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DISCHARGE GAP

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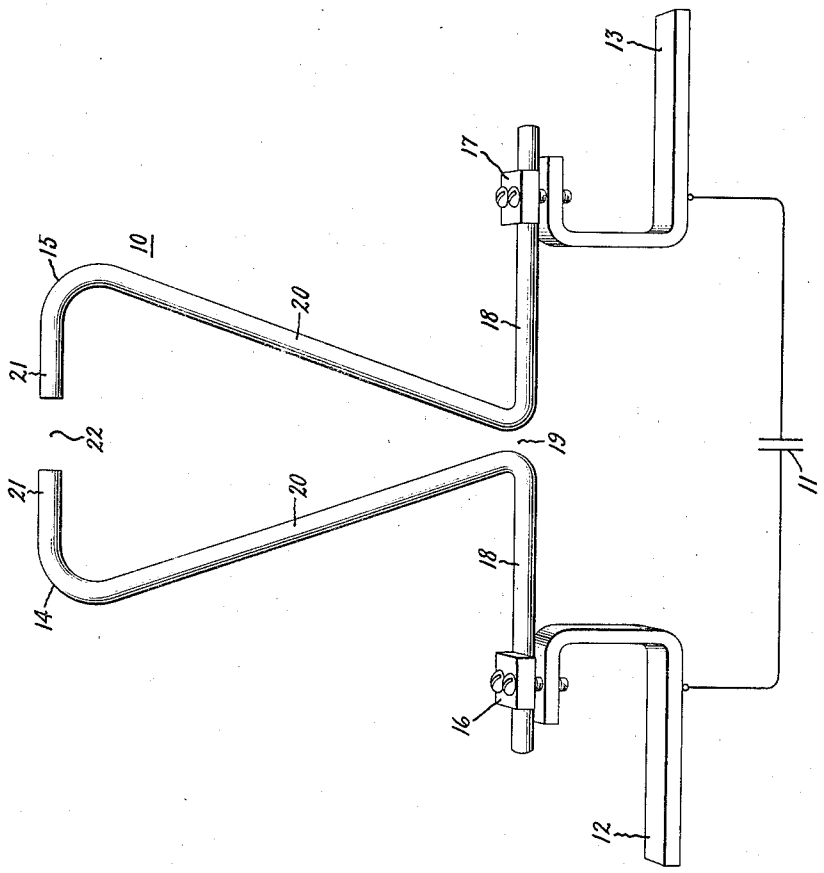

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DISCHARGE GAP

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3 Claims. (Cl. 175—30)

My invention relates to discharge gaps and more particularly to discharge gaps of the horn type. A discharge gap may be connected across various kinds of electrical apparatus such as condensers and transformers to protect the apparatus from excess voltages. A conventional horn gap as used in the past has included two horn electrodes accurately spaced at their lower ends to provide a gap which will arc-over when the voltage between them reaches a predetermined value, the arc serving to short circuit the apparatus across which the gap is connected so as to prevent appreciable rise of voltage above that at which the gap has arced over. The electrodes of the conventional horn gap extend upwardly and diverge from each other so that the space between them gradually increases until it reaches a maximum at their upper ends. After an arc forms between the bases of the electrodes where the spacing is a minimum, the arc will rise between the electrodes until it reaches their upper tips where the spacing is a maximum, the arc being forced upwardly by a magnetic action and also because the temperature of the arc is far above the surrounding air. The current flowing in the arc also flows in both electrodes so that this current surrounds the restricted space between the electrodes and creates a concentrated magnetic field which tends to force the arc upwardly even after it reaches the upper tips of the electrodes. This action will force the center of the arc above the tips of the electrodes until the arc is finally so long that the voltage can no longer maintain it and it goes out. If the voltage has not decreased, an arc will again strike between the base portions of the electrodes and this cycle will be repeated indefinitely until the voltage has been reduced below that necessary to break down the gap at the base of the electrodes. This repeated striking of the arc at the base of the electrodes soon burns the surfaces of the electrodes at this point and changes the characteristics of the gap so that it may not give the desired protection for the apparatus across which it is connected. It is obviously desirable that the arc should persist after it has reached the upper tips of the electrodes until the voltage has been reduced below that which will cause the arc to restrike between the bases of the electrodes. This will greatly reduce the injury to the arcing surfaces between the bases of the electrodes and greatly prolong their useful life.

The general object of the invention is to provide a discharge gap of the horn type having such characteristics that an arc which may reach a position between the upper tips of the electrodes will persist until the voltage has been reduced sufficiently to prevent restriking of the arc between the bases of the electrodes or at least to delay the extinguishment of the arc and greatly reduce the frequency at which it will restrike between the bases of the electrodes as compared with its action in a horn gap of the conventional type.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which the single figure shows a horn gap constructed in accordance with the invention and connected across a condenser to protect the condenser from the effects of excess voltage, the condenser being shown diagrammatically. In the drawing the gap is shown rotated ninety degrees counterclockwise from its position when in use.

The horn gap 10 shown in the drawing is connected across a capacitor 11 between two terminals 12 and 13. The horn gap 10 includes two horns 14 and 15 connected respectively to the two terminals 12 and 13 and adjustably secured in place by the clamps 16 and 17. Each electrode includes a base portion 18 accurately spaced at their adjacent ends to provide a protective gap 19 proportioned to arc-over when the voltage between the electrodes reaches a predetermined maximum value beyond which it would be apt to injure the condenser 11. The intermediate portions 20 of the electrodes diverge upwardly from the protective gap 19 and their upper ends or tips 21 extend toward each other to provide a gap 22 which is somewhat longer than the protective gap 19 but considerably shorter than the distance between the adjacent upper parts of the intermediate portions 20 of the electrodes 14 and 15.

If the voltage across the condenser 11 increases and approaches a dangerous value, it will cause an arc to strike across the protective gap 19 to protect the condenser. This arc will rise between the electrodes 14 and 15 under the influence of its heat and the magnetic field surrounded by the current in the arc and in the portions of the electrodes below the arc. As the arc rises it becomes longer and longer until it reaches the upper ends of the intermediate portions 20 of the electrodes, finally decreasing as it reaches the upper gap 22 where the length of the arc will be somewhat greater than at the protective gap 19. The heated condition of the arc at the gap 22 tends to cause the arc to rise into an upwardly curved position but the magnetic

field produced by the arc current between the sides of the electrodes is very much less than in the conventional horn arrester because the space between the intermediate portions **20** of the horns is much greater and the magnetic field much less concentrated under the arc. An arc having once reached the upper gap **22**, therefore, tends to persist if the gap **22** is properly proportioned until the voltage between the terminals **12** and **13** has decreased to such a value that it cannot cause the arc to restrike across the gap **19** if it should be extinguished at the gap **22**. Even if the arc should be extinguished at the gap **22** before the voltage can cause it to restrike at the gap **19**, this action will be very much retarded as compared with that of the conventional horn gap so that restriking of the arc at the protective gap **19** will be much less frequent and injury to the arcing surfaces of the electrodes at this gap **19** much reduced.

The electrodes **14** and **15** may be formed of any suitable metal such as copper and a plating of chromium has been found to be of advantage in preventing corrosion and in prolonging the life of the arcing surfaces of the electrodes. Electrodes formed of round, copper wires or rods about ¼ inch in diameter have given excellent results as good as or better than those secured by the use of conventional sphere gaps and a horn gap constructed in accordance with the present invention is obviously much simpler and more economical than a sphere gap. Parts of the horn gap subject to deterioration from effects of the arc are also inexpensive and may be easily and quickly replaced. If the arc current is found to exceed more than about 60 amperes, it may be desirable to use horns somewhat larger than ¼ inch in diameter. The tendency of the arc to persist after it reaches the upper gap **22** provides adequate time for any ionized air produced initially by the arc at the gap **19** to be carried away from this protective gap **19** and thus help to prevent restriking of the arc after the voltage has decreased below it normal restrike value.

The invention has been explained by describing and illustrating a preferred embodiment thereof, but it will be obvious that changes may be made without departing from the spirit of the invention and the scope of the appended claims.

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

1. An electrical discharge gap including electrodes spaced to provide a protective gap, the electrodes extending upwardly from said gap and diverging from each other, and the upper ends of the electrodes finally extending toward each other to provide a second gap longer than said protective gap but shorter than the distance between the adjacent upper parts of said diverging portions.

2. An electrical discharge gap including electrodes having base portions with their adjacent ends spaced to form a protective gap, intermediate portions diverging upwardly from said base portions, and upper end portions extending toward each other from said intermediate portions to form a second gap longer than said protective gap but shorter than the adjacent upper parts of said intermediate portions.

3. A voltage limiting arc gap for capacitors comprising, in combination, a pair of electrodes in air spaced to form a calibrated discharge gap which arcs-over at a predetermined voltage, metal arms extending upwardly from said electrodes in a vertical plane and diverging from each other whereby an arc between said electrodes will rise vertically under the combined influence of the heat of the arc and the magnetic action of the current and will be drawn out by the divergence of said arms, and a second gap formed between the upper extremities of said arms, said second gap having a maximum spacing which is less than the spacing between the upper extremities of said arms, said arms being of such length and divergence that an arc rising between them will transfer to said second gap and remain there without restriking across the calibrated gap if the voltage does not fall below the arc-over voltage of the calibrated gap, said second gap having a minimum spacing which is sufficiently greater than the spacing of said calibrated gap to cause an arc across said second gap to clear at a voltage lower than the arc-over voltage of said calibrated gap.

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