Sept. 23, 1969 J. McORLLY 3,468,023

METHOD OF MAKING ELECTRIC RESISTANCE HEATING UNITS

Filed Nov. 1, 1966 2 Sheets-Sheet 1

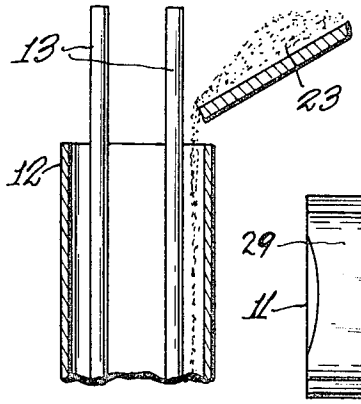


FIG. 3.

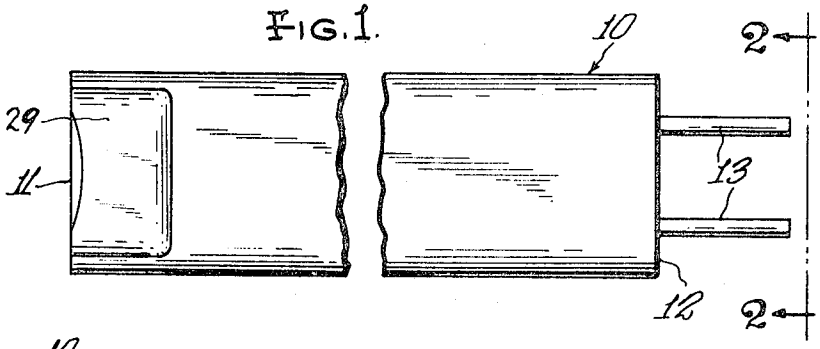
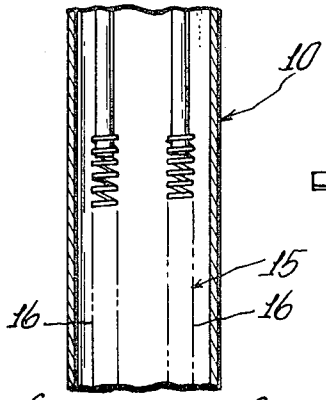


FIG. 1.



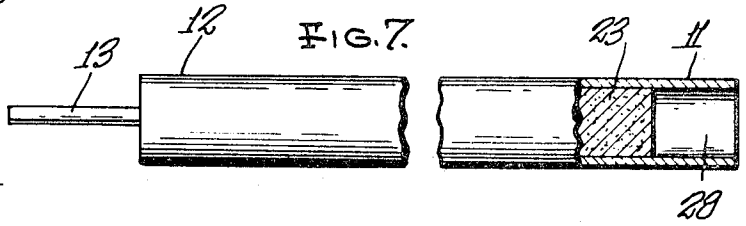
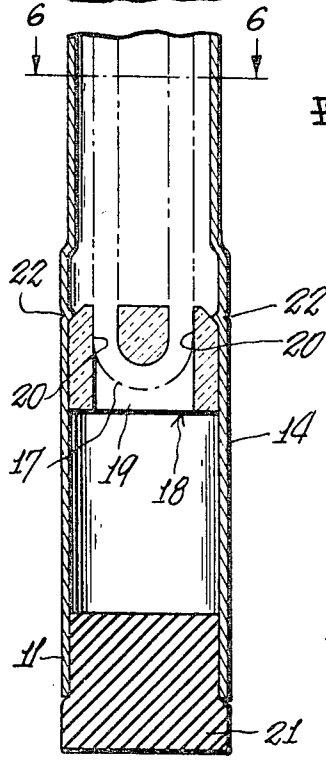


FIG. 7.



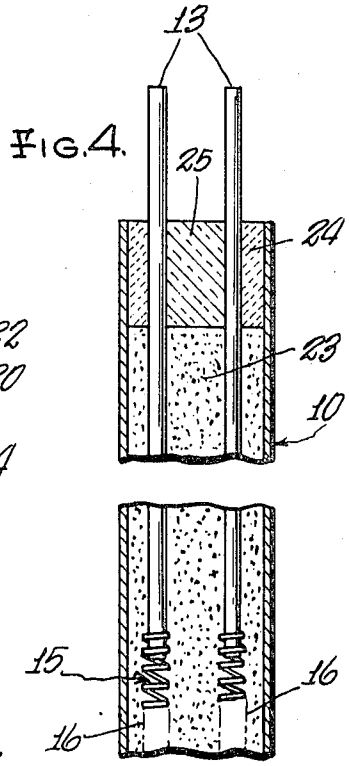
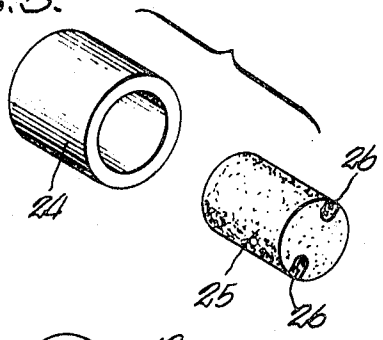


FIG. 4.

FIG. 5.



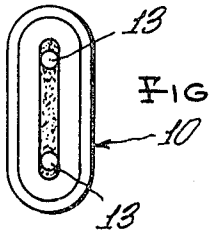


FIG. 2.

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METHOD OF MAKING ELECTRIC RESISTANCE HEATING UNITS

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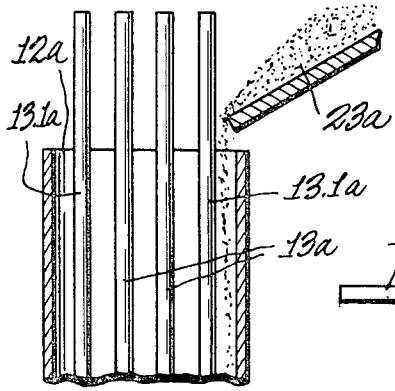


FIG. 10.

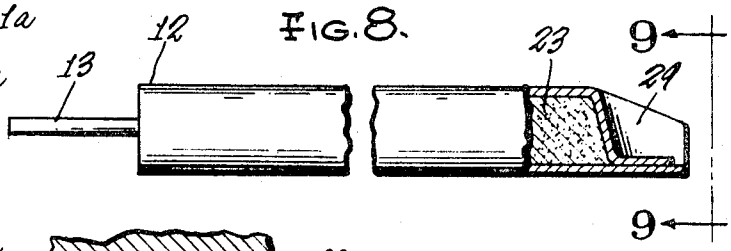
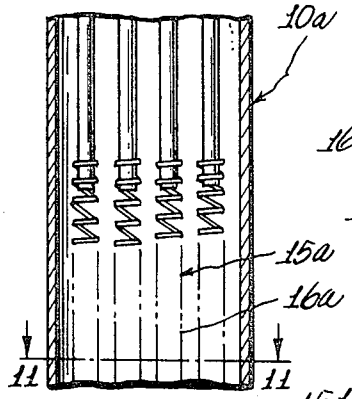


FIG. 8.



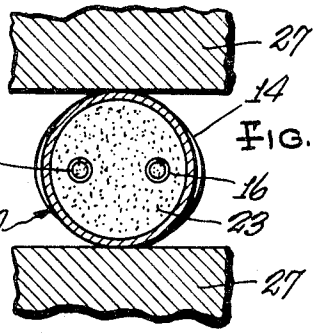


FIG. 6.

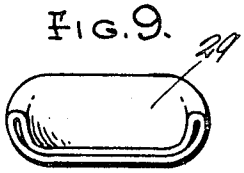


FIG. 9.

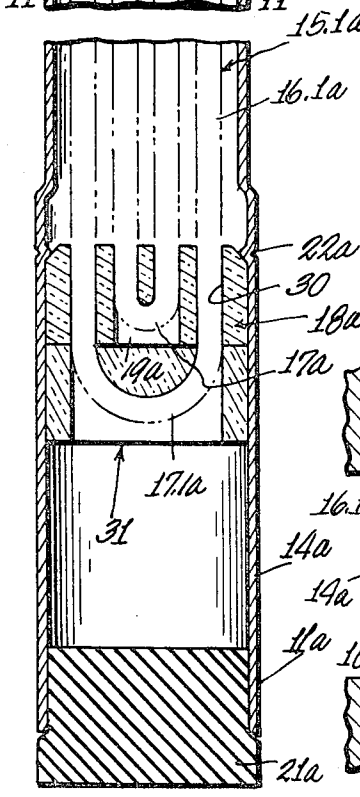
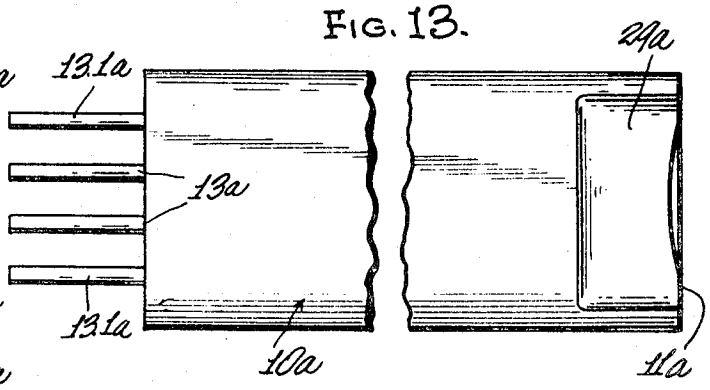


FIG. 13.



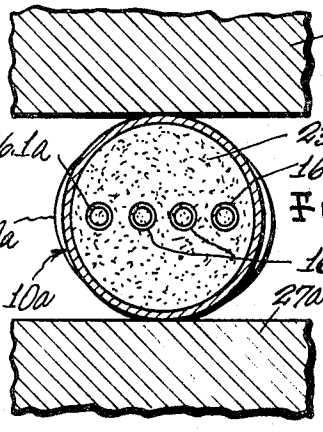


FIG. 11.

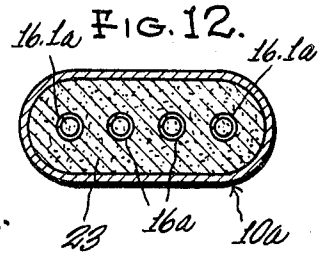


FIG. 12.

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3,468,023

METHOD OF MAKING ELECTRIC RESISTANCE HEATING UNITS

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Int. Cl. H01c 17/00
U.S. Cl. 29—615 8 Claims

ABSTRACT OF THE DISCLOSURE

An electric strip heater, made by disposing a pair of elongated, resistor conductor legs lengthwise within an elongated, cylindrical metal sheath and maintaining the legs in spaced, parallel relation, out of contact with the inner periphery of the sheath and in a diametrical plane extending longitudinally of the sheath, filling the sheath with finely divided refractory material, and flattening the sheath transverse to the diametrical plane to compact the refractory material and to form the sheath to oblong shape.

The present invention relates to electric resistance heating, more particularly to improved electric resistance heating units and methods of making the same, and the principal object of the invention is to provide new and improved methods and articles of the character described.

Metallic sheathed, electric resistance heating units of the type disclosed in Letters Patent No. 2,284,078 or No. 2,330,652, commonly known as strip heaters, have achieved wide usage for a wide variety of heating purposes. Such heaters are in the form of elongated bars essentially rectangular in cross-section. Either of the opposed wide sides of such heaters provide for excellent heat conduction to an abutting body and, because such heaters are relatively thin they may, when desired, be readily bent to conform to the contour of a non-rectilinear surface of a body to be heated.

While prior art heaters of the type disclosed in the patents hereinabove mentioned, have been quite satisfactory, their efficiency has been less than other well-known types of heaters, such as tubular heaters of the general type disclosed in Letters Patent No. 2,428,899. This lower efficiency has resulted from the necessity to operate such strip heaters at a relatively lower sheath temperature, if optimum service is to be attained, for the following reasons:

With prior art strip heaters, it has not been possible to compress the granular refractory material, in which the resistor is embedded, to the degree possible in tubular heaters. Accordingly, since compaction of the material is not as great, such material can not as rapidly conduct heat away from the embedded resistor conductor. This causes a relatively large temperature gradient between the resistor and the metal sheath and, to prevent excessive resistor temperature and consequent premature failure thereof, it is necessary to operate such prior art strip heaters at a relatively lower sheath temperature.

Additionally prior art strip heaters required the addition of a binder, such as clay, to the granular refractory material. Unfortunately, such binder is a much poorer electrical insulator than the granular refractory material and thus the presence of the binder reduces the dielectric efficiently of the mass in which the resistor is embedded. This lowering of insulating value necessitates an increased thickness of insulating material and this, of course, has an adverse effect upon dissipating the heat from the embedded resistor.

In contrast, the present invention provides strip heaters whose efficiency is not materially less than that of the so-called tubular heaters. Moreover, strip heaters may

be made in accordance with the present invention at a much lower manufacturing cost than those of the prior art. These and other advantages will readily become apparent from a study of the following description and from the drawings appended hereto.

In the drawings accompanying the following specification and forming a part of this application there is shown, for purpose of illustration, embodiments which the invention may assume, and in these drawings:

FIGURE 1 is a broken plan view of a metallic sheathed, electric resistance strip heater made in accordance with the present invention,

FIGURE 2 is an end elevational view generally corresponding to the line **2**—**2** of FIGURE 1,

FIGURE 3 is a broken view of the heater of FIGURE 1 in longitudinal section during an early stage of manufacture thereof,

FIGURE 4 is a view of one end of the heater seen in FIGURE 3 at a later stage of manufacture,

FIGURE 5 is an exploded perspective view of details seen in FIGURE 4,

FIGURE 6 is a transverse sectional view, generally corresponding to the line **6**—**6** of FIGURE 1, but at a still later stage of manufacture,

FIGURE 7 is a side elevational view of the heater prior to a final stage of manufacture, a portion of the sheath on the near side being broken away to show the interior thereof,

FIGURE 8 is a view similar to FIGURE 7 but after another manufacturing stage,

FIGURE 9 is an end elevational view generally corresponding to the line **9**—**9** of FIGURE 8,

FIGURE 10 is a view similar to FIGURE 3 but of another embodiment,

FIGURE 11 is a transverse sectional view, generally corresponding to the line **11**—**11** of FIGURE 10, but at a later stage of manufacture,

FIGURE 12 is a view similar to FIGURE 11 but at a still later stage of manufacture, and

FIGURE 13 is a broken plan view of the completed embodiment of the heater seen in FIGURES 10, 11, and 12.

With reference to FIGURES 1 and 2 wherein a preferred embodiment of a heater constructed in accordance with the present invention is seen, such heater is shown to be of elongated bar-like configuration which, in cross-section, is considerably wider than it is thick. Such heater has a metal sheath **10**, one end **11** of which is closed in a manner later to be disclosed and from whose other end **12** a pair of terminal conductors **13** protrude in spaced, side-by-side relation. Although not shown, suitable power leads may be connected to the terminals **13** when the heater is to be energized. In the conventional manner and as will later be disclosed in greater detail, a resistor conductor member is disposed within the sheath **10** and extends between the terminals **13**, such member being adapted to generate heat when electrical energy is passed therethrough.

FIGURE 3 illustrates an initial stage in the manufacture of the heater seen in FIGURES 1 and 2, and at this stage of manufacture, all but the lower, in the position of parts shown, end **11** of the sheath **10** is round in cross-section. Such lower end is preferably slightly flattened to provide an oval configuration at **14**, for a purpose to appear. Disposed within the sheath **10** is the previously mentioned, elongated, helically coiled resistor conductor **15** whose opposite ends are electrically and mechanically secured to the terminal pins **13**. As illustrated, the resistor **15** is doubled back on itself to provide a pair of legs **16** in spaced, side-by-side relation joined at one end by a bight portion **17** within the sheath and with the terminal pins **13** projecting axially outwardly of the sheath upper

end. Means are provided for anchoring the resistor bight portion **17** within the sheath so that the resistor leg portions **16** are spaced from the sheath inner surface and as herein disclosed, such means comprises a frangible, dielectric bushing **18** having a slot **19** for receiving the resistor bight portion **17** and apertures **20** for passing resistor legs **16**. In order to prevent rotation of bushing **18** relative to the sheath, such bushing will preferably be oval to complementarily fit within the oval sheath portion **14**.

With the resistor **15** assembled with the bushing **18** and both disposed within the sheath **10** as shown, the sheath end **11** will temporarily be closed by a resilient plug **21** of rubber or the like. The sheath will then be disposed in the upright relation shown and the terminals **13** pulled up sufficiently to slightly tension the resistor legs **16**. It is essential that the terminals **13** and the resistor legs **16** be maintained in spaced, side-by-side relation and spaced radially inwardly of the sheath interior. Moreover, the resistor legs **16** must not be twisted but must lie in the same plane for a reason to appear. In order to retain the bushing **18** in proper position against the upward pull of the tensioned resistor legs, the sheath is preferably dimpled at **22** to form abutments against which the bushing seats.

With the parts assembled as seen in FIGURE 3 and as hereinabove described, the sheath will be filled from its upper end with a granular, electric-insulating, heat-conductive material **23**, such as finely divided magnesium oxide or the like. To insure complete filling of the sheath, the latter will preferably be vibrated in the usual manner during introduction of the granular material. Although not shown, the periphery of bushing **18** is grooved to pass the granular material so that it will fill the space between the bushing and the rubber plug **21**.

Filling of the sheath with the granular material will progress until a small void remains at the upper end of the sheath; alternatively, the sheath can be more or less completely filled and enough material then removed to provide the void. Into the void thus formed at the top of the sheath, and as seen in FIGURES 4 and 5, a tubular dielectric body **24**, presently formed of mica, will be disposed about the terminal pins **13**. The central bore of the body **24** will be closed by a frangible body **25** having opposed, longitudinally extending grooves **26** for passing respective terminal pins **13**. The bodies **24** and **25**, it will be clear, thus close the upper end of the sheath **10** while passing the terminal pins **13**.

With the sheath filled as hereinabove described and closed at its lower end by the plug **21** and at its upper end by the bodies **24** and **25**, the assembly will be placed between dies **27** (FIGURE 6) and flattened from end-to-end to the cross-section seen in FIGURE 2. It is an important feature of the invention that the sheath will be flattened in the same plane as that in which the resistor legs **16**, **16** lie, such flattening of the sheath reducing its cross-sectional area and thus compacting the material **23** to a rock-like hardness.

During flattening of the sheath, the opposed, unpressed sheath sides will move away from each other and the resistor legs **16** will tend to follow their adjoining sheath sides to increase the transverse spacing between such legs. It is to be noted, however, that the minimum radial spacing between the resistor legs and interior of the sheath will actually be increased following the flattening operation, since the unpressed sheath sides move away from each other a greater distance than the increase in distance between the resistor legs.

It is to be understood that since the bushing **18** and the body **25** are frangible, such components will be pulverized during the flattening operation aforesaid. Body **24**, however, since it is formed of mica, is quite flexible and will assume the flattened shape of the sheath substantially without deterioration. Similarly, since plug **21** is of rubber, it too will distort to follow the flattened form of the sheath while retaining its function of closing the sheath end to prevent loss of material **23**.

After the sheath is flattened as above described, the rubber plug **21** will be removed to leave a void **28** in the sheath end **11** as seen in FIGURE 7. While the sheath end **11** could be closed in any suitable manner to retain the adjoining compacted material **23** against loss of compression thereon, it is presently preferred to displace one of the flattened sheath sides against the other, as seen at **29** in FIGURES 8 and 9, to thus close the sheath end **11**. In the event the sheath end is to be hermetically sealed, as when the heater end **11** is to be immersed in water or the like, the pressed-together sheath margins may be welded together. This expedient, however, will not normally be necessary when the heater is used in the usual atmospheric environment.

The embodiment of the invention seen in FIGURES 10 through 13 is similar to that heretofore described; accordingly, corresponding parts are identified by the same reference characters but with the suffix "*a*" added. The embodiment of FIGURES 10–13 differs primarily from that earlier disclosed in that instead of employing a single resistor, a pair of resistors are employed. For clarity of disclosure, one of the resistors and its associated parts will be identified by the suffix "*a*" as above mentioned while the other and its associated parts will be identified by the suffix "1*a*".

As illustrated, it is preferable to dispose the resistor **15***a* between the legs **16.1***a* of the resistor **15.1***a* with respective resistor bight portions **17***a*, **17.1***a* spaced longitudinally of the sheath and with the portion last-mentioned being closest to the sheath end **11***a*. All of the resistor legs and their terminal pins (FIGURES 10 and 11) are adapted to be disposed in the sheath **10***a* in the same plane and in spaced, side-by-side relation and, in order to maintain the necessary spacing between the resistor legs and between the latter and the inside of the sheath, the latter will preferably be somewhat larger in diameter than the previously disclosed sheath **10**.

Since two instead of one resistor bight portion must be anchored adjacent the sheath end **11***a*, the bushing **18** will have an additional pair of apertures **30**, **30** for respectively passing the legs **16.1***a*, **16.1***a* of the resistor **15.1***a*. Additionally, to anchor the bight portion **17.1***a* of the resistor **15.1***a*, a second bushing **31** will be provided for abutting the underside of the bushing **18***a*. As will be evident, bushing **31** closely resembles the previously described bushing **18** with the exception, of course, that it is larger to complementarily fit with the larger sheath portion **14***a* and provides for retaining the resistor legs **16.1***a* far enough apart to accommodate the resistor **15***a* therebetween.

With reference to FIGURE 11, it will be understood that the filled sheath **10***a* will be flattened in the same plane as that in which the resistor legs **16***a*, **16.1***a* lie to the configuration seen in FIGURE 12. Although not shown, after the sheath **10***a* is filled with the granular material **23***a*, the sheath end **12***a* may be closed in the manner similar to that described in the first-disclosed embodiment.

In view of the foregoing it will be apparent to those skilled in the art that I have accomplished at least the principal object of my invention and it will also be apparent to those skilled in the art that the embodiments herein described may be variously changed and modified, without departing from the spirit of the invention, and that the invention is capable of uses and has advantages not herein specifically described; hence it will be appreciated that the herein disclosed embodiments are illustrative only, and that my invention is not limited thereto.

I claim:

1. The method of making an electric strip heater which comprises,

disposing a pair of elongated, resistor conductor legs lengthwise within a rectilinear, peripherally closed, tubular metallic sheath and maintaining both legs in spaced parallel relation in a plane extending longi-

tudinally of the sheath, with the legs out of contact with the inner periphery of the sheath,

feeding finely divided refractory material through an opening in said sheath and maintaining such feeding until the resistor legs are embedded and electrically insulated from the inner periphery of the sheath,

and transversely flattening the sheath in the same plane as that in which the resistor legs lie to compact the refractory material and to form the sheath to an oblong cross-sectional shape.

2. The method of claim 1 wherein at least one end portion of the flattened sheath is devoid of refractory material, and including the further step of pressing together the sides of the sheath at the void portion to close the sheath at this end.

3. The method of claim 1 including forming the resistor conductor legs by doubling an elongated resistor conductor member on itself and disposing the bight portion at one sheath end and the terminals of the legs at the other sheath end.

4. The method of claim 3 and further comprising the steps of anchoring the bight portion of the legs within the sheath at said one end and holding the terminals of said legs at said other end prior to feeding refractory material into the sheath from said sheath other end.

5. The method of claim 1 wherein the refractory material is fed through one end of the sheath and a bushing is disposed within the other end to prevent escape of refractory material, and including the further steps of removing said bushing following the flattening operation to leave a void portion in said sheath other end, and further pressing together the sides of the sheath at the void portion to close the sheath at this end.

6. The method of making an electric strip heater which comprises,

disposing a pair of elongated resistor conductor legs within an elongated, peripherally closed, cylindrical metal sheath and maintaining both legs in spaced parallel relation in a diametrical plane extending longitudinally of said sheath and with the legs out of contact with the inner periphery of the sheath,

feeding finely divided refractory material through an opening in said sheath and maintaining such feeding until the resistor legs are embedded and electrically insulated from the inner periphery of the sheath,

and flattening the sheath by pressing against those opposite sides of the sheath which are transverse to said diametrical plane to compact the refractory material and to form the sheath to an oblong cross-sectional shape.

7. The method of claim 5 wherein one end of the sheath is of non-circular shape and including the step of disposing a complementarily-shaped dielectric bushing within said end for holding the adjacent ends of said resistor legs against rotation with the sheath.

8. The method of claim 6 wherein the non-circular sheath end is elliptical in shape and the resistor legs are disposed in said diametrical plane which is located coincidental with the long axis of the elliptical shape, and flattening is performed coincidental with the short axis of the elliptical shape.

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