Oct. 6, 1953 M. LAVERTY 2,654,815

ELECTRIC CIRCUIT INTERRUPTER

Filed Dec. 27, 1948

Fig. 1.

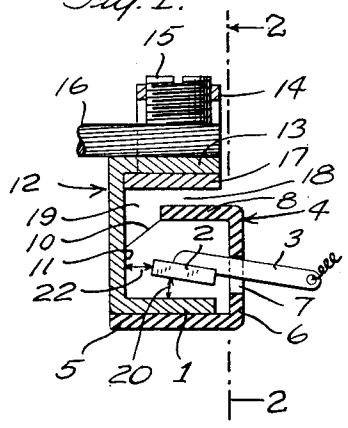


Fig. 2.

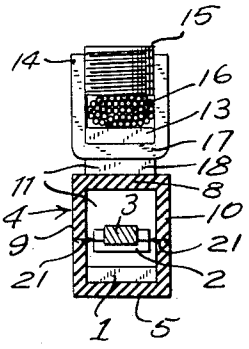


Fig. 3.

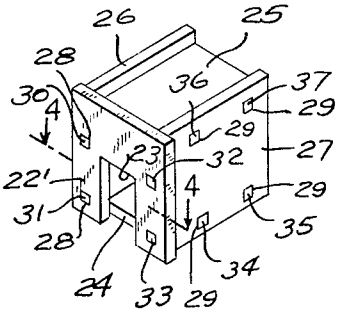


Fig. 4.

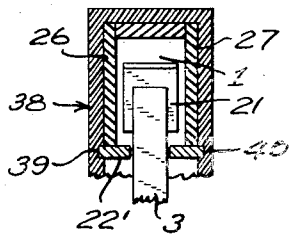


Fig. 5.

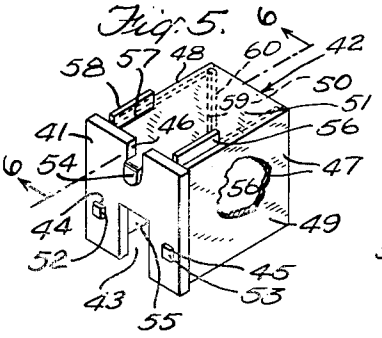


Fig. 6.

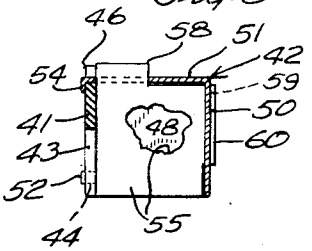


Fig. 7.

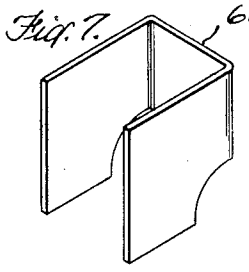


Fig. 9.

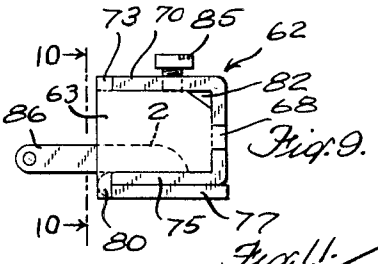


Fig. 10.

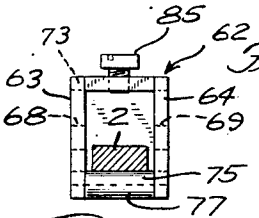


Fig. 11.

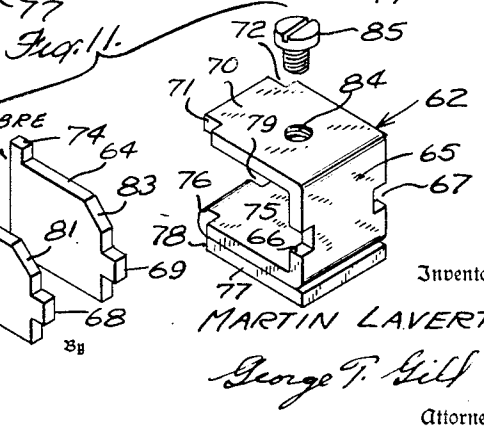
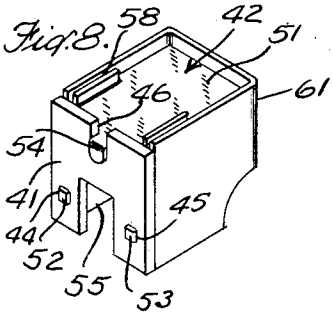


Fig. 8.



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ELECTRIC CIRCUIT INTERRUPTER

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4 Claims. (Cl. 200—144)

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The invention herein disclosed relates to an electric circuit interrupter of the kind in which relatively movable contacts are separated to open or interrupt an electric circuit, such for example, as switches and circuit breakers. More particularly, and specifically, the invention relates to circuit interrupters of nominal capacity, that is rated around one hundred amperies and one hundred to two hundred and fifty volts, such as are commonly enclosed in a molded, thermoplastic case, and suitable for general use in factories, offices and homes.

The primary object of the invention is to provide an arrangement of contacts and surrounding structure, in a circuit interrupter of the kind mentioned, which arrangement minimizes the arc produced at the contacts upon the separation of the contacts to interrupt or open an electric circuit. Another object of the invention is to provide such an arrangement in which, on interrupting an alternating current, the arc dies out as the current wave approaches zero. A further object of the invention is to provide an arrangement of the kind mentioned which acts to minimize the burning action of the contacts. Another object of the invention is to provide such an arrangement wherein the air surrounding the arc is materially limited. An additional object of the invention is to provide such an arrangement in which the expanding gases generated in the formation of an arc are caused to travel a tortuous path in contact with heat-dissipating surfaces so that the gases and solid particles carried thereby are substantially cooled before the gases are vented to the surrounding air.

The foregoing objects, and certain advantages that will hereinafter appear, are realized in the arrangements illustrated in the accompanying drawings and described in detail below, from which description a clear understanding of the invention may be had.

The drawings include:

Fig. 1 which is a sectional, side elevation of an arrangement of contacts and surrounding structure embodying the invention;

Fig. 2 which is a transverse section of the same, taken on the line 2—2 of Fig. 1;

Fig. 3 which is an isometric view of one form of housing for the contacts;

Fig. 4 which is a section of the housing of Fig. 3 taken on the line 4—4 of Fig. 3 and showing the housing within a case;

Fig. 5 which is an isometric view of another modified form of housing for the contacts;

Fig. 6 which is a sectional, side elevation of the housing of Fig. 5, taken along the line 6—6 of Fig. 5;

Fig. 7 which is an isometric view of a shield for the housing of Fig. 5;

Fig. 8 which is an isometric view of the housing of Fig. 5 with the shield of Fig. 7 in place;

Fig. 9 which is a side elevation of another

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form of an arrangement embodying the invention;

Fig. 10 which is a sectional, end elevation of the same taken on the line 10—10 of Fig. 9;

Fig. 11 which is an isometric, exploded view of the housing of Figs. 9 and 10.

While the principles forming the basis of this invention appear to have general utility in circuit interrupters of the kind mentioned, the invention is particularly and specifically useful in circuit interrupters, such for example, as switches and circuit breakers that are enclosed within a plastic case and which are of nominal, rated capacity, such as circuit interrupters of general utility in factories, offices and homes. In general, an arrangement embodying this invention includes two relatively movable contacts and an enclosing or surrounding housing that forms an arc chamber. The relation of the contacts to each other, their size or mass, their relation to the enclosing housing and the structure and material of the enclosing housing are important factors in the arrangement of this invention. These several factors are so related as to minimize the arc produced upon the separation of the contacts, and to minimize the destructive effects of any arc produced.

In accordance with the invention, the area and cross section or the mass of the contacts, at the arcing surfaces, are greater than that required for normal heat dissipation and arc disposal; the separation of the contacts, in interrupting a circuit, is limited to that distance which is necessary to insure a positive break regardless of any burning or lumping of the contact surfaces; the contacts are surrounded, as closely as is mechanically feasible, with an arc chamber housing; and the housing, at least the side walls adjacent the side edges of the contacts, consists of an insulating material which does not lose its insulating characteristics after being subjected to numerous arcs, and, preferably, a material which assists in quenching any arc formed. Many and various arrangements may be designed to incorporate these principles and secure the advantages of the invention. However, after numerous experiments and tests, the arrangements illustrated in the drawings have been found to be satisfactory in performance and economical to manufacture.

The arrangement illustrated in Figs. 1 and 2 of the drawing includes a stationary contact 1 and a cooperating movable contact 2 that is fixed on a movable arm 3. A housing, designated generally by the numeral 4 and forming an arc chamber, surrounds or encloses the contacts 1 and 2. The housing 4 includes a bottom wall 5, an end wall 6 having a slot 7 therethrough, through which the movable arm 3 extends, a top wall 8, side walls 9 and 10, and an end wall 11, opposite the end wall 6. In this particular arrangement, the end wall 11 consists of a portion of a metallic strip, designated generally by the

numeral 12, another portion of which constitutes the stationary contact 1. The end wall 11 extends at right angles to the contact 1, and at the opposite end thereof, another portion 13, extending at right angles to the wall 11 and parallel to the contact 1, forms a base for a solderless connector 14. The solderless connector 14 is provided with a pressure screw 15. In connecting the arrangement into an electric circuit, a solid or stranded wire 16 is inserted between the pressure screw 15 and the portion 13 of the strip 12. The screw 15 is then tightened down and binds the wire 16 in intimate contact with the surface of the portion 13 of the strip 12. The arm 3 is connected to another wire in any suitable manner.

The portion 13 of the strip 12 is spaced from the top wall 8 of the housing 4 a distance such that the engaging wall 17 of the solderless connector is spaced from the wall 8 to provide a passage 18 therebetween. The top wall 8 is foreshortened so as to provide a vent opening 19 between the end edge thereof and the wall 11. This vent opening 19 communicates with the passage 18.

The arrangement illustrated in Figs. 1 and 2, and described above, is suitable for incorporating the features which form the basis of this invention. In designing an arrangement of this kind, each of the contacts 1 and 2 are designed so that the area and cross section, or mass thereof, at the contacting surfaces or arcing surfaces is two or more times the area and cross section or mass of that required, for the particular circuit interrupter, for normal heat dissipation and arc disposal.

Contacts of electrical switches are considered to have sufficient contact area, cross section and mass, by the recognized authority, the National Board of Fire Underwriters, if they do not rise in temperature, when carrying full rated load, more than thirty degrees (30°) centigrade from an ambient temperature of twenty-five degrees (25°) centigrade. The contacts of circuit breakers are considered satisfactory, by the same authority, if their contacts do not rise more than forty degrees (40°) centigrade from an ambient temperature of twenty-five degrees (25°) centigrade when carrying full rated load. In accordance with this invention, the contacts are made so that the area and cross section or mass is two or more times that specified for the full rated capacity of the particular circuit interrupter.

Experiments have shown that with such contacts, the arc formed on short circuit tests is, on the average, markedly milder. The extra or greater metallic mass of the contacts acts to quickly conduct the heat away from the surfaces at which it originates. An electric arc in which the heat is drawn out rapidly becomes less of an arc, and this heat abstraction coupled with the arc reduction of the falling alternating current wave tends to insure its disappearance within one-half cycle, and to prevent reestablishment of the arc when the voltage rises in the reverse direction.

In addition, movement of the arm 3 is limited so that the separation 20 of contacts 1 and 2, in interrupting a circuit, is limited to that distance necessary to insure a positive break. The limitation of the separating movement of the arm 3 may be effected by the length of the slot 7 in the end wall 2, or by any other suitable means. Numerous experiments have shown that a separation of the contacting surfaces of the contacts 1 and 2, indicated by the arrow designated 20, which approximately equals the thickness of the movable contact 2, or, preferably, with circuit interrupters normally used on circuits of from one hundred to two hundred and fifty volts, a separation of the contacting faces of the contacts of between one one-thousandth and two one-thousandths of an inch per volt, assures a positive break. By so limiting the separation of the contacts, any arc formed is reduced to a minimum.

The housing 4, which forms an arc chamber, should surround or enclose the contacts 1 and 2, as closely as is mechanically feasible. One reason for this is to limit the amount of air, or oxygen, available for any arc formed. In switches and circuit breakers having an Underwriter's rating up to one hundred amperes full load, and which are required to interrupt a short circuit current up to five thousand amperes, the space between the side edges of the movable contact 2 and the side walls 9 and 10 of the housing 4 is critical. If this distance, designated by the numeral 21, and indicated by the arrow, is one-thirty-second of an inch, the arc that is formed on interrupting a current of five thousand amperes is at a minimum. As this space 21, between the side edges of the movable contact and the walls 9 and 10 of the housing, is increased beyond one-thirty-second of an inch, the arc becomes more severe. If the side walls 9 and 10 are removed, the arc becomes extremely violent, to the point of exploding the plastic case normally used with devices of this character, and whose strength is ample for the higher arcs produced, with spaces between the edges of the contacts and the side walls 9 and 10 of one-thirty-second of an inch. The side edges of the stationary contact 1 should, preferably, fit or rather make a tight or snug connection with the side walls 9 and 10 of the housing in order to prevent burning of the side walls and molten metal accumulation.

Contrary to the usual and accepted procedure in arc suppression, this invention minimizes magnetic blow-out action. Experiments and tests have demonstrated that a magnetic blow-out action may tend to increase the violence of an arc. The magnetism forces the arc away from the contacts, and the higher the current value on an alternating current wave the more intense is the magnetic action. The net result is that whereas, with the heavy contacts, short breaks and other means described, the arc tends to die out with the current wave, with magnetic blow-out means the arc often is broken high on the current wave and is much more destructive in its burning action and flame production. To avoid this situation, the stationary contact 1 and the movable contact 2 with its movable arm 3 are carried in a straight line through opposite ends of the arcing chamber. Experiments have shown that when the stationary contact 1 is carried out through a side wall such as either the side wall 9 or 10, and up along the side wall of the arc chamber, the explosive action of any arc produced is greatly intensified.

The material adjacent the side edges of the contacts 1 and 2 is particularly important. As previously stated, it must be an electrical insulating substance which does not lose its insulating characteristics after being subjected to numerous arcs. In addition, it is highly desirable that the material adjacent the side edges of the contacts be such that its reaction to the heat an arc produces assists in minimizing or dissipating the arc. Fibre, either vulcanized fibre or horn fibre possesses these characteristics. The process of extinguishing an arc is a de-ioniz-

ing process and the arc is extinguished when there no longer are sufficient ions in the gap to maintain the arc. Vulcanized fibre or horn fibre, under the heat of the arc, evolves neutral gases and water vapor which produce a turbulence in the arc stream, thereby accelerating the recombining of the ions with those of the opposite polarity to form neutral molecules. In addition, the gases evolved physically blow out the ionized arc stream if not completely enclosed, or when enclosed build up the pressure, thereby increasing the arcing potential in pressure-tight enclosures. Furthermore, the gases generated by fibre under an electric arc consist of approximately fifty percent carbon-monoxide, forty percent hydrogen and a five percent mixture of hydrocarbon gases in addition to the water vapor. The large percentage of carbon-monoxide generated shows that the carbon formed on the surface by the arc actually combines with the oxygen in the cellulosic molecular structure of the fibre and escapes as a gas instead of being deposited on the surface in sufficient quantities to cause tracking. Hence, fibre does not break down under the arc until the material has been depleted of its oxidizing gases. Furthermore, by the action mentioned, the fibre adjacent the contacts assists in extinguishing any arc that is formed.

With the several factors, described above, for minimizing arc production and cooling such arcs as are produced, it is possible to avoid the use of expensive arc-resisting contact tips, such as those made of tungsten-silver and other alloys. The burning of the contacts is reduced to a point where copper and brass combinations may safely be employed for many operations at full load, over load and short circuit values of current. Because of the light burning action, the tendency of the contacts to weld together under short circuit current is almost entirely eliminated. The contacts tend to remain flat and the lumps and beads which result in contact welds are greatly reduced.

In the construction shown in Figs. 1 and 2, and described above, the distance between the end edge of the contact 2 and the metallic end wall 11, indicated by the arrow and designated 22, is slightly more than the break distance 20 to insure that any arc that may be formed will not "hang-on." The metallic strip 12 is either copper or brass. When an arc is formed, upon separation of the contacts to interrupt a heavy current, the molten particles flying out of the flaming arc stream tend to attach themselves to the surface of the metallic end wall 11 as they strike it and are cooled thereby. This reduces the solid matter in the hot gases passing out through the vent 19 and the passage 18. In addition, the metal of the end wall 11 and the passage 18 dissipates the heat of the gases so that as the gases pass out of the passage 18, the temperature thereof is materially reduced.

In Fig. 3 of the drawing, there is illustrated a contact housing, or arc chamber, which, with the exception of one end wall is made up of sheets of fibre. This housing includes an end wall 22' having a slot 23 therethrough for the arm 3 of the movable contact, a bottom wall 24, a top wall 25 and side walls 26 and 27. The several sheets forming these walls of the housing are assembled together through tongue and groove joints. The end wall 22' is provided with several, four in number, openings 28 therethrough. The side walls 26 and 27 are likewise provided with several openings, for example the four openings 29

in the side wall 27. The side wall 26 is provided with two tongues 30 and 31 which enter in the openings 28, and the side wall 27 is likewise provided with tongues 32 and 33 which enter in to openings 28 in the end wall 22'. The bottom wall 24 is provided with tongues 34 and 35 which enter into the lower openings 29 in the side wall 27. Similar tongues on the bottom wall 24 enter into similar openings in the wall 26. The top wall 25 is provided with tongues 36 and 37 which enter into the upper pair of openings 29 in the wall 27. Similar tongues on the opposite edge of the top wall 25 enter into like openings in the wall 26. No end wall opposite the end wall 22' is provided. As in the arrangement of Figs. 1 and 2 an extension of the stationary contact which will rest upon the bottom wall 24 may provide the end wall opposite to the end wall 22'.

The housing of Fig. 3 provides a simple and inexpensive housing or arc chamber for a switch or circuit breaker that is mounted within a plastic case. In the first place, it is made up of sheets of fibre that are readily stamped or cut to form. In addition, it may be readily inserted in a plastic case such for example as the case 38 (Fig. 4). In such an arrangement, the case 38 is provided with grooves 39 and 40 which receive the extended edges, side edges, of the end wall 22'. The housing makes a snug fit within the case 38 and is securely held together by the case.

It is not necessary that the entire housing for the contacts be made of fibre or other insulating material. In Figs. 5 and 6, there is disclosed an arc chamber that includes an end wall 41 which consists of fibre, and a metallic case designated generally by the numeral 42 which forms the remaining part of the chamber. The end wall 41 is provided with a slot 43 for the movable arm 3 of the movable contact 2. It is also provided with openings 44 and 45 and a groove 46 in the upper edge thereof.

The metallic casing 42 is desirably stamped from sheet metal and includes side walls 48 and 49, an end wall 50 and a top wall 51. The side wall 48 is provided with a tab or tongue extension 52 which extends through the opening 44 in the end wall 41 and which is bent over to retain the side wall in contact with the end wall. A like tab 53 is formed on the side wall 47 and extends through the opening 45 in the end wall 41. In addition, a tab 54 extends through the groove 46 in the upper edge of the end wall 41 and is bent over. These three tabs hold the stamping 42 to the fibre end wall 41. With this construction, the side walls 48 and 49 are provided with inner fibre linings 55 and 56. To secure the inner fibre lining 55 in place, the top wall 51 is provided with a slot 57 through which a tongue or extension 58 of the lining extends. In addition, a slot 59 is provided between the side wall 48 and the end wall 50 through which another tongue 60 of the lining 55 extends. In a like manner the lining 56 is secured to the side 49 of the metallic casing 42. Thus, in this arrangement there are fibre pieces adjacent the side edges of the contacts.

With a contact housing or arc chamber such as that shown in Figs. 5 and 6, it is desirable to provide a shield that surrounds the metallic casing 42 to prevent carbonization of the plastic case in which the housing is mounted. Such a shield, 61, is shown in Fig. 7. The shield 61, desirably, is a pressed fibre shield. Before mounting the arc chamber 42 of Figs. 5 and 6 in a case,

such as the case 38, the shield 61 of Fig. 7 is applied to the housing as shown in Fig. 8.

In Figs. 9 to 11, there is disclosed a very simple arrangement embodying this invention. The arrangement includes a metallic strip of bronze or copper, designated generally by the numeral 62, and two fibre side plates 63 and 64. The strip 62 includes a central portion 65 which forms an end wall of the arc chamber. The central portion 65 has slots 66 and 67 in its side edges to receive tongues 68 and 69 of side pieces 63 and 64 respectively. The strip 62 also includes a portion 70 that extends at right angles to the portion 65 and constitutes the top of the arc chamber. The portion 70 has cut-away portions at 71 and 72 to receive extensions 73 and 74 of the side pieces 63 and 64. At the end of the central portion 65 opposite to that end from which the portion 70 extends, there is a portion 75 which also extends at right angles to the portion 65, and parallel to the portion 70. The cross section and area of the portion 75, which forms the stationary contact, is that required for normal dissipation of heat and arc disposal. In order to obtain the mass desired, or twice the area and cross section necessary for heat dissipation and arc disposal at the contact, the strip is bent back upon itself at 76 to provide a portion 77 that is beneath, and in intimate contact with the portion 75. The end edge of the stationary contact is notched at the corners, as at 78 and 79, to receive extensions on the fibre pieces 63 and 64, such as the extension 80 on the piece 63. The body of each of the fibre side walls 63 and 64 is received between the portions 70 and 75. The side wall 63 is cut away at 81 to provide a vent 82. In like maner the side wall 64 is cut away at 83 to provide a similar vent. The portion 70 is provided with a threaded opening 84 to receive a terminal screw 85. A movable contact 86 extends into the arc chamber with slight clearances. The whole assembly fits into a case (not shown) which holds the parts in assembled relation.

In addition to the foregoing arrangements, a fibre tube may be used as an arc housing for the contacts. Tubing made of fibre is a commercial product available on the open market. With its use, a simple and economical arc chamber may be provided, utilizing the principles herein disclosed.

From the foregoing description of the principles of this invention and the detailed description of specific embodiments of the invention that are illustrated in the drawings, it will be apparent to those skilled in the art that by this invention there is provided, in a circuit interrupter, an arrangement of contacts and surrounding structure which arrangement minimizes the arc produced at the contacts upon the separation of the contacts to interrupt or open an electric circuit; which is such that on interrupting an alternating current any arc formed dies out as the current wave approaches zero; which acts to minimize the burning action of the contacts; which materially limits the air and oxygen surrounding the contacts and the arc acting therebetween; and which provides a tortuous path for the expanding gases generated in the formation of an arc which path is lined by heat dissipating surfaces so that the gases and molten metal particles carried thereby are substantially cooled before the gases are vented to the surrounding air.

It will be obvious, to those skilled in the art, that various changes may be made in the details of the several embodiments of the invention illustrated in the drawings and specifically described above within the principle and scope of the invention as defined in the appended claims.

I claim:

1. In an electric circuit interrupter of the kind described, the combination comprising a stationary contact, a movable contact positioned to cooperate with the stationary contact, said stationary contact constituting a portion of a strap of metal that includes a portion extending at an angle to the contact portion and another portion spaced from, extending in the same direction as and substantially parallel to the contact portion, and fibre cooperating with said strap of metal to form a housing enclosing the contacts, the housing having openings therethrough for the passage of gases generated by an arc formed between the contacts.

2. In an electric circuit interrupter of the kind described, the combination comprising a movable contact, a stationary contact positioned to cooperate with the movable contact, said stationary contact constituting a portion of a metal strip having a portion extending substantially at an angle to the contact portion and forming one wall of a housing for the contacts and another portion spaced from and substantially parallel to the contact portion and constituting another wall of the housing for the contacts and providing a connection for a line conductor, and fibre plates cooperating with said metal strip to form the housing for the contacts.

3. In a circuit interrupter of the kind described, the combination comprising a pair of relatively movable contacts, and a housing forming an arcing chamber for the contacts and including fibre side walls, a metal case for retaining the fibre walls in assembled relation, a fibre shield enclosing the metal case for minimizing the burning action of escaping arc-produced gases, and a plastic case enclosing the circuit interrupter.

4. In a circuit interrupter of the kind described, the combination comprising a pair of relatively movable contacts, and a housing for the contacts consisting of a fibre, tube-like structure enclosing the contacts on four sides, and a metallic strip constituting one wall, one of the contacts entering the tube-like structure from one end thereof, and the other contact entering the tube-like structure from the opposite end thereof.

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