Oct. 31, 1950 H. F. STORM 2,528,019

EMBEDDED ELEMENT SOLE PLATE

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Fig. 1

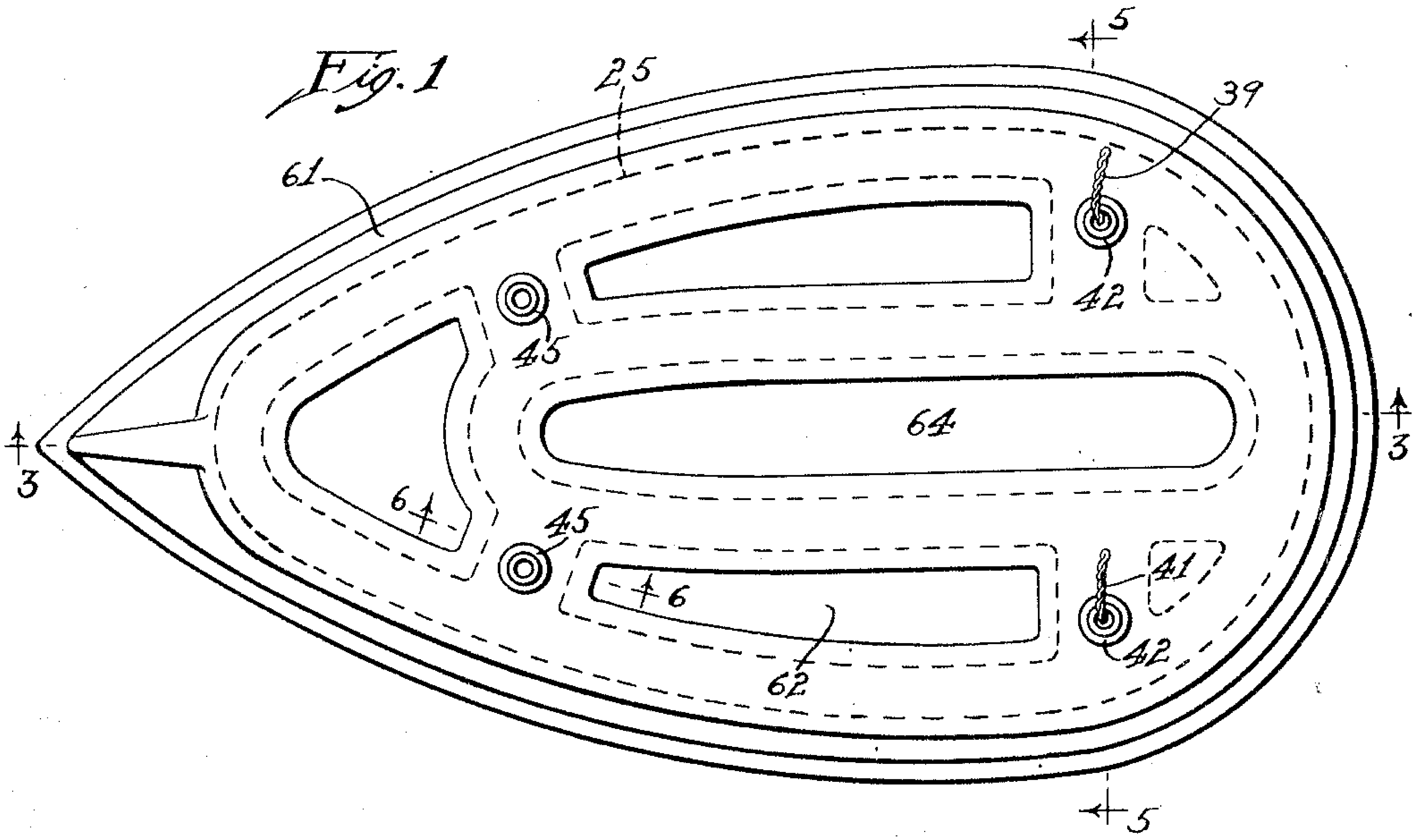

Fig. 2

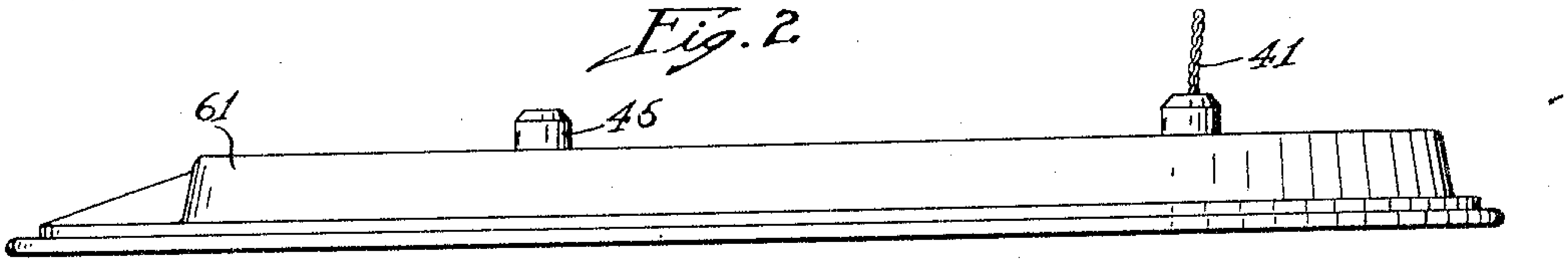

Fig. 3

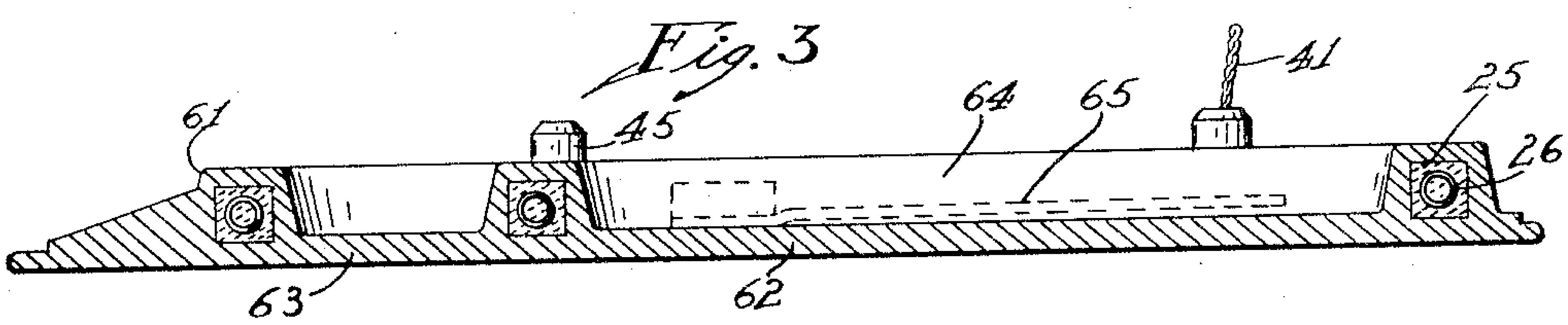

Fig. 4

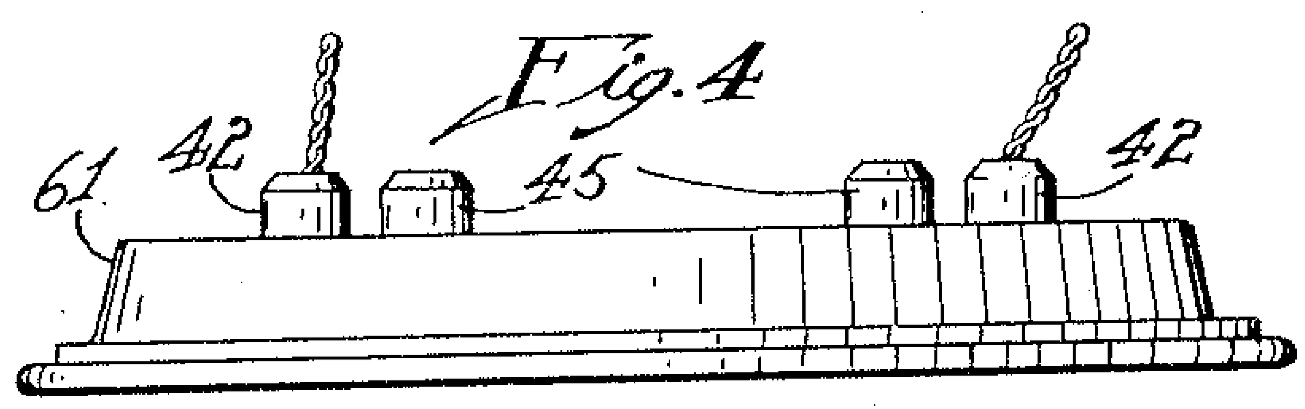

Fig. 6

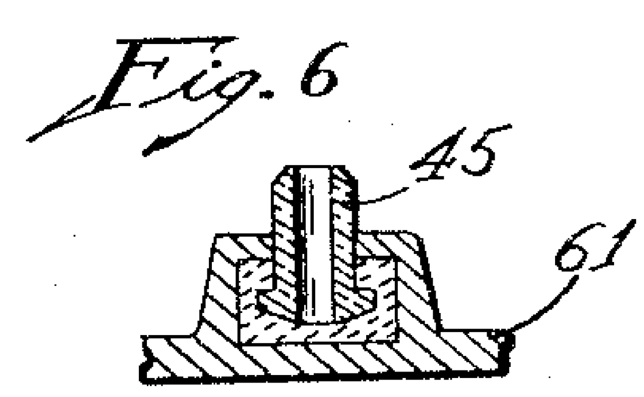

Fig. 5

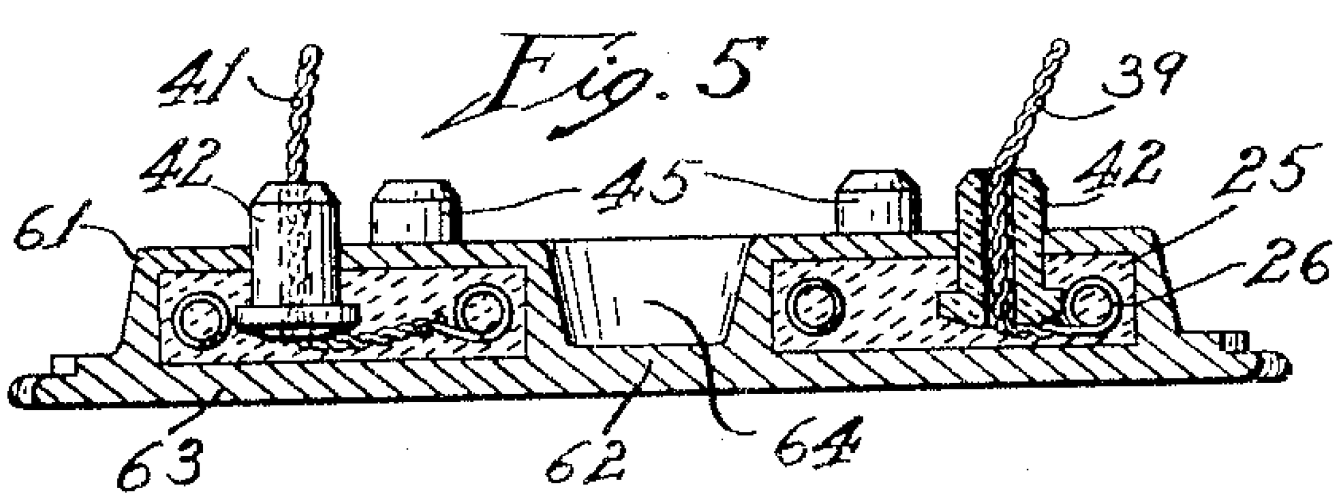

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Fig. 7

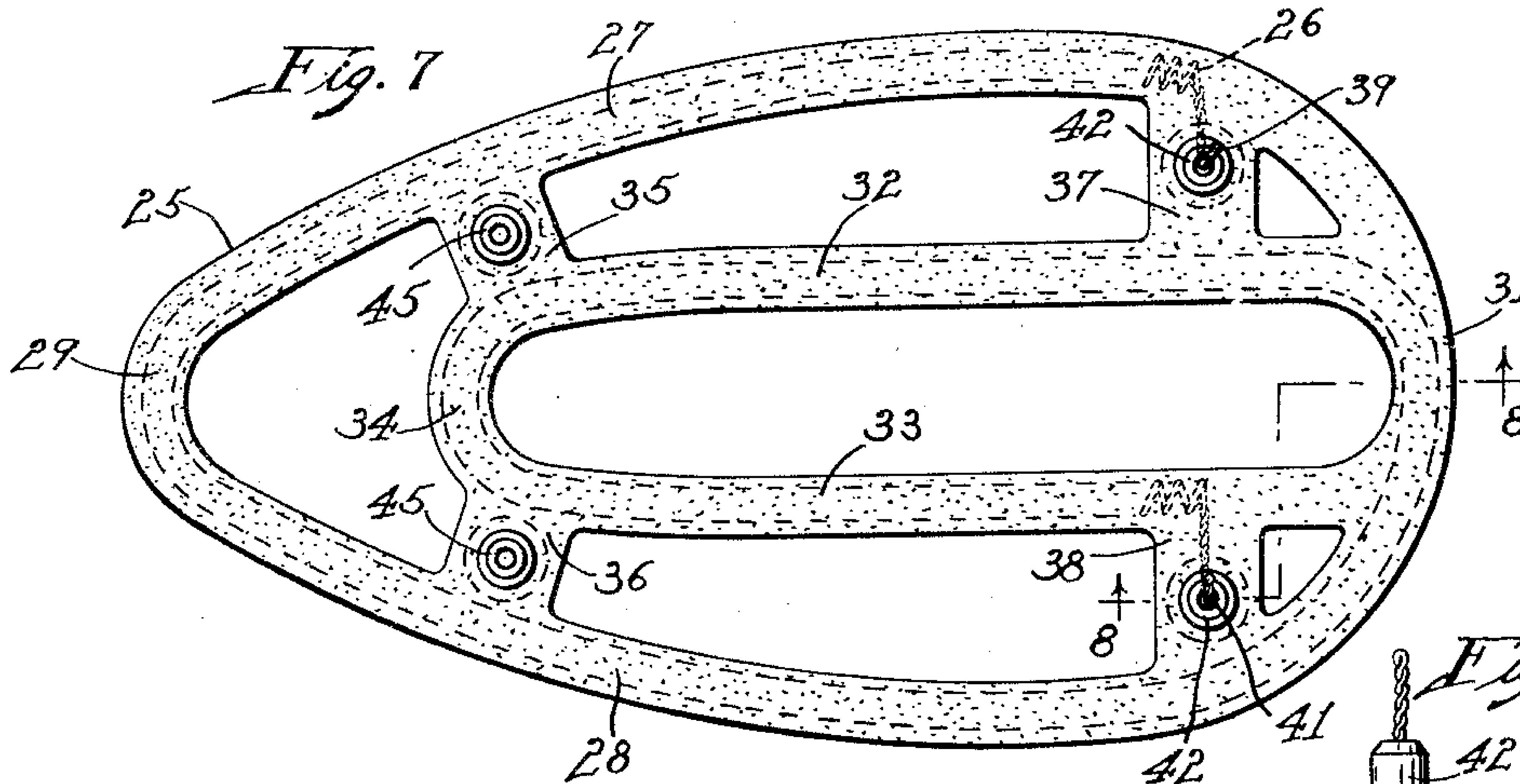

Fig. 9

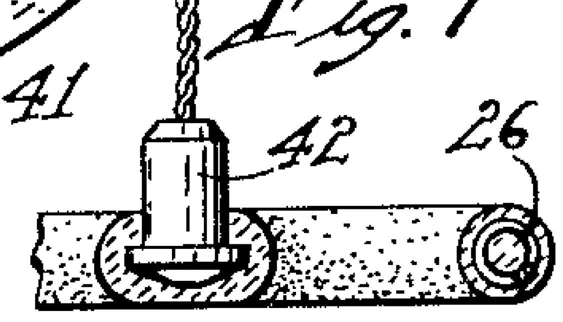

Fig. 8

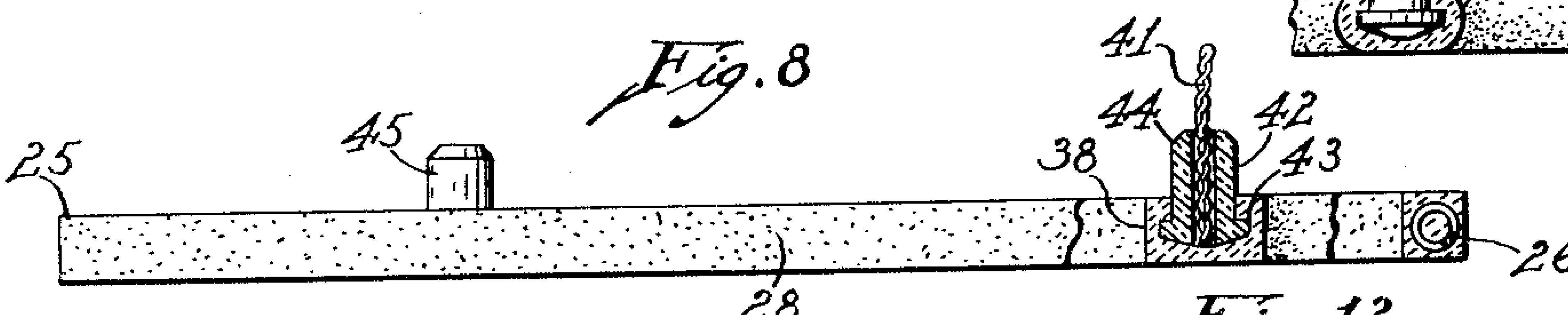

Fig. 10

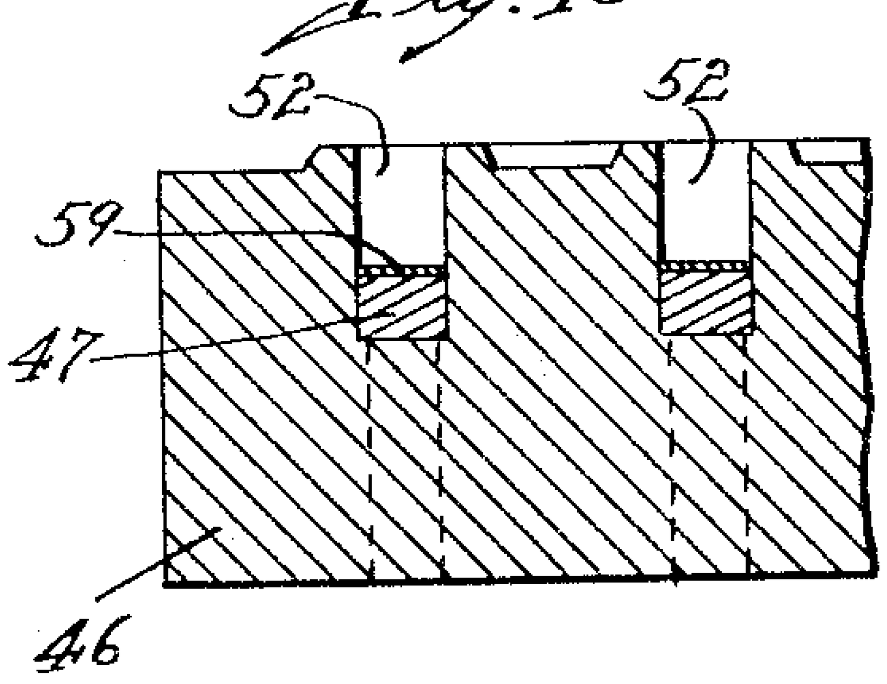

Fig. 11

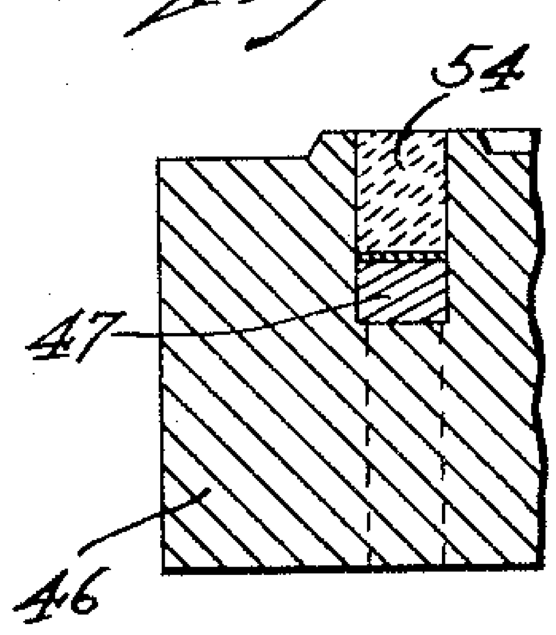

Fig. 12

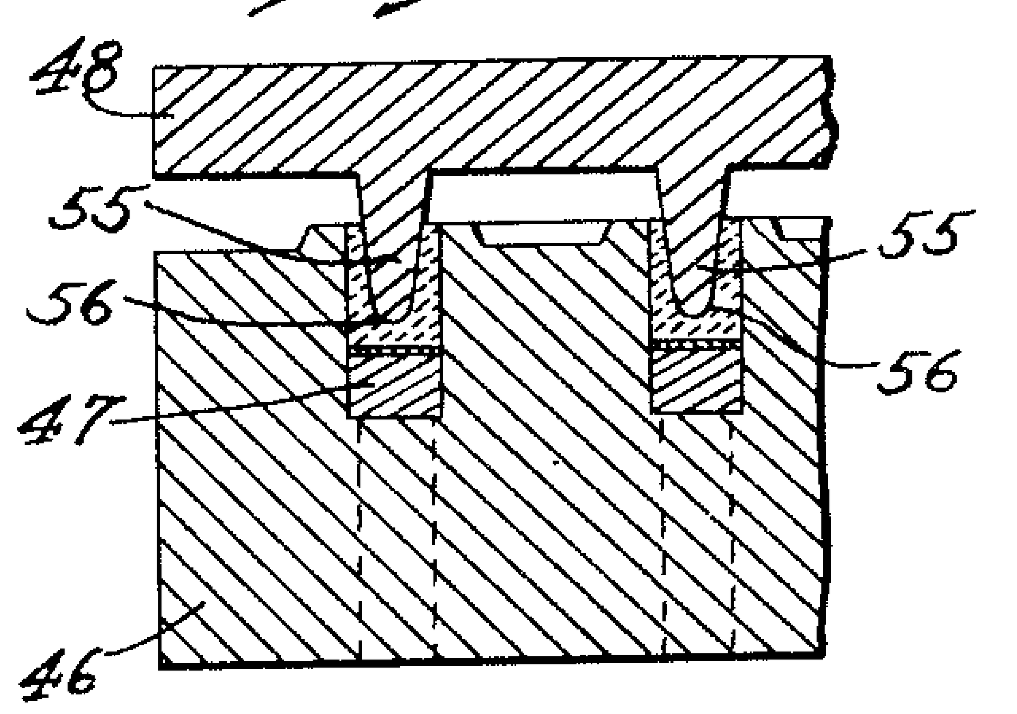

Fig. 13

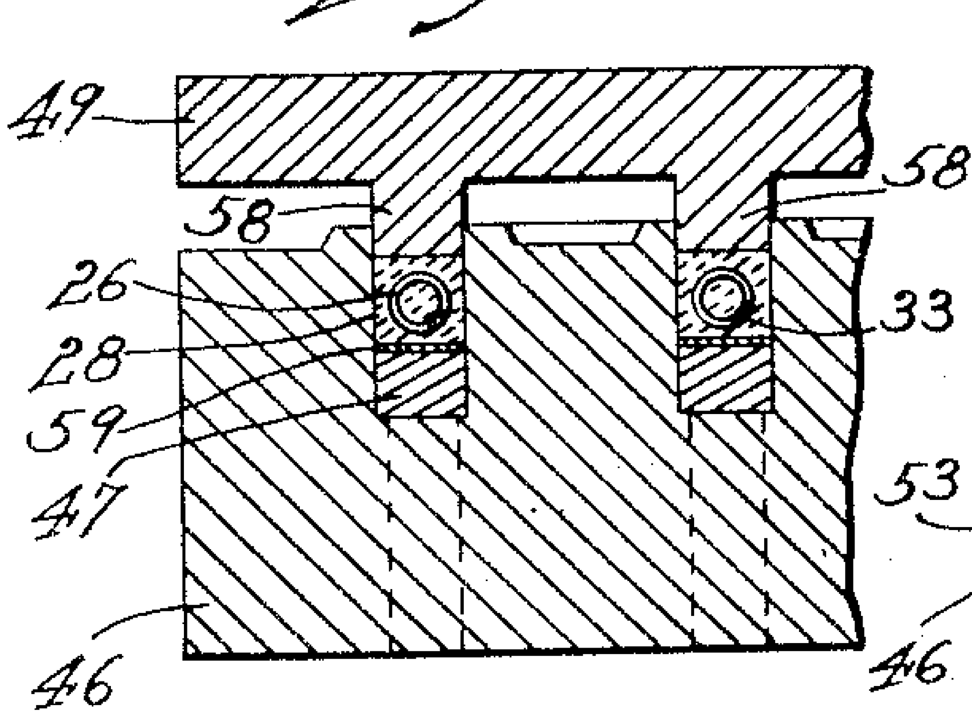

Fig. 14

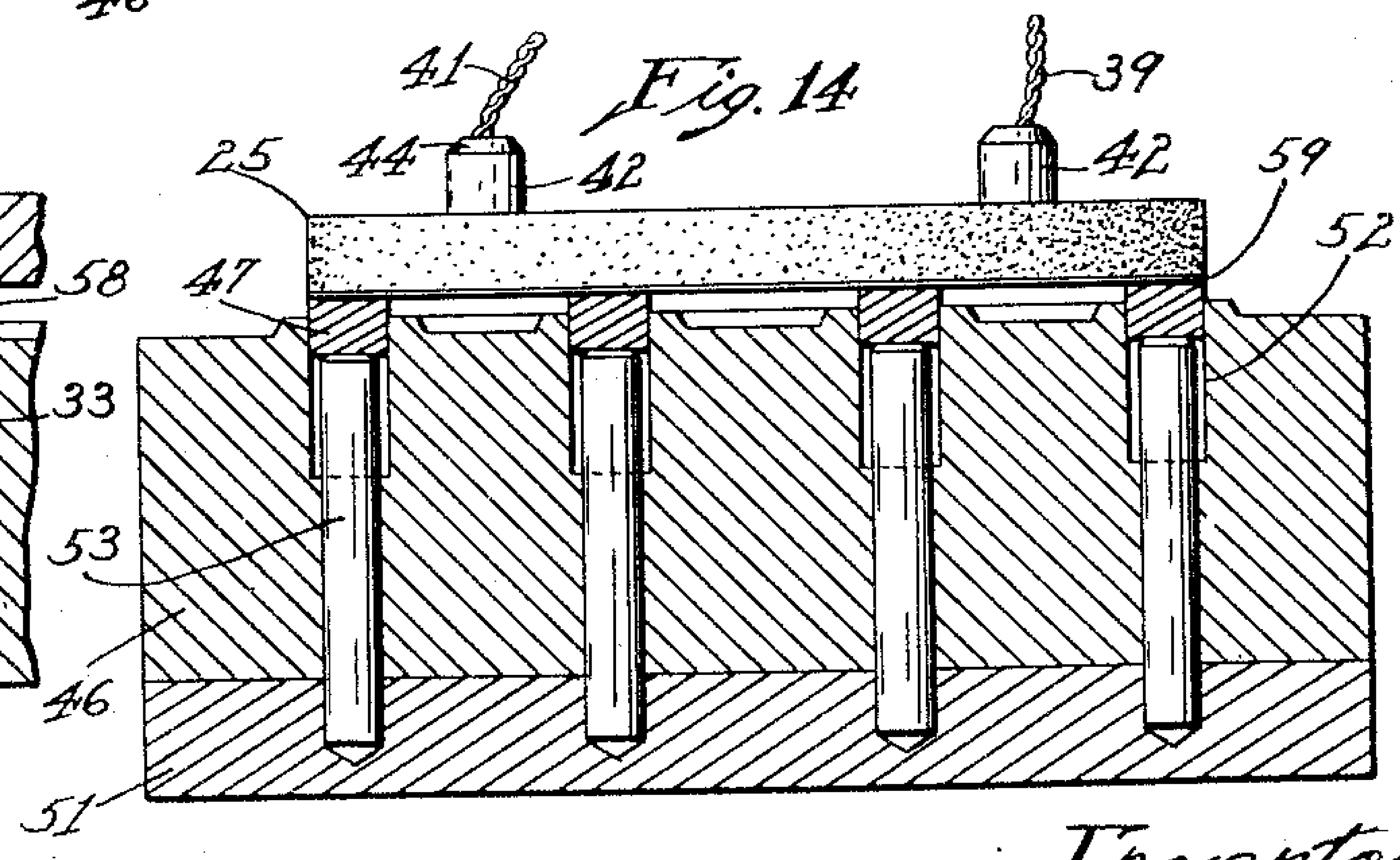

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Fig. 15

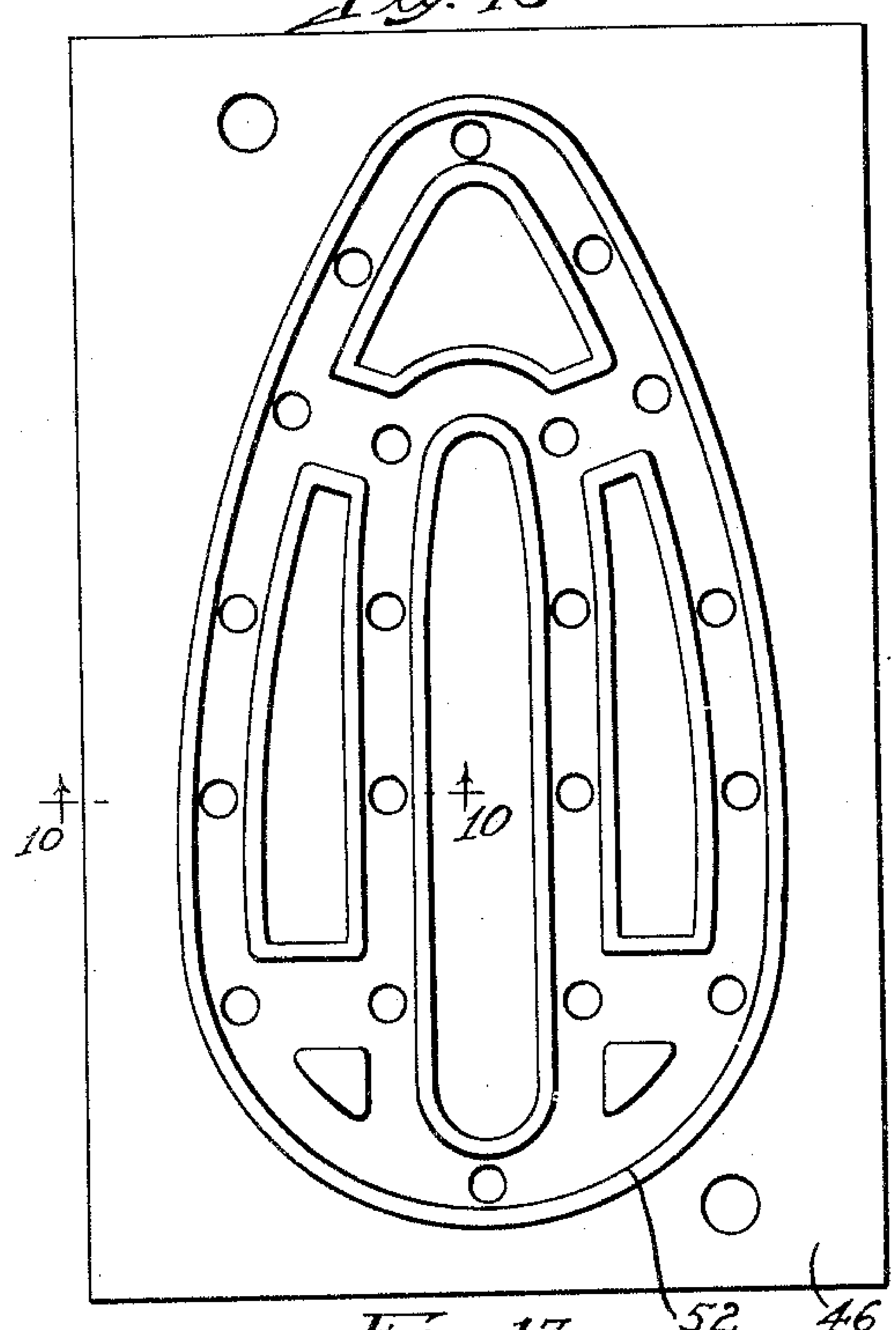


Fig. 16

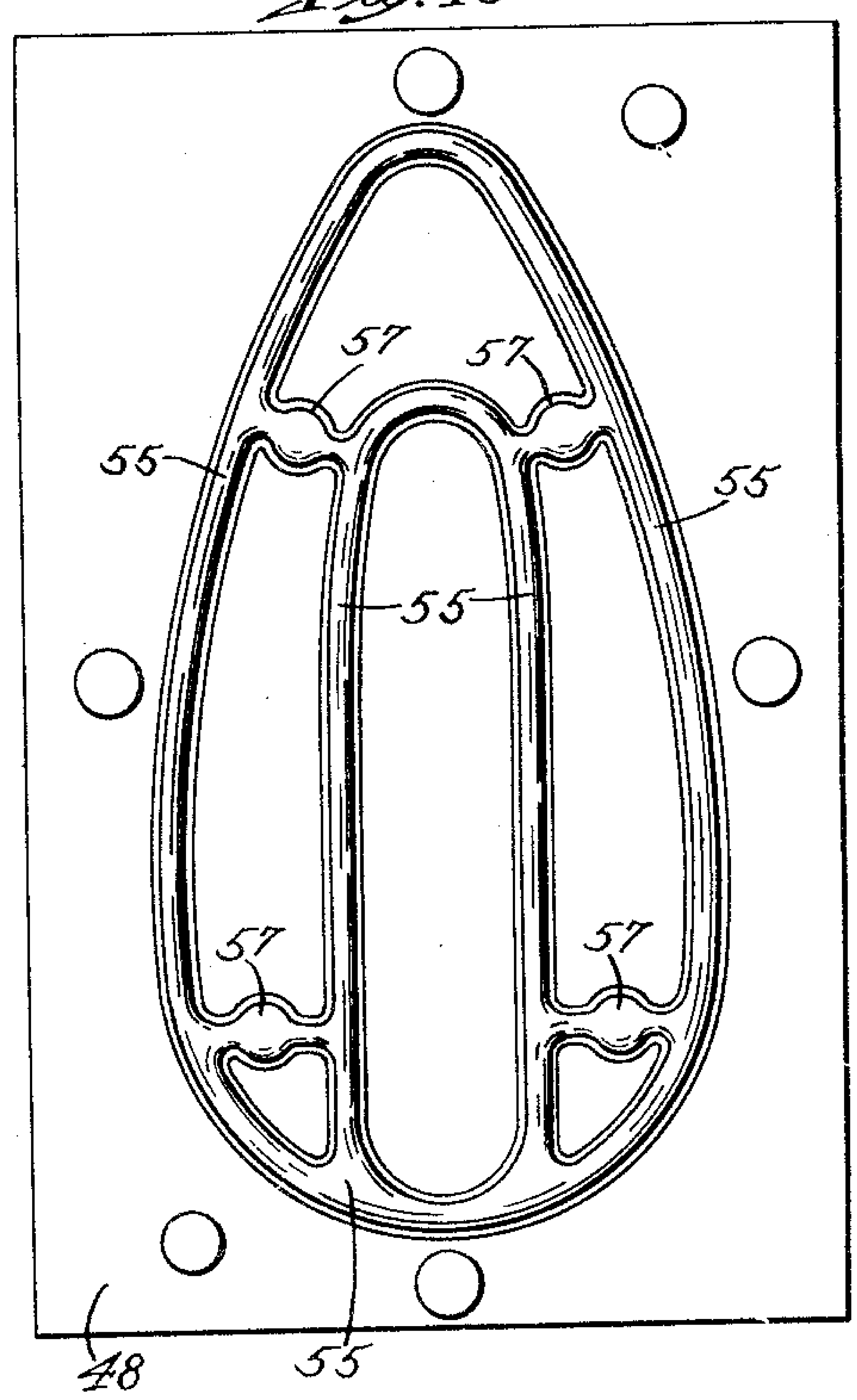


Fig. 17

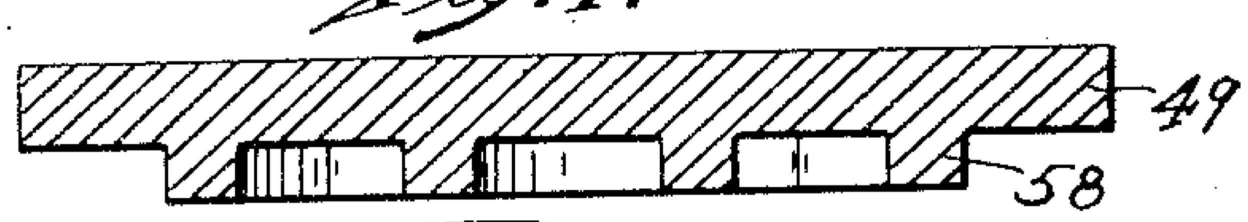


Fig. 18

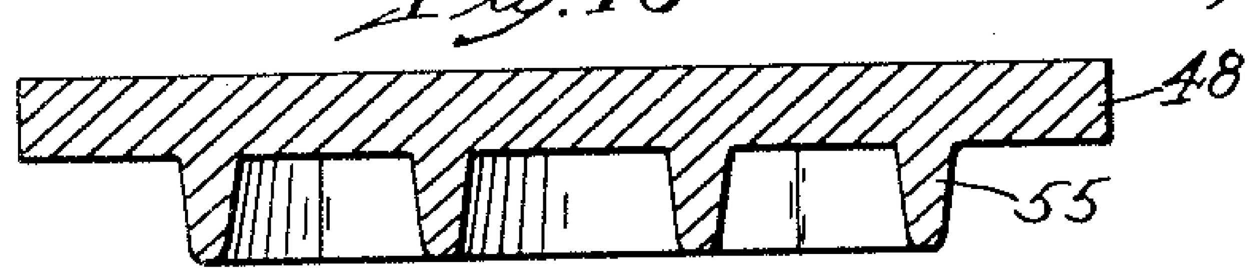


Fig. 19

Fig. 20

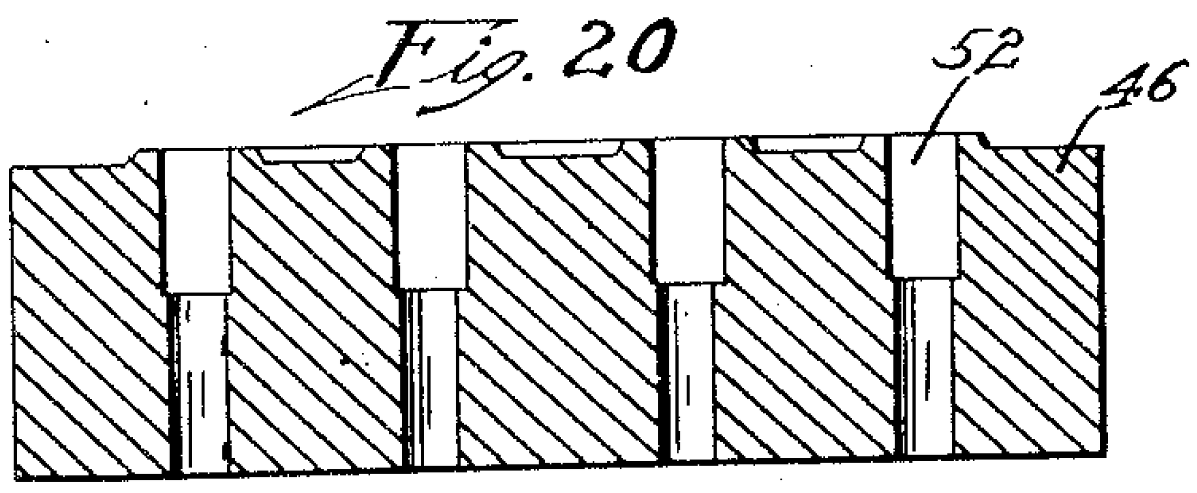


Fig. 21

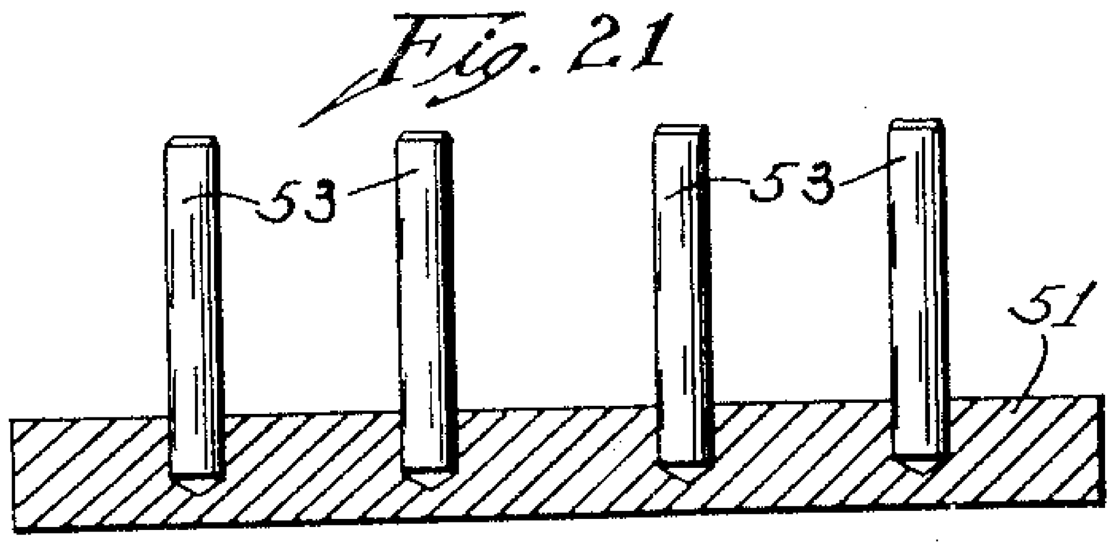
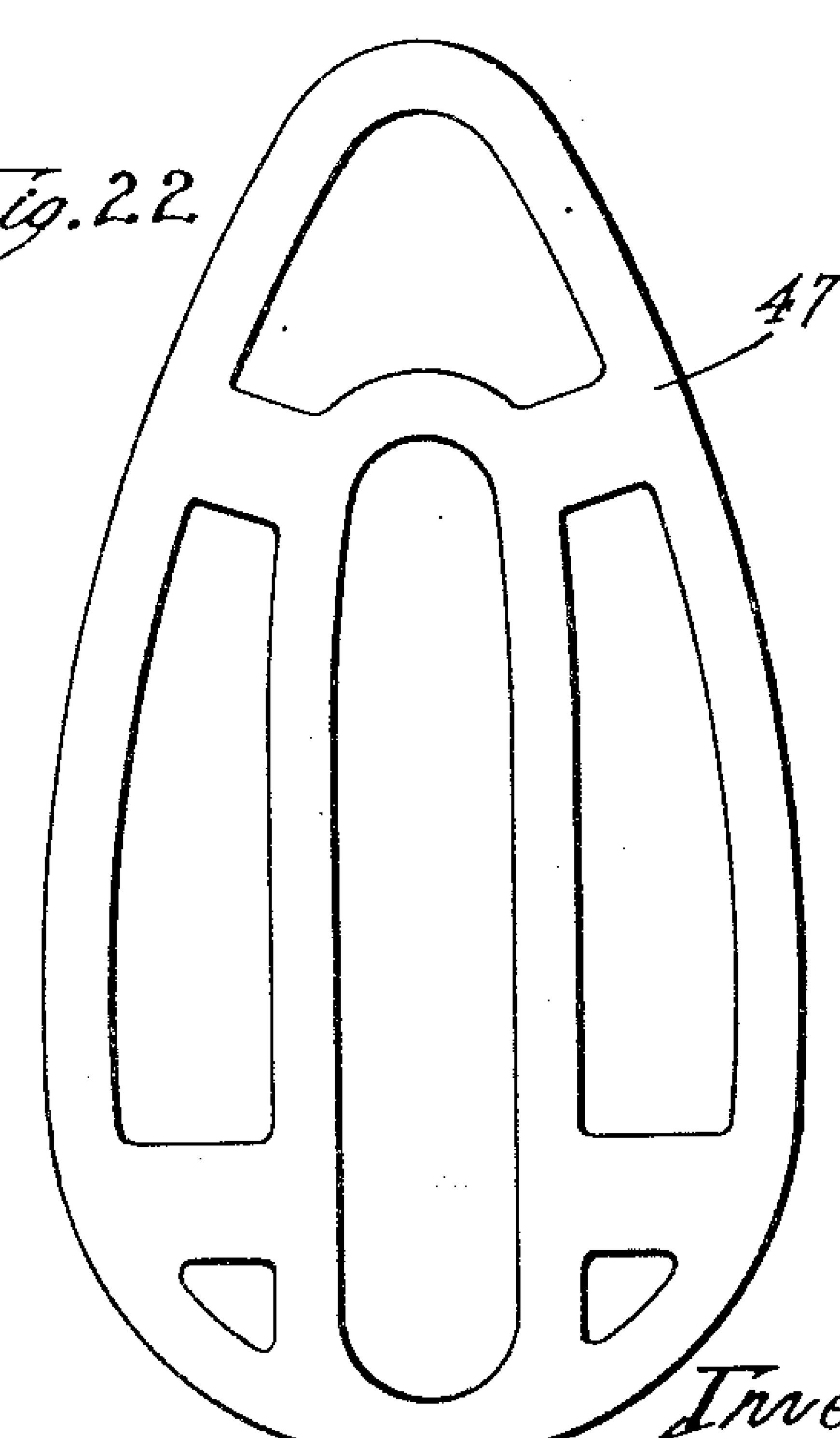


Fig. 22



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Patented Oct. 31, 1950 2,528,019

UNITED STATES PATENT OFFICE

2,528,019

EMBEDDED ELEMENT SOLE PLATE

Herbert F. Storm, West Allis, Wis., assignor to Sunbeam Corporation, a corporation of Illinois

Application July 20, 1944, Serial No. 545,789

2 Claims. (Cl. 219—25)

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This invention relates to electric sadirons and has more particular reference to the construction and manufacture of the sole plate and its heating element.

The invention has for its main object the provision of a new and improved sole plate characterized by its cast metal construction and by a preformed ceramic heating element embedded in the sole plate in the casting thereof. The construction is such as to possess relatively light weight with strength and durability for the purposes intended. The sole plate structure also provides for uniformity of temperature distribution due in part to the characteristics of the materials used and to the form of the embedded element and its heat transfer relation to the surrounding metal body in which it is cast.

Another object of the invention is to provide a new and improved embedded heating element especially adapted to be cast in a metal sole plate and having novel form and construction characteristics which make it a good heat conductor and a poor electrical conductor at elevated temperatures, and which will maintain its shape and form without cracking while being subjected to the drying and vitrifying processes in the course of its manufacture, and which has sufficient mechanical strength to permit of its being handled in production and being subjected to the casting process.

Another object of my invention is to provide a new and improved method of making a ceramic heating element having an embedded electric resistor.

Another object of my invention is to provide a new and improved method of making a sole plate for an electric iron.

Another object of my invention is to provide a new and improved sole plate of the character described with the view to more economical manufacture.

Other objects and attendant advantages will be appreciated by those skilled in this art as the invention becomes better understood by reference to the following description when considered in connection with the accompanying drawings, in which—

Figure 1 is a top view of a sole plate embodying my invention;

Fig. 2 is a side elevation thereof;

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Fig. 3 is a longitudinal section taken substantially on the section line **3—3** of Figure 1;

Fig. 4 is an end elevation, looking at the heel end of the sole plate;

Figs. 5 and 6 are sections taken on the section line **5—5** and **6—6**, respectively, of Figure 1;

Fig. 7 is a top view of a ceramic heating element embodying my invention;

Fig. 8 is a side elevation of the heating element, partly in section on the section line **8—8** of Fig. 7;

Fig. 9 is a fragmentary section showing a modified form;

Figs. 10, 11, 12, 13, and 14 are fragmentary views showing steps in the manufacture of the ceramic heating element, the sections being taken substantially on the section line **10—10** of Fig. 15 which shows the bottom die presently to be described, these sections respectively showing the coaction of other die parts with the bottom die;

Fig. 15 is a top view of the bottom die;

Fig. 16 is a bottom view of the top die;

Figs. 17, 18, 19, 20, and 21 are cross sections through certain of the die members used in forming the ceramic heating element; and

Fig. 22 is a top view of an insert die member, which die members will be presently described.

An illustrative embodiment of the ceramic heating element is shown in Figures 7 and 8. This is a preferred embodiment intended for incorporation in a sole plate substantially of the design shown in Figure 1. It should be understood, however, that in the practice of my invention the ceramic heating element will be of such size and proportion as to conform with the sole plate into which it is to be cast, bearing in mind the novel characteristics and functions of the ceramic heating element which will now be described. The heating element designated generally by **25** is composed of a ceramic refractory material which is formed to a skeleton-like shape constituting a self-supporting body having portions of relatively small cross section within which an electrical resistor designated generally by **26**, preferably helical, is embedded. According to my invention the ceramic element is formed to provide a continuous outer body portion made up of what may be termed longitudinal outer body portions **27** and **28** joined by toe and heel portions **29** and **31**, respectively, longitudinal inner body portions **32** and **33** spaced laterally from each other and from the longitudinal outer body portions, a portion **34** connecting the portions **32** and **33** with the toe portion, and a plurality of narrow portions **35**, **36**, **37**, and **38** connecting the inner and outer longitudinal body portions. The helical resistor element **26** is arranged to extend continuously through the longitudinal body portions from the input to the output terminals **39**—**41**. Assuming the resistor input terminal is at **39**, the resistor extends continuously through the body portions **27**, **29**, **28**, **31**, **32**, **34**, and **33**, to the output terminal **41**. In order to firmly and positively locate the terminals **39**—**41** against displacement and to position them in definite relationship to the thermostatic switch mechanism (not shown) which controls the flow of electric current to the resistor, I have provided ceramic inserts in the form of cylindrical posts **42** each preferably formed to provide an enlarged base end **43** and a tapered or chamfered top end **44**. Similar ceramic posts **45** are inserted in the connecting body portions **35** and **36**. These posts **42**—**45** serve as locating and supporting elements when casting the ceramic heating element in the aluminum or other metal body which constitutes the sole plate proper, as will be presently described. The body portions of the ceramic heating element are arranged to give good heat distribution when the element as a whole is cast in the metal sole plate, and as a consequence of this construction the sole plate proper will assume uniform temperature substantially throughout its ironing surface and the heat transfer will be direct and efficient. The cross sectional shape of the body portions may be prismatic such as square as shown generally throughout the drawings, or round as shown in the modified form Figure 9. In the functioning of the completed sole plate the cylindrical form of the element **25** would require a slightly lower temperature for the helix than with the square cross section but the die and mold cost are lower with the latter form. Also, the square cross section has advantages in its mechanical strength and in connection with its manufacture, as will be presently apparent.

The ceramic heating element in addition to its self-supporting shape and permanency of its structure, is composed of a material which will serve as a bond between the electrical resistor (such as a nichrome wire) and a cast metal shell or body which constitutes the sole plate proper. According to my invention the material composing the body **25** should have high thermal conductivity so as to be a good heat conductor between the electrical heating element and the metallic sole plate. It should also have high electrical resistivity so as to be a poor electrical conductor at the elevated temperatures such as are encountered in high wattage automatic sadirons under thermostatic switch control. The material should have sufficient mechanical strength to permit handling in production and so that it will not be destroyed or impaired mechanically when subjected to the metal casting process. It should have no tendency for developing cracks while being subjected to the drying process and later to the vitrifying process in the course of making the ceramic element. A material which I have found suitable for this purpose is a refractory high temperature cement kown as "Alfrax 13." In practice I have obtained good results by mixing this material with 4.7% of water by weight, making a plastic cement. I have found the water percentage rather critical in obtaining the resultant characteristics above described. If less water is used the cement crumbles; and if more water is used the material is too soft when taking it out of the mold and is sticky and difficult to handle.

The manufacture of the ceramic element will now be described, referring more particularly to Figures 10 to 22 inclusive. The mold or die parts comprise, generally stated, a bottom mold **46**, an insert die member **47**, a top mold **48**, a pressure die member **49**, and an ejector member **51**. The bottom mold has a cavity **52** of a shape identical with the described profile shape of the ceramic heating element **25**, so that the profile or outline shape of this cavity determines the corresponding shape of the body to be molded therein. The cavity **52** is of substantial depth as shown in Figure 10 and the side walls are vertical, with slight draft. The die member **47** also conforms with the shape of the ceramic member **25** and is adapted to be inserted in the cavity **52** so as to rest at the bottom thereof and constitute the bottom proper of the cavity. After the plastic mold is completed this bottom member **47** will be raised to eject or discharge the plastic molded member by means of the ejector die member **51** which is equipped with a plurality of pusher pins **53** which are adapted to be moved up through the bottom of the cavity for lifting the ejector member **47** to the ejecting position shown in Figure 14. The first step is to fill the cavity **52** with the described plastic material **54**, as shown in Figure 11. The next step is to apply the top mold **48** in a material displacement operation shown in Figure 12. It will be apparent that the top mold is provided with projecting mold members **55** shaped to displace the plastic material to provide a cavity **56** therein conforming in outline with the outline shape of this projecting mold body shown in Figure 16. The cavity **56** formed in the plastic material is for reception of the helical heating element **26** and also for the reception of the refractory holders **42** and **45**, it being observed that the top mold has portions **57** which provide properly located cavities for the reception of the wide lower ends of these refractory holders. In actual practice the face of the upper mold is covered with a thin film of machine oil or a similar oil to facilitate parting from the plastic material when drawing the mold and also a suitable vibrator (not shown) is applied to the mold when making the draw. The next step is to place the helical resistor wire in the cavity **56** and the refractory holders **42** and **45** in the corresponding cavities in the plastic material, the holders **42** being strung on the terminal ends **39** and **41** of the resistor wire which is bent to conform to this location of the holders as will be obvious from the location shown in Figure 7. However, before inserting the helix it will be filled with the same refractory cement as used for the body, except that I prefer to use a slightly greater moisture content. This makes the material more plastic to facilitate filling the helix by rolling it through the cement. The next step is to apply the pressure die member **49** which has projecting mold members **58** shaped to fit into the main cavity **52** in a plunger action completely covering the plastic material but without disturbing the refractory holders. This operation is performed in a press under sufficient pressure to displace the plastic material from the side walls and dispose it in a compact body about the helical walls, filling all voids and interstices and making intimate contact between the plastic material and every point on the surface of the wire. This compression gives the final cross sectional shape to the heating element, as shown in Figure 13. The pressure die is then withdrawn and the ejector die operates to raise the heating element to an elevated position as shown in Figure 14, from which the heating element may be removed for transfer to a drying station. To facilitate removal of the plastic heating element from the bottom member 47 a layer 59 of paper or an equivalent is applied to the face of said member. This paper facing remains on the bottom member and prevents sticking of the plastic material. The plastic element at this stage is sufficiently form-sustaining as to permit of its being picked up by hand and placed in a position for drying. The drying may be accomplished by air or by applying a reduced voltage to the heating element so that the molded body reaches a temperature of about 212° F. in about an hour. Acceleration of the drying process beyond this may result in cracking of the molded form. Following this the molded element is put in a furnace and heated to about 2200°–2300° F. for about an hour. This vitrifies the ceramic heating element, and produces a hard form-sustaining body in which the resistor wire and the refractory bosses are permanently embedded in the relationship shown in Figures 7 and 8. The surface of this body is rock-like and granular. The heating element is now complete and ready to be cast into a sole plate. In the casting operation the ceramic heating element is supported in the mold through means of the projecting refractory bosses or holders 42 and 45. For this purpose the metal casting mold (not shown) is provided with cavities for the reception of the projecting holders and through means of these cavities and holders the ceramic heating element is accurately located and held in proper position during the casting process. By holding the ceramic heating element in this manner I provide against displacement or floating of the element with respect to the mold and obtain the desired uniformity in wall thickness of the shell which is cast around the entire outer surface of the ceramic heating element with the exception of the projecting refractory holders. The refractory, granular surface of the heating element makes a good bond with the cast metallic shell. A complete sole plate casting is shown in Figures 1 to 6 inclusive, the metal sole plate being designated generally by 61. It will be observed that the metal sole plate is cast to a shape providing a comparatively thin sole plate portion 62. The outline shape of this sole plate portion 62 determines the outline shape of the face 63 of the sole plate, which face is flat and constitutes the ironing surface. The sole plate portion 62 extends marginally beyond the ceramic heating element and the upper body portion of the metallic sole plate body preferably conforms with the exterior shape of the ceramic heating element so as to provide a comparatively thin enclosing shell structure. This construction provides a centrally located cavity or well 64 in the top of the sole plate for location of a thermostat element 65 which is shown diagrammatically in dotted lines in Figure 3. While any suitable or preferred thermostat means may be employed in conjunction with the switch for controlling the electric current supply to the heating element, I prefer a thermostatic switch structure having a bimetallic thermostatic element located close to the ironing surface so as to be quickly responsive to the temperature thereof. I also prefer aluminum as the metal for the sole plate casting, but other suitable lightweight metal may be used. The use of aluminum not only reduces the weight but provides the advantage of greater uniformtiy of temperature distribution due to its greater heat conductivity. With this construction the heat will be conducted away from the heating element in a short direct path to the face of the sole plate proper. This is advantageous in a flatiron because it promotes quick heat transfer to the ironing surface with minimum of heat loss upwardly and it enables reduction in the operating temperatures of the heating element. Light weight is highly desirable because it makes ironing easier and avoids fatigue. A further advantage is in the embedded unitary structure as compared with prior sole plates which employ a heating element held in position by means of a top pressure plate or the like. Also, it is believed that a construction such as herein disclosed is less expensive than prior constructions which use mica as an insulator and which require machine operations to accommodate the top pressure plate to the sole plate proper.

It is believed that the foregoing conveys a clear understanding of the objects prefaced above.

In the practice of my invention modifications may be made in the form of the resistor element and in the circuitous arrangement thereof as well as in the form of the molded ceramic body in which the resistor is embedded. While I have shown a particular embodiment of the invention it will be understood that the I do not wish to be limited thereto since many modifications may be made and I therefore contemplate by the appended claims to cover any such modifications as fall within the true scope and spirit of my invention.

I claim:

1. A sole plate for an electric iron comprising a ceramic skeleton-like body molded to provide a loop outer body portion of relatively small cross section conforming substantially with the outline shape of a sole plate ironing face and an inner loop body portion of similar cross section extending within said outer body portion and laterally spaced from the adjacent outer body portion except for one section common to said inner and outer body portions, additional narrow bridging body portions connecting said outer and inner portions, a resistor embedded in said outer and inner body portions and extending from one of said body portions to another through said common section, refractory bosses embedded in said bridging body portions and projecting beyond the surface thereof, and a metallic shell cast around said ceramic body.

2. A heating element for the sole plate of an electric iron comprising a ceramic skeleton-like body of vitrified cementitious material having the properties of high electrical resistivity and high thermal conductivity, and a helical electrical resistor wire embedded in said body, said wire arranged to extend substantially entirely around the peripheral portion of the heating element and in a circuitous path entirely within and spaced inwardly from said peripheral portion, said ceramic body conforming to the described path of the helical wire and having narrow bridging portions for maintaining the peripheral portion of the ceramic body and the portion associated with the inner circuitous path in fixed relationship, said bridging portions providing a path for por-

tions of said wire other than that disposed in the outer peripheral portion and the inner circuitous path, said ceramic body being defined so that there are provided substantial open spaces intermediate the relatively narrow body portions in which the wire is embedded, a plurality of bridging portions located at a forward position on the element and another plurality located rearwardly thereof, and a refractory boss embedded in each of such bridging portions and projecting above the same to provide a locating portion, the rear refractory bosses also serving as insulators for the terminal ends of the resistor wire.

HERBERT F. STORM.

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