May 26, 1959 J. L. GRATZMULLER 2,888,540

CIRCUIT BREAKER

Filed March 17, 1954 2 Sheets-Sheet 1

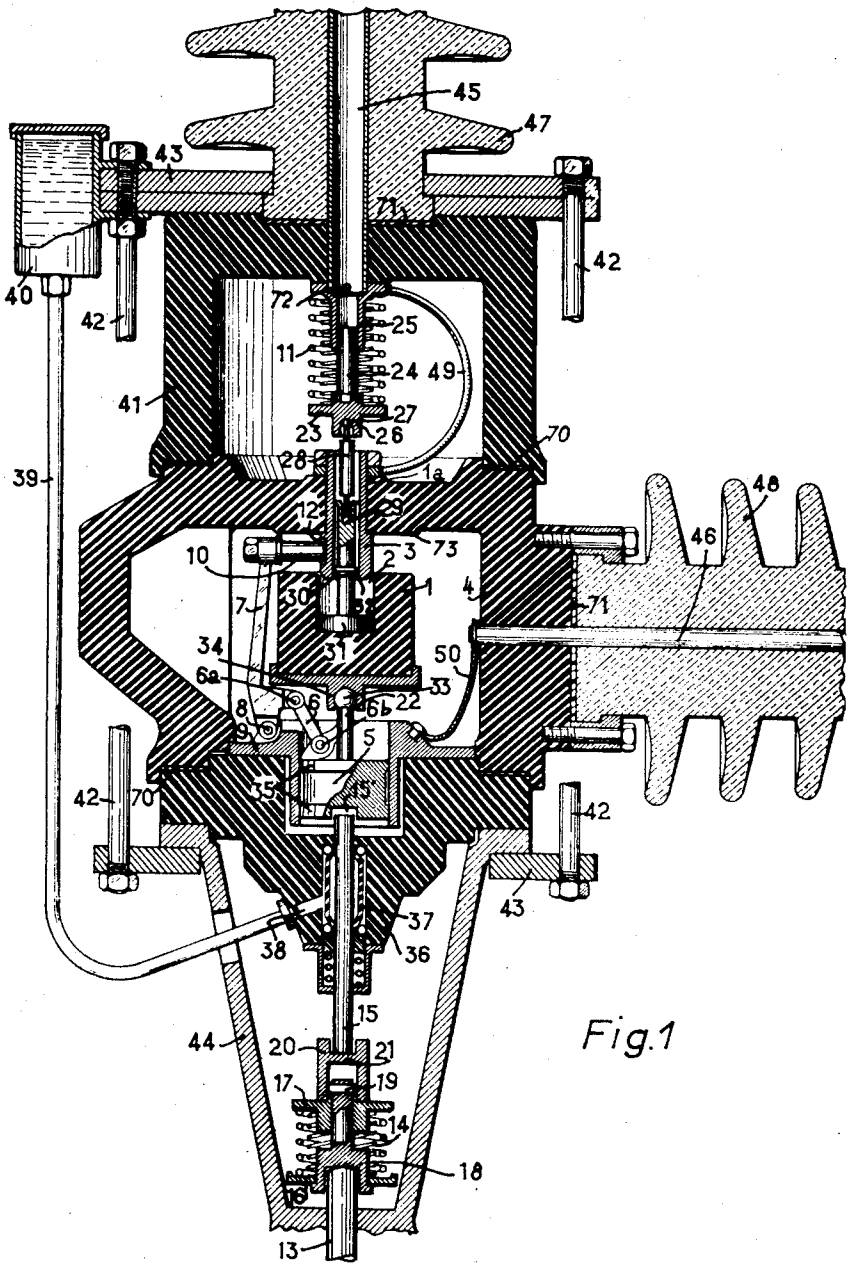

Fig.1

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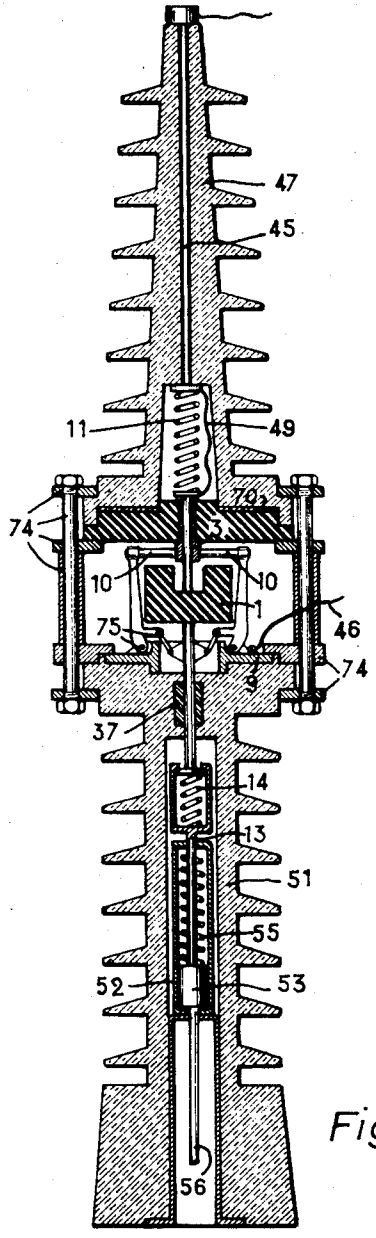

Fig. 2

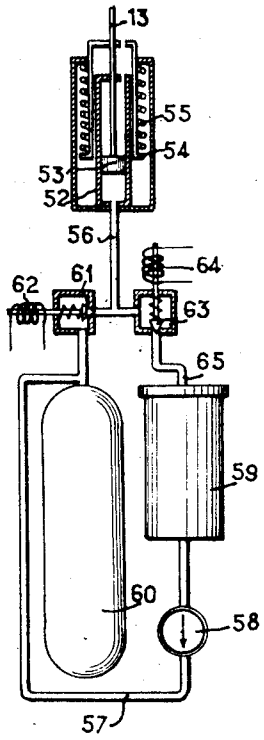

Fig. 3

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CIRCUIT BREAKER

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9 Claims. (Cl. 200—151)

This invention relates to circuit breakers.

In the known circuit breakers, two normally interconnected conductor terminals immersed in a liquid or gaseous fluid are separated as suddenly as possible. Said fluid is then immediately ionised and there is established a breaking arc that must be snuffed out as quickly as possible.

Many devices have been proposed for extinguishing the breaking arc, such as oil circuit breakers.

These devices, however, are bulky and expensive, liable to fire hazards and they are not easily adapted to quick operation.

Another more recent type is the air-blast circuit-breaker. In this type of apparatus, the contacts after having been separated receive a violent jet of compressed air which rapidly blows the ionised air away, thus ensuring a rapid extinguishment of the arc.

Such air-blast circuit-breakers offer a good safety and are extremely efficient. Unfortunately, they also have a number of drawbacks, the most objectionable of which is to imply the use of a source of pressure fluid and associated control apparatus, which greatly increases the expense and complication of the device.

This invention has for its purpose to provide a new and improved circuit-breaker having none of the above enumerated drawbacks.

An object of the invention is therefore to provide a circuit breaker in which an arc-proof insulating partition is interposed between the conductor terminals when the same are separated, said partition being made of a solid and, hence, non-ionisable dielectric material and being so dimensioned that it prevents an arc from being established along a path surrounding said partition.

This arrangement permits suppressing the ancillary installations which, in the known circuit-breakers, are provided to rapidly and continuously renew the dielectric fluid as it becomes ionised until the arc is completely extinguished.

Another object of the invention is to provide a circuit-breaker of this type, so designed that the only possible path of the current, upon formation of a breaking arc passes through an opening in said insulating partition, while a movable valve member made of a solid dielectric material is adapted to close said opening with a gas-tight and arc-proof seal, a short time after separation of the conductor terminals.

A further object of the invention is to provide a circuit-breaker of the type described wherein control means are provided to bring the arc-proof insulating valve member into operative position between the conductor terminals, upon separation of the same in a time sufficiently short to avoid any objectionable effect of heating due to the breaking arc, said control means being furthermore adapted to remove said valve member while re-establishing the normal interconnection between the conductor terminals either through usual metallic leads, or through any suitable conducting fluid.

The use of a solid dielectric material according to the invention offers many advantages: it suppresses the drawbacks of ionisation and, hence, the necessity of renewing the dielectric medium. Moreover, a fluid dielectric material evidently requires a container, while, with a solid dielectric material, it is possible to leave, if desired, one of the conductor ends in free air, an insulating closed working chamber being unnecessary.

A circuit-breaker according to the invention offers the same degree of safety and the same rapidity of operation, all other things being equal, as an air-blast circuit-breaker, while the suppression of the compressed air installation permits a considerable reduction of cost.

A more particular object of the invention is to provide a circuit-breaker of the type described, in which one of the conductor terminals to be disconnected is constituted by a fixed electrode on which at least one movable contact constituting the other conductor terminal is normally pressed and said movable contact is actuated from the control means of the dielectric valve member in such a manner as to be removed from the fixed electrode by a sufficient distance to accommodate the valve member when the same is brought into its operative insulating position around the aforesaid opening.

In a preferred embodiment, the movable dielectric valve member and the movable contact are actuated by a same mechanism operatively connected with the above-mentioned control means.

A particular object of the invention is to provide such a mechanism in which the movable valve member is actuated by a sliding rod operatively connected with the movable contact through a linkage designed in such a manner that that portion of the movable contact stroke during which said contact is removed to accommodate the valve member corresponds to a small portion of the valve member stroke.

With this arrangement, it is possible to considerably reduce the distance between the two extreme positions of the valve member.

Another object of the invention is to provide a circuit breaker of the type described in which the solid dielectric partition with its movable valve-like member and the conductor terminals to be disconnected are enclosed in an insulating housing which is separated with an air-tight seal by said partition, when said valve member is seated, into two compartments.

Still another object of the invention is to provide a circuit breaker of the above-described type, in which the control means are constituted by a hydraulic or pneumatic jack capable of ensuring either connection or disconnection of the conductor terminals against the action of return elastic means.

The operating medium of such a jack is preferably oil from an oil-and-air accumulator.

This mode of control permits ensuring a quick operation of the circuit-breaker, say about $\frac{1}{100}$ of a second, while using only a comparatively small volume of oil.

Still a further object of the invention is to provide a circuit breaker controlled in the manner just described, in which the piston rod of the jack is operatively connected with the dielectric valve member through a shock absorbing device capable of protecting said valve member against abnormal stresses of the jack.

Such a shock-absorbing device offers the further advantage of permitting a certain play in the transmission so that the movable valve member is only connected with the jack when the same has reached its maximum speed of displacement, which reduces to a minimum the duration of the operative stroke of said valve member.

Other objects and advantages of the invention will be apparent from the following detailed description, to-

gether with the accompanying drawings, submitted for purposes of illustration only and not intended to define the scope of the invention, reference being had for that purpose to the subjoined claims.

In these drawings:

Fig. 1 is an axial sectional view of a circuit-breaker according to the invention.

Fig. 2 is an axial sectional view of another embodiment in which one of the conductor ends to be disconnected is not insulated with respect to atmosphere.

Fig. 3 is a diagram of a hydraulic control installation for a circuit breaker according to the invention.

In the example shown in Fig. 1, the movable portion of the dielectric partition of the circuit-breaker according to the invention is constituted by a valve movable member 1 made of a solid dielectric material and provided with a cylindrical recess 2 by which member 1 covers, when closed, the tip of an electrode 3 emerging from an opening 1*a* provided in the wall of an insulating enclosure 4 that constitutes the fixed portion of said partition. The valve movable member 1 is brought into its closing position on seat 73 around opening 1*a* by a slidable member 5 operatively connected through a connecting rod 6 with a tilting contact carrier 7 articulated at 8 on a member 9 fixedly secured with respect to enclosure 4 and on which is slidably mounted, in the example shown, the controlling member 5. The opening of the valve movable member 1 is ensured by elastic means such as springs 11 which, in the example shown, bear in the bottom of recess 2 of member 1 through guiding elements, as described hereunder.

In the opened position of the valve movable member 1 shown in Fig. 1, the movable contact 10 carried by support 7 is engaged in a small recess 12 provided, for this purpose, in the peripheral surface of the emerging tip of electrode 3 and is maintained in the bottom of said recess under the action of the return springs 11 through the above-mentioned guiding elements and through members 1 and 5 and connecting rod 6.

In the example shown, the control of the valve movable member 1 through the slidable element 5 is ensured from a jack (not shown) which may be actuated in the manner described hereunder with reference to Fig. 3. The rod 13 of said jack acts on the slidable member 5 through a shock-absorbing device comprising elastic means, such as springs 14, capable of absorbing abnormal stresses occurring in the jack and through an insulating rod 15. It is to be noted that the transmission of the jack action to the valve movable member 1 and, hence, to the return springs 11, exclusively gives rise to thrusts, which is also the case for the return action of springs 11 on the valve movable member 1. This arrangement permits avoiding any play between the elements of the transmission, while ensuring a safe operation of the latter without requiring a rigorous relative centering of said elements and while facilitating assembling of the parts. The above-mentioned shock-absorbing device includes in addition to the springs 14 two coaxial plates 16 and 17 which are urged away from each other by said springs, plate 16 bearing on an annular shoulder of an intermediate part 18 slidably mounted in an axial bore provided for this purpose in plate 17.

A gudgeon-pin 19 passing through that end of the intermediate part 18 which is opposed to the above-mentioned shoulder limits, in cooperation therewith, the spacing of plates 16 and 17, while avoiding a complete release of springs 14. The intermediate part 18 is provided at its end opposed to the gudgeon-pin 19 with an axial recess in which is engaged rod 13 of the jack. Plate 17 bears on one end of a sleeve 20 divided by a diametral partition 21 into two compartments, that compartment of which the end bears on plate 17 housing the gudgeon-pin 19 as well as that end of the intermediate part 18 in which said gudgeon-pin is engaged. Finally, when the springs 14 happen to be strongly compressed

under the action of jack 13, plates 16 and 17 are held spaced by the abutment of two annular surfaces, one of which is provided on plate 17 while the other one is disposed on the intermediate part 18, the above-mentioned compartment of sleeve 20 in which the gudgeon-pin 19 is housed being sufficiently deep to permit a relative displacement between plate 17 and the assembly 16—18 from the position shown in Fig. 1 to mutual abutting position. The partition 21 of sleeve 20 bears on one end of an insulating rod 15 surrounded by the second one of the above-mentioned cylindrical compartments of sleeve 20, while the other end of said rod rests in the bottom of an axial recess provided for this purpose in the slidable member 5, the latter bearing through a pushing-rod 22 integral therewith on the movable member 1.

A certain play is provided at any point between the insulating rod 15 and the slidable member 5, e.g. at 15' as shown. Thus, the valve movable member 1 only begins to be moved as the rod 13 of the jack has reached its maximum speed, which permits imparting said valve movable member with a very high acceleration from the very beginning of its stroke. It goes without saying that the minimum strength of springs 14 should be considerably stronger than that of the return springs 11 of the valve movable member 1.

In the example shown, said springs 11 are mounted between a plate 23 fast with a rod 24 and a member 25 fixed with respect to enclosure 4 and in a bore of which said rod 24 is slidably mounted. Plate 23 carries on its face opposed to that which is acted upon by springs 11 an axial boss 26 in the bottom of which bears through a ball 27 one end of a rod 28, the other end of which bears through a second ball 29 in the bottom of an axial recess provided in one end of another rod 30, the other reinforced end 31 of which is engaged in the bottom of the cylindrical recess 2 of the valve movable member 1. Rod 30—31 is guided in one single point near its middle in the bore of electrode 3 by a bead 32, while its end opposed to the valve movable member 1 is engaged in said bore with a sufficient clearance to provide said rod with a certain freedom of orientation.

The rod 22 of the slidable member 5 is mounted through a ball-and-socket joint, as shown at 33, in an axial recess of a boss 34 of the valve movable member 1, this arrangement ensuring a certain freedom of orientation to said member 1 with respect to rod 22.

Now, the slidable member 5 is guided in the bore of the fixed element 9 by means of two beads 35 axially spaced by a material distance, which avoids any risk of jamming. For a similar purpose, the insulating rod 15 is mounted with play in the slidable member 5 as well as in the sleeve 20. Moreover, the intermediate part 18 of the above-described shock-absorbing device is, again for the same purpose, also mounted with play, on the rod 13 of the jack. The insulating rod 15 passes through a head 36 also made of an insulating material with interposition of an oil packing gland 37 fed through a passage 38 and a pipe 39 from a tank 40 with oil under a light pressure, tank 40 being disposed above the level of the packing gland 37, so as to avoid the presence of any air bubbles in said packing gland.

In the example shown, the return springs 11 are housed in a second enclosure 41 disposed above enclosure 4, both enclosures, as well as the head 36, being held assembled together by means of draw-bolts 42 cooperating with rings 43, the lower one of said rings moreover holding a casing 44 in which is housed the shock-absorbing device. Casing 44 may also support the control jack (not shown). Insulating joints 70 are interposed between enclosures 41 and 4 as well as between the latter and head 36. The two conductors 45 and 46 to be disconnected are led-in through the usual insulators 47 and 48, respectively, the first one to the top of enclosure 41

and the second one on a side of enclosure 4. A cable 49 interconnects conductor 45 with electrode 3, while another cable 50 interconnects conductor 46 with the fixed part 9 supporting the carrying member 7 of the movable contact 10. Joints 71 are interposed between insulators 47—48 and the enclosures 41 and 4, respectively. If the conductors are constituted by insulated cables, the insulators 47 and 48 may be substituted for by junction-boxes.

In the position shown in Fig. 1 of the circuit breaker, the conductors 45 and 46 are interconnected through the cable 49, the fixed contact electrode 3, the movable contact 10, its carrying member 7, the fixed element 9 and the cable 50.

A hole 72 communicates the inner space of enclosure 41 with atmosphere. In the embodiment shown in Fig. 1, for the sake of clearness, the left-hand half of the axial sectional view shows one single movable contact 7—10, while the other half of said view is taken in the plane of conductor 46. It is to be noted that, in practice, there are preferably provided at least two movable contacts symmetrically arranged with respect to the general axis of the circuit breaker, so as to uniformly distribute the transversal forces of inertia.

The circuit breaker which has been just described operates as follows: as oil is sent into the jack of the circuit breaker (e.g. by means of the installation shown in Fig. 3), rod 13 exerts a thrust, preferably only after having reached its maximum speed on the valve movable member 1 through part 18, plate 16, springs 14, plate 17, sleeve 20, the insulating rod 15, the sliding member 5 and rod 22. As soon as the slidable member 5 begins to move (upwardly in the drawing), the connecting-rod 6 tilts anticlockwise the contact carrier 7 and hence the movable contact 10 around axis 8 (as shown in Fig. 1). It is to be noted that the connecting-rod 6, the contact carrier 7 and the slidable member 5 are so designed that, at the beginning of its stroke, the movable contact 10 moves more rapidly than later on. Thus, the position of the valve member corresponding to maximum opening may be chosen closely spaced from its closing position.

In the example shown, it may be seen that the valve movable member 1 begins to cap electrode 3 as soon as its displacement is initiated. When the movable contact 10 has been removed by a sufficient distance, the conjugated displacements of said movable contact and the valve member 1 going on, the latter is free to completely recover the tip of electrode 3 while surrounding the whole periphery of the opening 1*a* and while seating with an air-tight arc-proof seal on seat 73. The control means of the circuit breaker are so designed that the active stroke of the valve movable member 1 takes place in a very short time (about $\frac{1}{100}$ sec.). In these conditions, it will be easily understood that the breaking arc which is initiated as the movable contact 10 is removed away from the stationary electrode 3 is literally snuffed out as member 1 suddenly caps the electrode tip 3, whereupon member 1 pressed on its seat 73 maintains said electrode tip insulated. The reestablishment of the electrical connection interrupted by the circuit breaker is caused by releasing the pressure in the jack to permit the return springs 11 to bring the valve movable member 1 and the movable contact 10 back into the position shown in Fig. 1, in which the circuit is completed again upon application of the movable contact 10 on the stationary electrode 3 under the pressure exerted by the return springs 11.

It is to be noted that the re-establishment of the circuit is not necessarily so rapid as its breaking since if an arc were produced during the terminal portion of the stroke of the movable contact 10, said arc would be immediately extinguished upon application of said movable contact on the fixed electrode.

In the alternative embodiment shown in Fig. 2, the various insulating enclosures have been omitted. One of

the conductors, 46, is directly connected with the fixed member 9 and the device merely comprises two insulators, one of which, 47, supported by a suitable structure protects the other conductor 45, while the other one, 51, insulates the contacts of the circuit breakers with respect to ground. The insulators 47 and 51 are connected together by clamping assemblies 74. Conductor 45 is directly connected with the fixed electrode 3 and conductor 46 is connected through member 9 with one or more movable contacts 10 (two in the example shown).

As previously, the breaking of the circuit is ensured by a dielectric valve movable member 1 completely capping electrode 3, this operation causing simultaneously, thanks to a mechanism similar to that of Fig. 1, and diagrammatically shown at 75, a sufficient removal of the movable contact 10 to accommodate member 1 between said movable contact and electrode 3. Otherwise, the operation and design of the device of Fig. 2 are similar to those of the device shown in Fig. 1.

Fig. 3 is a diagram of a hydraulic control installation adapted to be used for actuating a circuit breaker according to the invention.

There is shown at 52 a jack, of which the piston 53 carries a rod which may be the above-mentioned rod 13. This movable assembly of jack 52 exerts in the direction of the active stroke of the jack a pressure on a stirrup member 54 on which bears a spring 55 provided to ensure the return stroke of the jack. Jack 52 is fed through a pipe 56 from an air-oil accumulator 60 under the control of an electro-valve 61 operated by an electro-magnet 62. The oil stock of the accumulator 60 may be renewed from time to time, if necessary, from a tank 59 by means of a pump 58 through a suitable pipe 57. The release of the pressure in jack 52 is ensured by means of a derivated arm 65 of the duct 56 connected with tank 59 under the control of a second electro-valve 63 actuated by an electro-magnet 64.

It is to be understood that the invention is not intended to be limited to the examples shown and described, nor otherwise that defined in the appended claims.

What is claimed is:

1. A circuit breaker comprising, in combination, two conductor terminals, means to interconnect said terminals to thereby establish an electrical conducting path therethrough and to separate said terminals to thereby interrupt said path, an arc-proof solid dielectric body interposed between said terminals when the same are separated, said body being so dimensioned as to interrupt any possible arc path between said terminals and having a fixed portion provided with an opening through which said conducting path is accommodated and a movable portion constituted by a valve member, means to seat said valve member on said fixed portion around the whole periphery of said opening, when said terminals are separated, under a pressure sufficient to ensure arc-proof gas-tight sealing of said opening and means to lift said valve member off said seat to permit said interconnection of said terminals.

2. A circuit breaker according to claim 1, wherein common control means are provided to ensure interconnection of said conductor terminals upon lifting of said valve member and seating of said valve member upon separation of said terminals.

3. A circuit breaker according to claim 2, wherein one of said conductor terminals is constituted by an electrode fixedly secured on said dielectric body fixed portion in said opening with its tip emerging therefrom, said valve member being adapted, when seated, to completely cap said emerging tip and wherein the other conductor terminal is constituted by at least one movable contact separable from said fixed electrode under the action of said control means by a distance sufficient to accommodate said valve member.

4. A circuit breaker according to claim 3, wherein said valve member is actuated by a sliding rod opera-

tively connected with said movable contact through a linkage so designed that the portion of the angular stroke of the movable contact during which the same is separated from said fixed electrode by a distance just sufficient to accommodate said valve member corresponds to a small portion of the stroke of said valve member.

5. A circuit breaker according to claim 1, wherein said conductor terminals are enclosed in an insulating housing and wherein said solid dielectric body is constituted by a partition separating, when said valve member is seated, said housing into two gas-tightly insulated compartments.

6. A circuit breaker according to claim 1, in which one of said valve member lifting and seating means is constituted by an elastic return system and in which the other one of said means is constituted by a hydraulic jack fed from an oil-and-air accumulator and acting against said elastic return system.

7. A circuit breaker according to claim 6, wherein the rod of said jack is operatively connected with said valve member through a shock-absorbing device.

8. A circuit breaker according to claim 7, wherein a slight play is provided in the interconnection between the jack rod and the valve member, so that the latter is only actuated by said rod when the same has reached its maximum speed of displacement, whereby the duration of the valve member active stroke is reduced to a minimum.

9. A circuit breaker according to claim 3, comprising a plurality of movable contacts symmetrically arranged with respect to the general axis of the circuit-breaker.

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