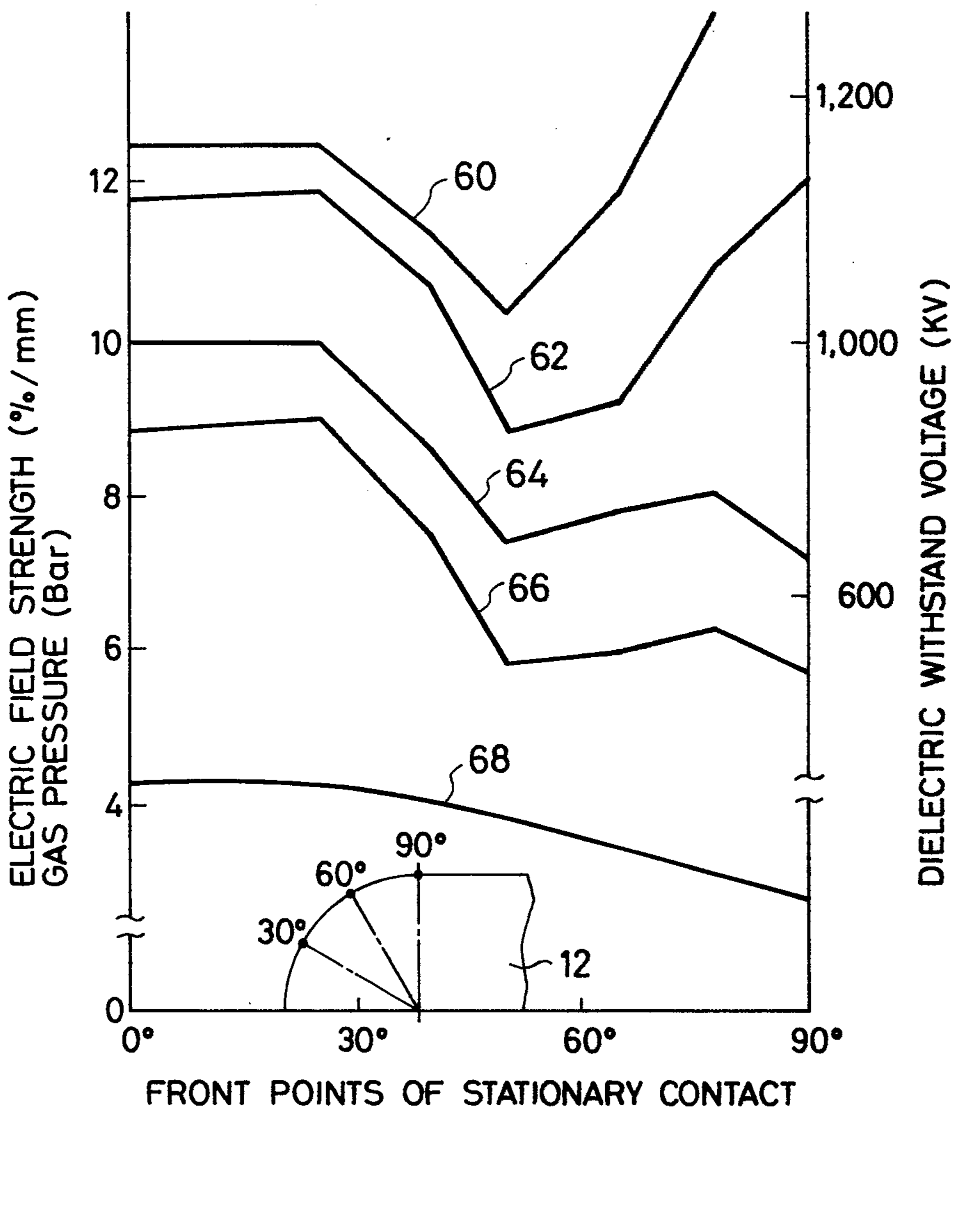


FIG. 4


ELECTRIC FIELD STRENGTH (%/mm)
GAS PRESSURE (Bar)
DIELECTRIC WITHSTAND VOLTAGE (KV)
0
4
6
8
10
12
1,200
1,000
600
60
62
64
66
68
90°
60°
30°
12
0°
30°
60°
90°
FRONT POINTS OF STATIONARY CONTACT