

Sept. 24, 1946.

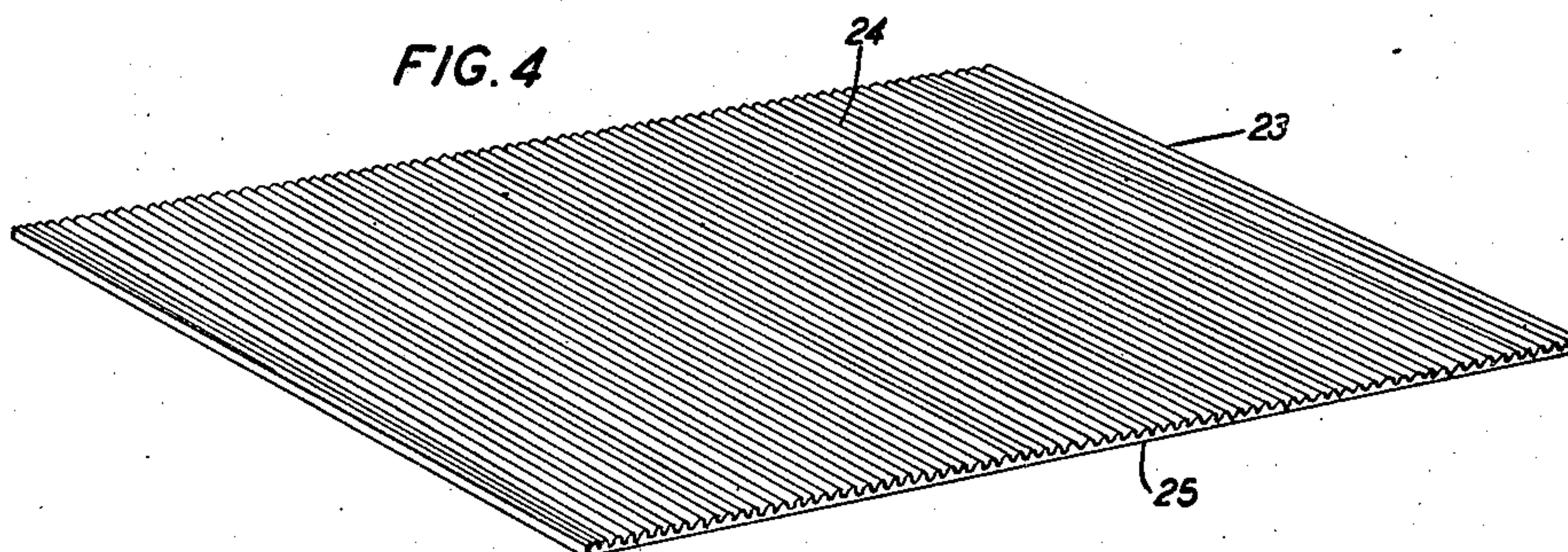
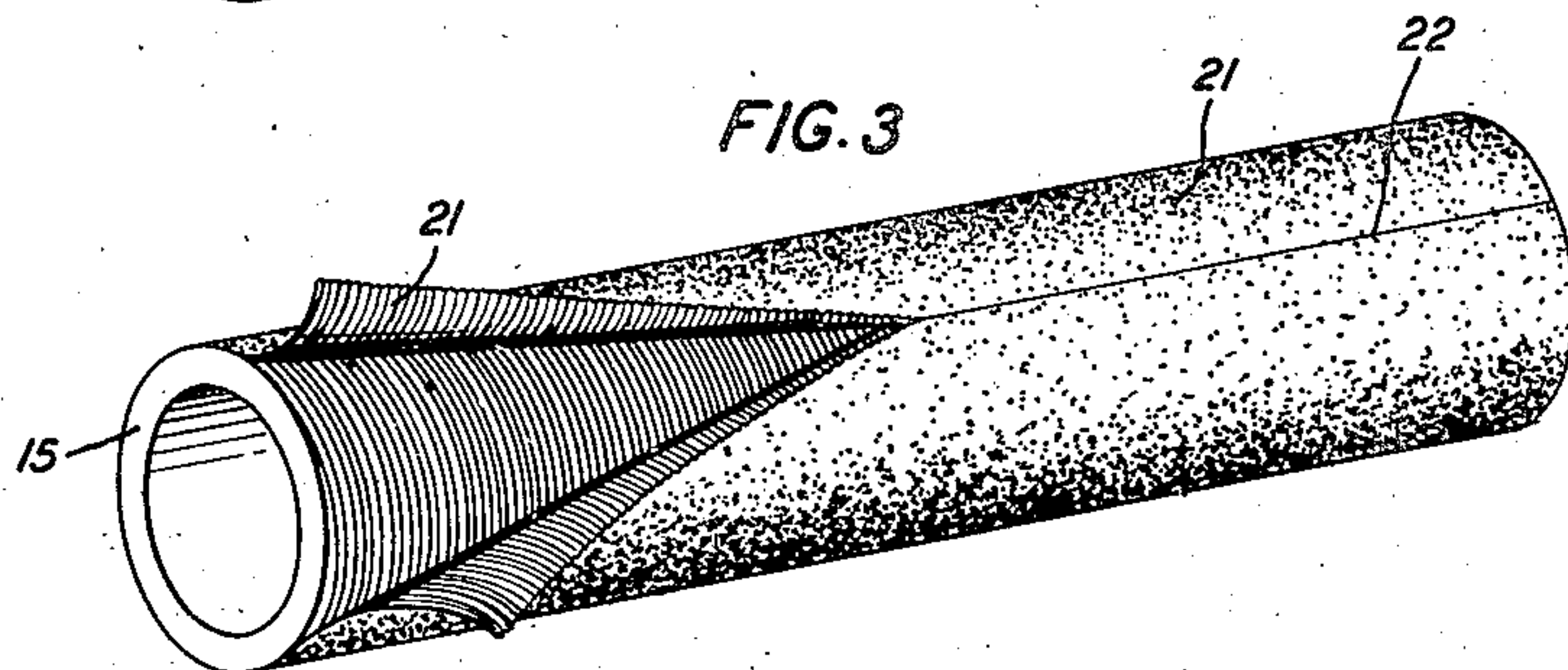
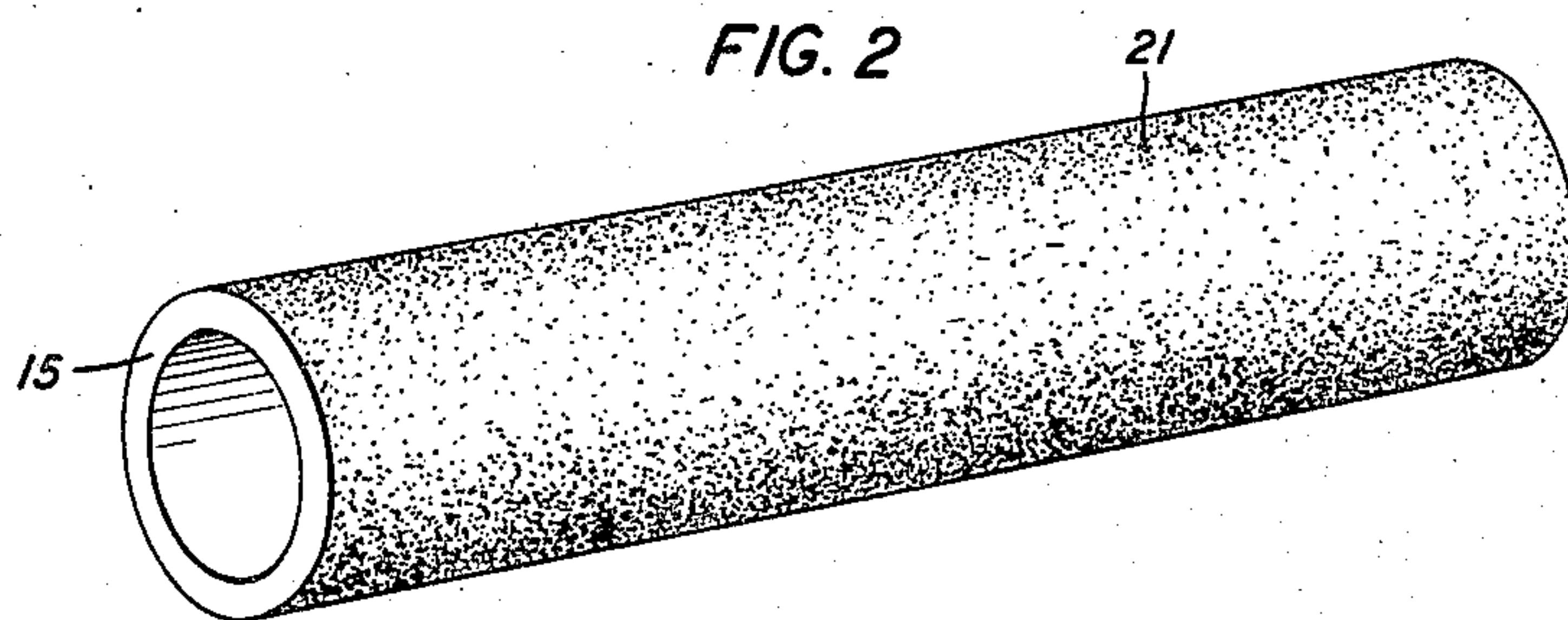
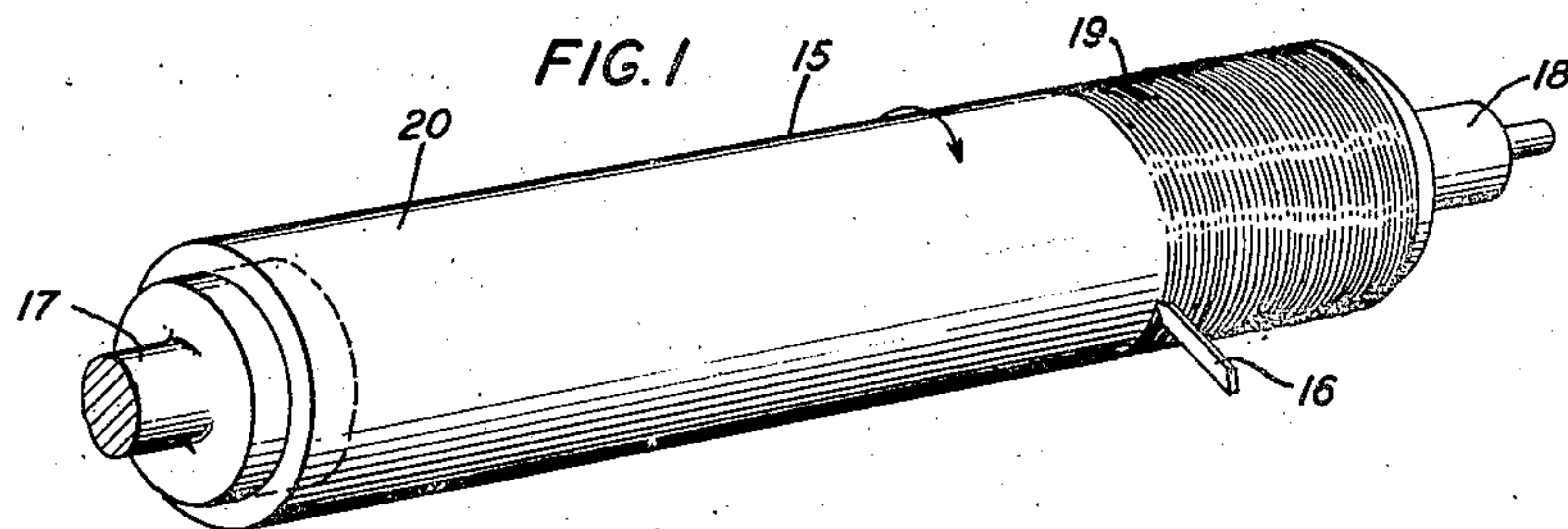
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2,408,093

METHOD OF MAKING WIRE-WOUND CARD-TYPE RESISTANCE DEVICES

Original Filed Jan. 30, 1943

3 Sheets-Sheet 1



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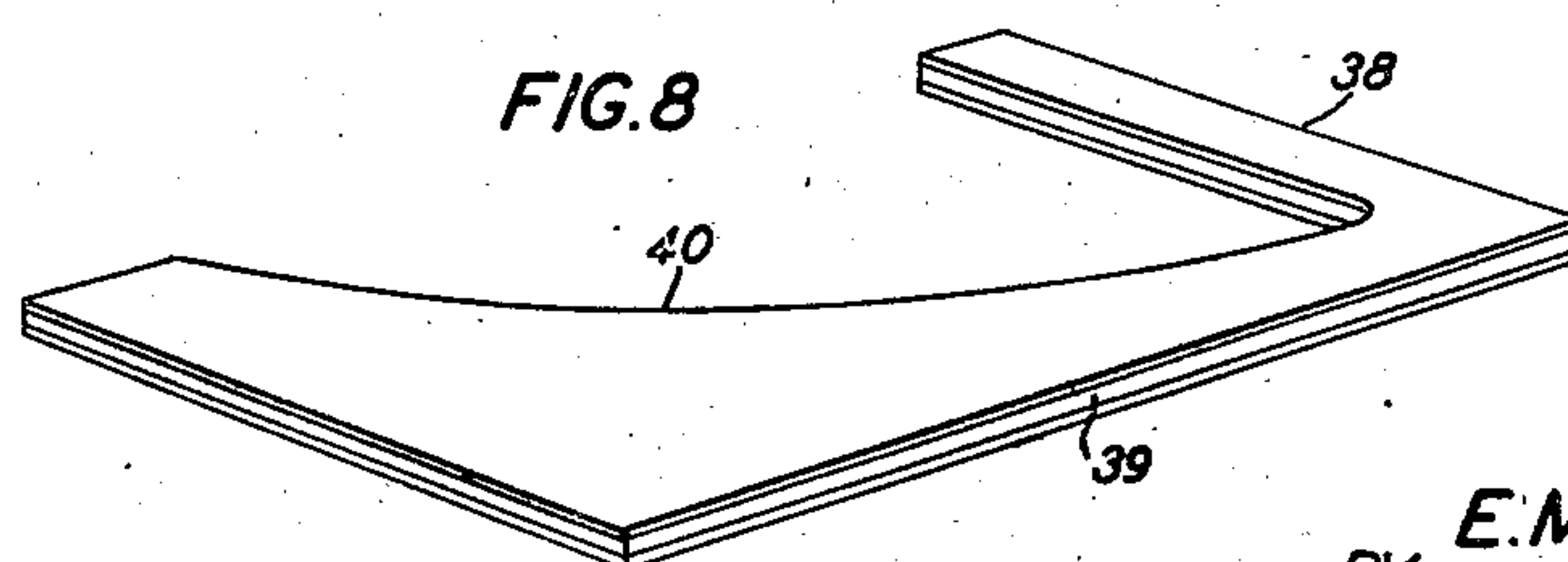
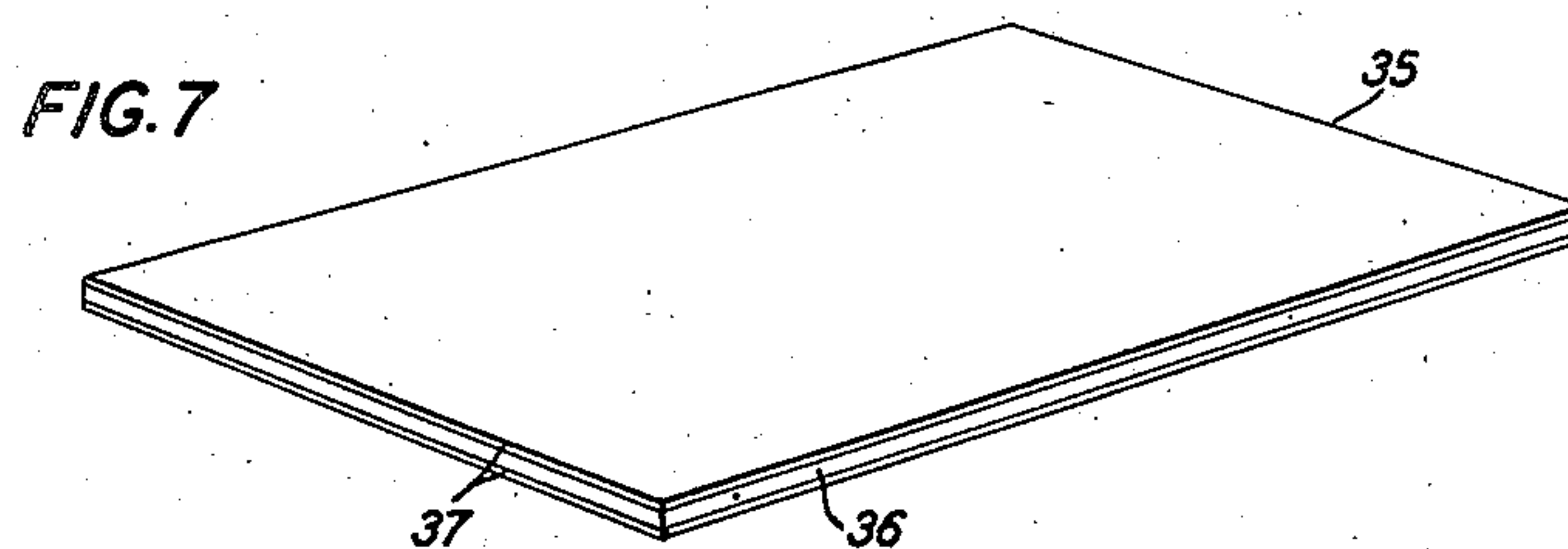
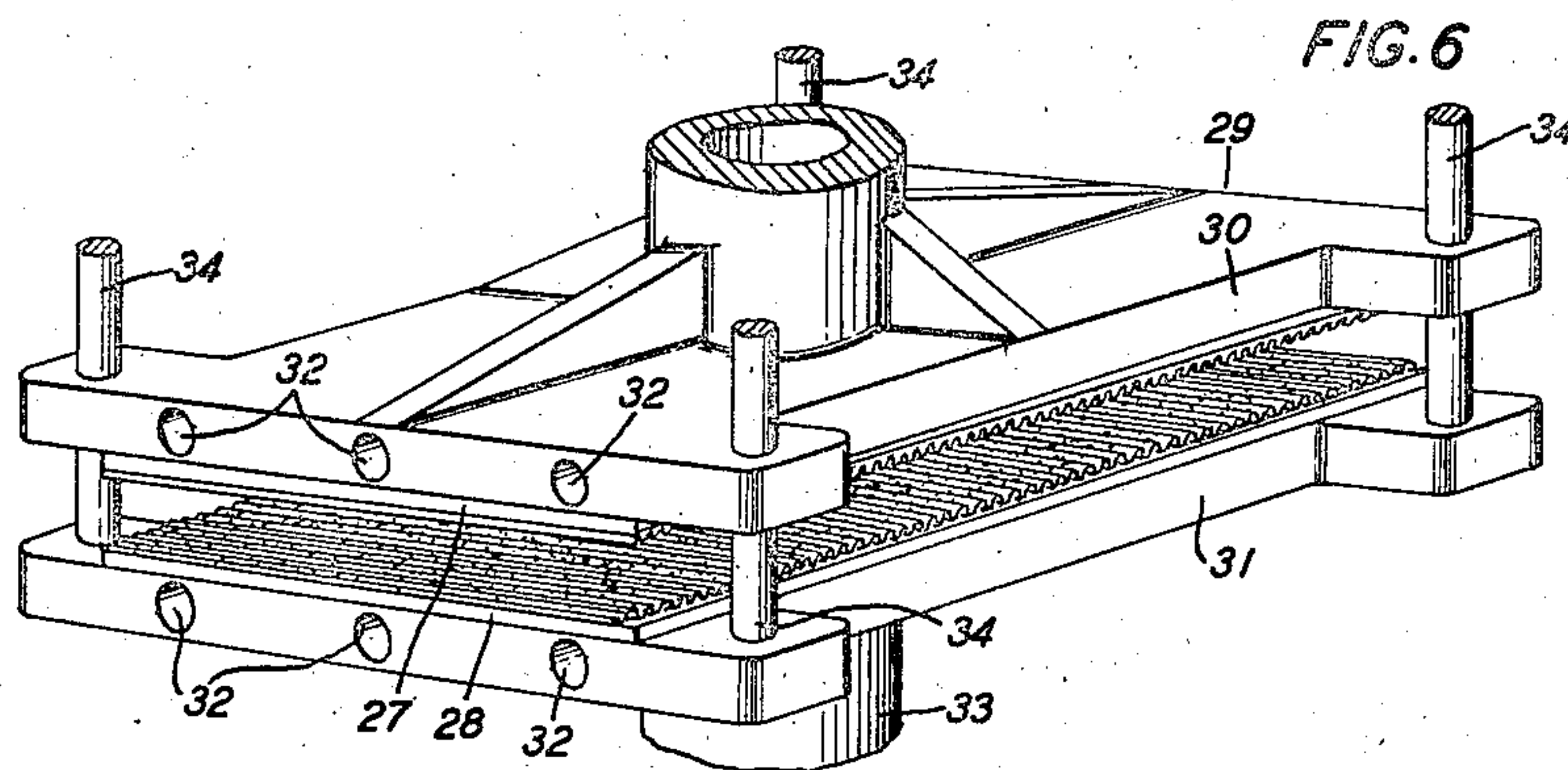
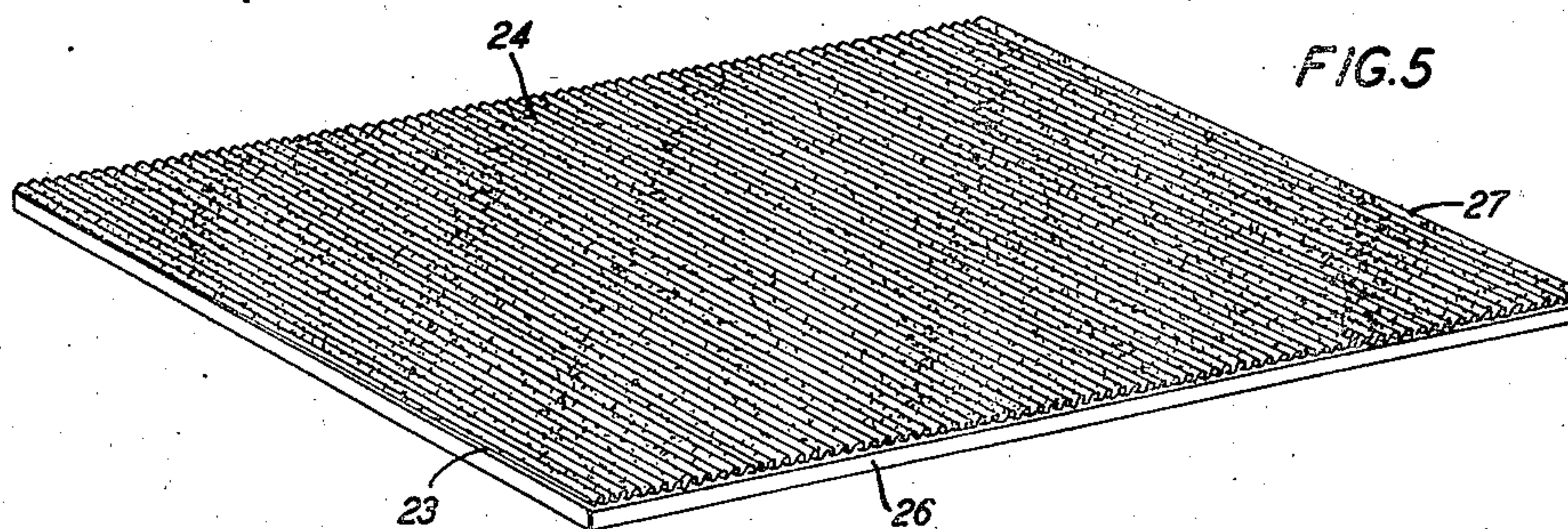
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METHOD OF MAKING WIRE-WOUND CARD-TYPE RESISTANCE DEVICES

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FIG. 9

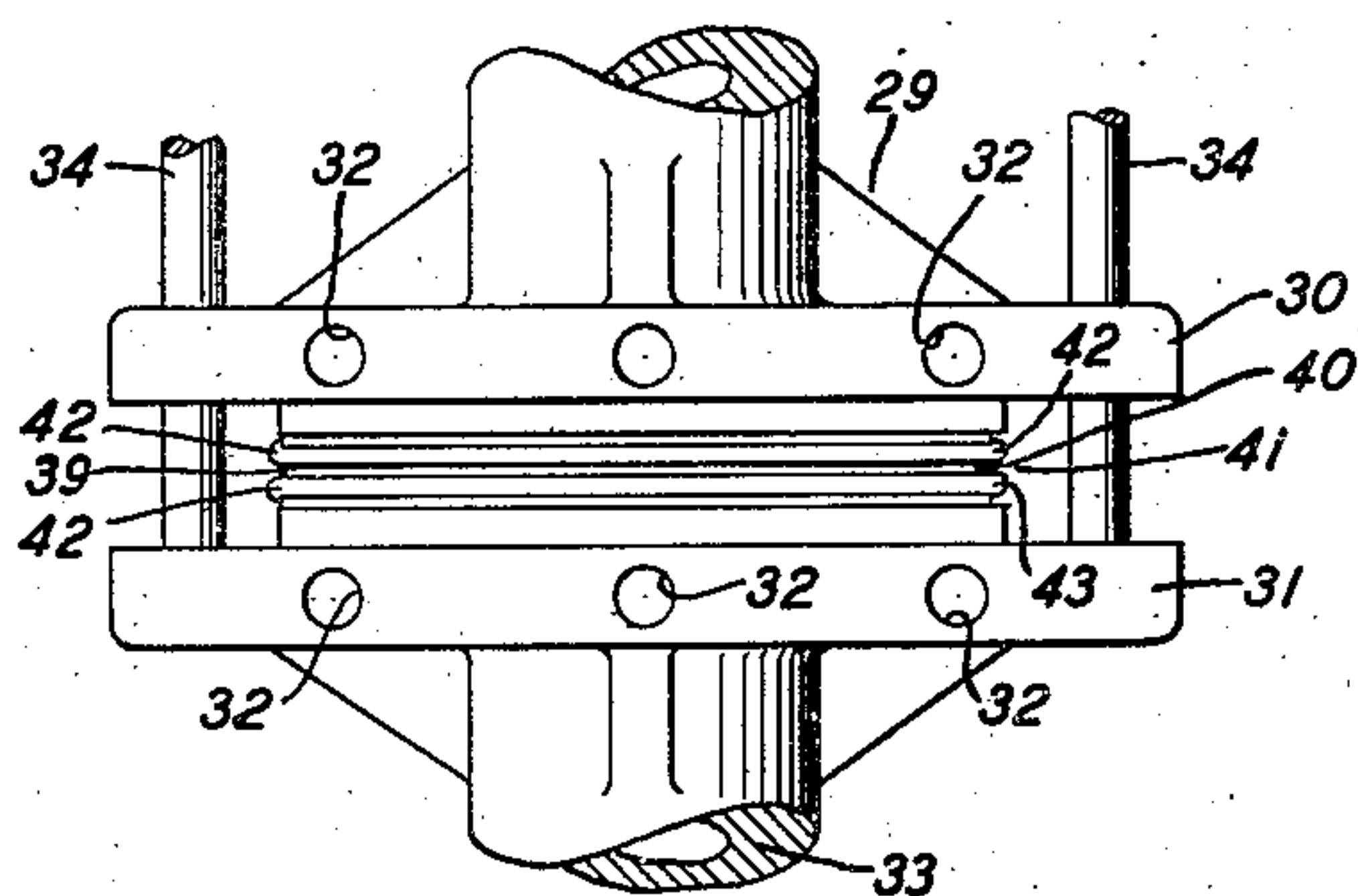


FIG. 10

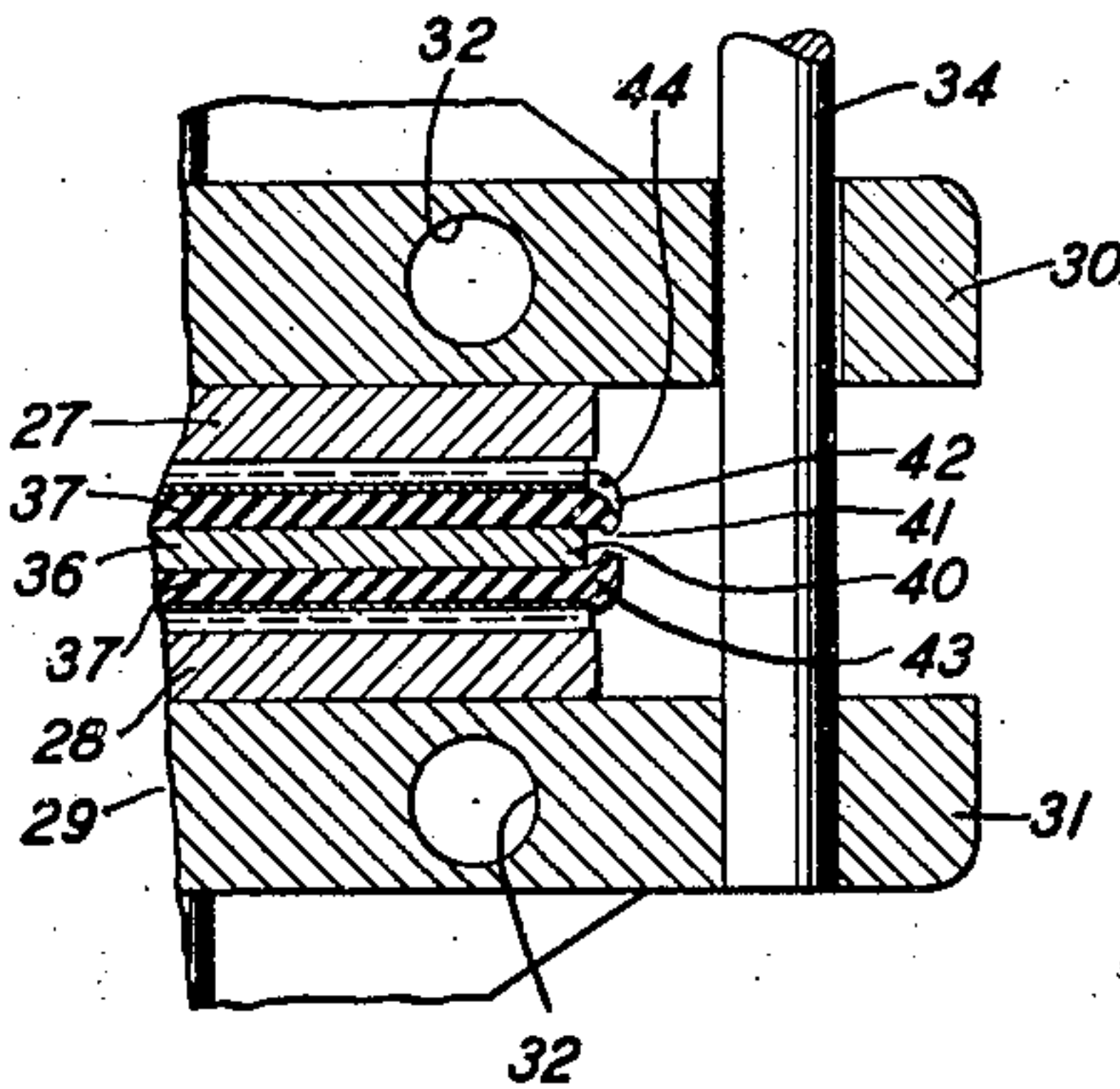


FIG. 11

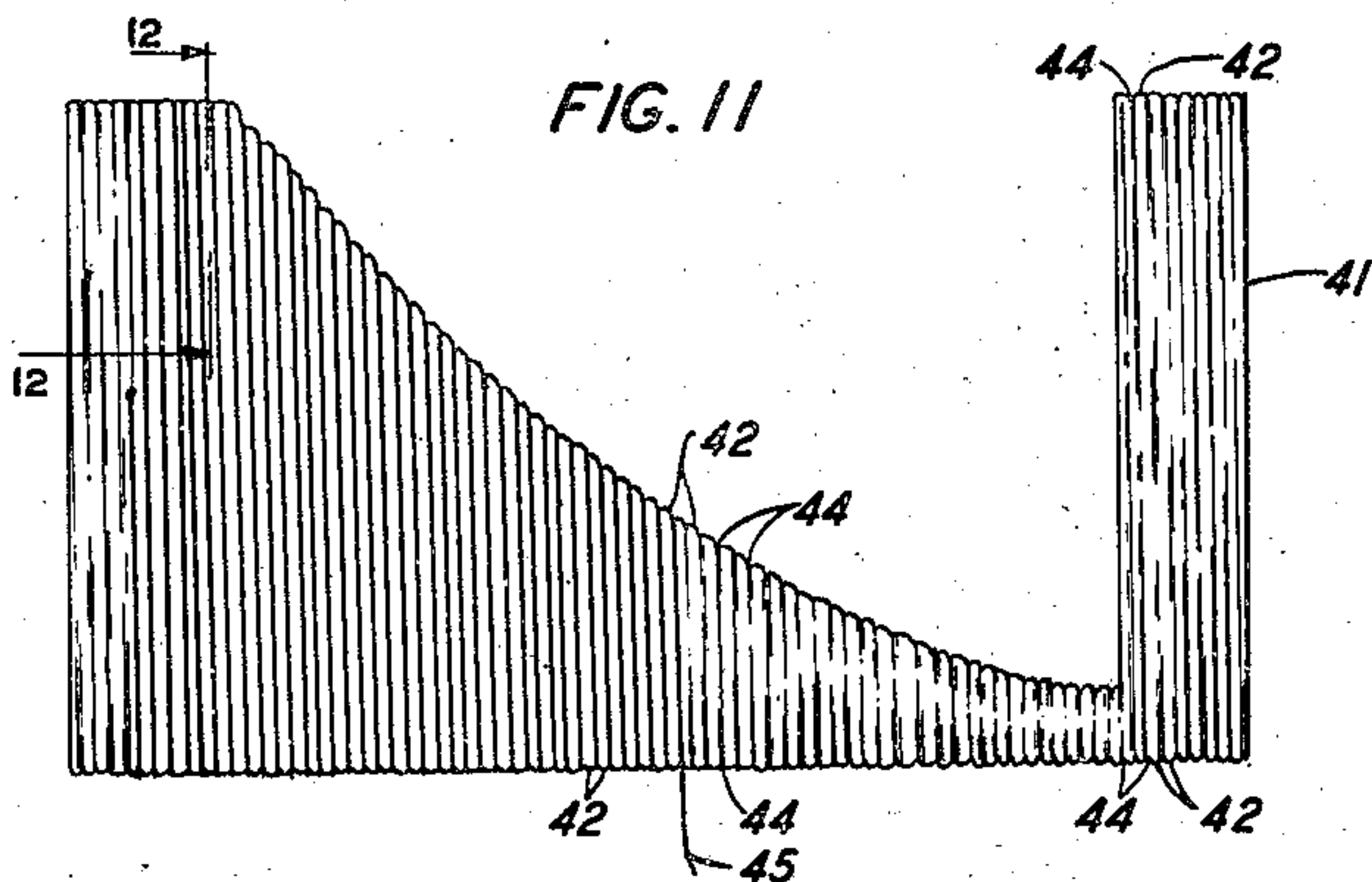


FIG. 12

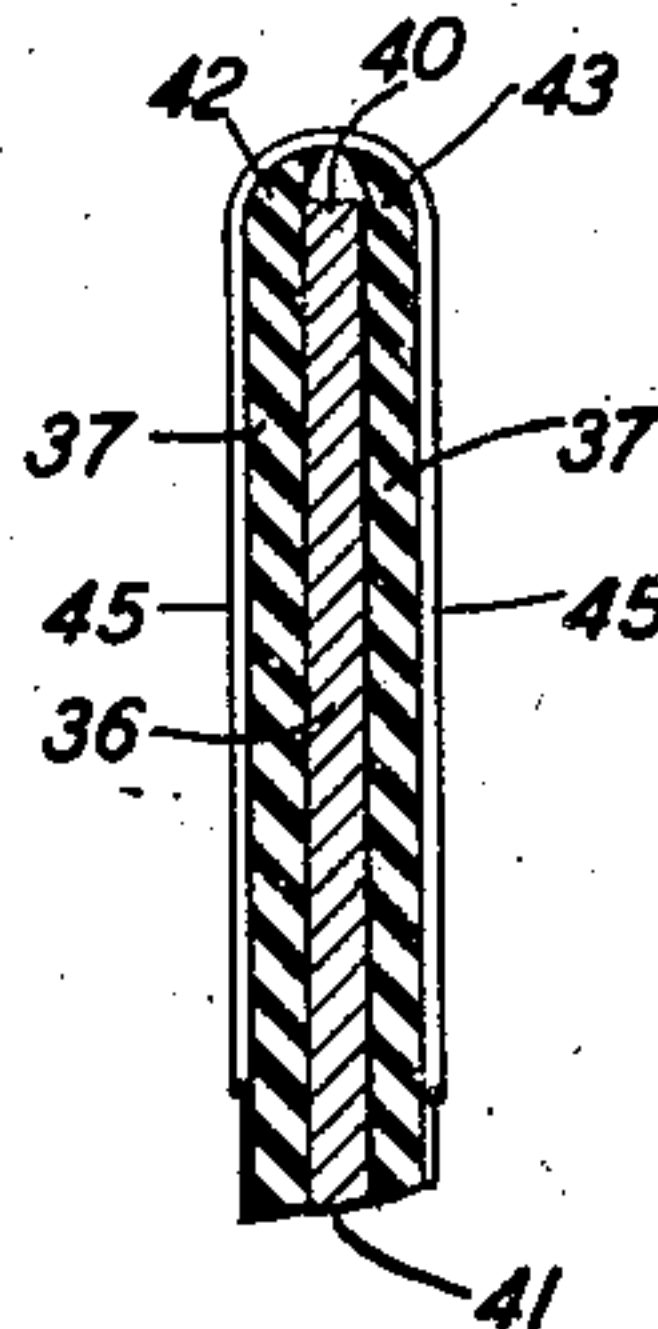


FIG. 13

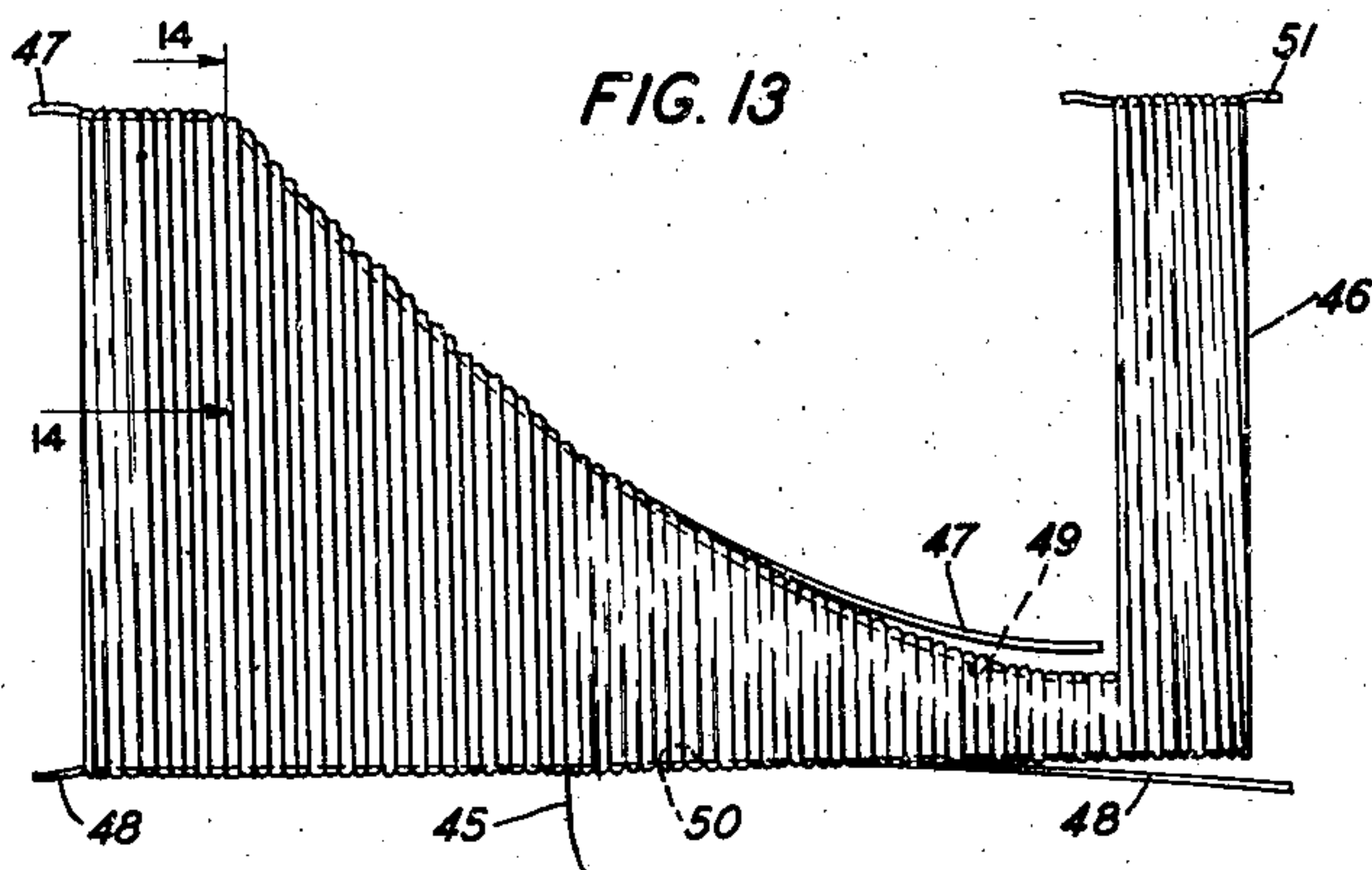
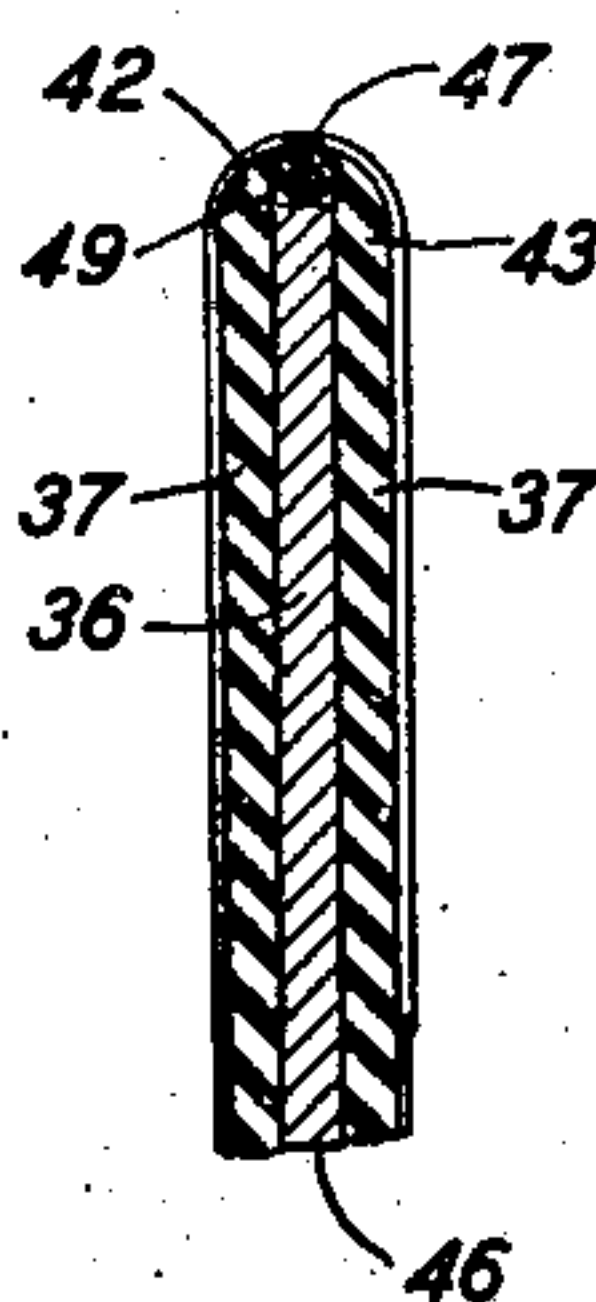


FIG. 14



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2,408,093

METHOD OF MAKING WIRE-WOUND CARD-TYPE RESISTANCE DEVICES

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Original application January 30, 1943, Serial No. 474,129. Divided and this application January 24, 1944, Serial No. 519,462

1 Claim. (Cl. 201—60)

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This application is a division of my copending application, Serial Number 474,129, filed January 30, 1943.

This invention relates to a method of making resistance devices comprising a card-type support and a resistance wire wound on the card-type support.

The object of the invention is to make a resistance device in which the turns of wire will remain in required positions on the card-type support.

A feature of the invention resides in the method of making the card-type support.

Another feature resides in a method of making a resistance device comprising a card-type support and a resistance wire wound thereon and in which a thread is provided along an edge portion of the card-type support.

The card-type supports made in accordance with this invention are grooved at required points to receive the turns of resistance wire and the grooves extend at least part way over edge portions of the card-type support. The grooves are formed in the card-type support by placing a suitably formed and constructed card between grooved plates and by pressing the plates against the card.

In the drawings:

Figs. 1, 2 and 3 show three steps in making a grooved plate to be used in pressure forming grooves in the card-type support;

Fig. 4 shows one of the grooved plates in perspective;

Fig. 5 shows an advanced step in forming the plate;

Fig. 6 is a view in perspective of a press with two of the grooved plates mounted in the press;

Fig. 7 is a view in perspective of a piece of sheet material from which a card-type support is to be cut;

Fig. 8 is a view in perspective of one form of card cut from the sheet shown in Fig. 7;

Fig. 9 is an end view of the press shown in Fig. 6 and with a card located between two plates mounted in the press and after the plates have been pressed against the card;

Fig. 10 is an enlarged cross-sectional view of portions of Fig. 9;

Fig. 11 is a plan view of one form of card-type support constructed in accordance with the invention and partly wound with resistance wire;

Fig. 12 is a cross-sectional view of a portion of the resistance device and taken on the line 12—12 in Fig. 11;

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Fig. 13 is a plan view of a modification of the resistance device structure; and

Fig. 14 is a cross-sectional view of a portion of the device shown in Fig. 13 and taken on the line 14—14.

In making electrical resistance devices comprising a card-type insulating support and a resistance wire wound helically on the support it is found necessary in some cases to maintain the turns of the resistance wire accurately spaced from each other. It has been found quite difficult to maintain the correct spacing of the turns of wire when the card-type support does not have parallel long edge portions and when at least one of the long edge portions is contoured to provide a rather steep curve. The difficulty is overcome in some cases by winding the wire under such tension that the wire will dig into edge portions of the support. In other cases where close spacing of the turns of wire is not necessary notches have been cut in the edge portion of the support and the wire is guided into these notches during the winding operation. These procedures have their limitations, however, since in the first case overtensioning the wire might break the wire or change its resistance value and in the second case hand cutting notches to very close space limits is tedious, expensive and, in most cases, not sufficiently accurate and machine tools operable to accurately cut notches across an edge portion of a card at, say 160 notches per inch, and suitable for cutting notches in cards of considerable length to such close limits are not readily available.

In the present invention the card-type support is provided with thermoplastic flat surfaces and these surfaces are molded to provide required grooves in the card-type support and some of the thermoplastic material is extruded beyond the original edge portions of the card-type support and retains parts of the groove pattern impressed on the card-type support.

When a wire is wound on the card-type support the portions of the wire extending over the edge portions of the card-type support are located in the grooves in the extruded portions of the thermoplastic material and the wire is thus prevented from slipping along the length of the card-type support.

To obtain the required groove pattern and provide means for forming the pattern on a card-type support a cylinder 15 of impressionable material as shown in Fig. 1 is rotated against a cutting tool 16 so that a required groove pattern will be cut in the outer cylindrical surface of the cylinder

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15, the cutting tool 16 being moved lengthwise of the cylinder 15 under the action of a lead screw or other suitable tool feeding means, not shown, and the cylinder 15 being supported at opposite ends by means of supports 17 and 18, one at least of which is in driving engagement with the cylinder 15 and rotated by a suitable driving means, not shown. The cylinder 15 should be made of such material that a helical groove 19 may be readily cut in the outer surface 20 by means of the tool 16. I have used, for instance, lead as the material for the cylinder 15 since the helical groove 19 may be readily cut in this material. It will be assumed merely for the purpose of explaining the invention that the cylinder 15 is made of lead and the groove 19 extends from one end of the cylinder 15 to the other.

After the groove 19 has been formed a metal coating 21 is applied to the outer surface of the cylinder 15 as shown in Fig. 2. The coating 21 may be applied, for instance, by electroplating the cylinder 15 with copper or other suitable metal, the inner surface of the coating 21 taking in reverse form the pattern of the groove on the cylinder 15 and the metal coating 21 being sufficiently thick to have no groove pattern on the outer surface.

The coating 21 is cut longitudinally as shown at 22 in Fig. 3 and is peeled off the cylinder 15 as shown in this figure and is then flattened out to make a flat plate 23 shown in Fig. 4, the plate 23 having the groove pattern 24 on the upper surface and having a plain ungrooved lower surface 25.

The plate 23 is mounted on a thicker backing plate 26 as shown in Fig. 5, the plain under surface 25 of the plate 23 being secured to the backing plate 26 in any suitable manner so that the plates 23 and 26 form a relatively thick plate 27, one surface of which contains the groove pattern 24.

An exact duplicate 28 is formed of the plate 27 and the two plates 27 and 28 are mounted in a press 29 shown in Fig. 6, the press 29 having two mounting plates 30 and 31 which may be heated in any suitable manner. It will be obvious that the mounting plates 30 and 31 may be electrically heated by heating means extending into the apertures 32 or that steam or other heat supplying pipes may be connected to the mounting plates 30 and 31 through the apertures 32 in order that the mounting plates 30 and 31 may be heated to a required temperature. The press 29 is constructed and arranged so that the mounting plates 30 and 31 may be brought closer together. A suitable press for the purpose is a hydraulic press in which the mounting plate 31 is supported on a hydraulically operated piston 33, the mounting plate 30 is fixed and guide rods 34 for the mounting plates are supported on the mounting plate 31 and extended through apertures provided in the mounting plate 30. It is obvious that if a sheet of thermoplastic material is placed between the groove patterned plates 27 and 28 mounted in the press 29 and the press is operated to move the plates 27 and 28 against opposite faces of the thermoplastic sheet while the mounting plates 30 and 31 are heated to a sufficient temperature to bring the groove patterned plates 27 and 28 to a temperature sufficient to soften the thermoplastic sheet, the upper and lower surfaces of the thermoplastic sheet will be molded to the groove pattern impressed therein by the plates 27 and 28. By applying sufficient heat and pressure to the thermoplastic sheet through opera-

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tion of the press 29 some of the thermoplastic material may be made to extrude beyond the original edges of the thermoplastic sheet. The thermoplastic material and the temperature imparted to it should be such that the groove pattern will remain in the extruded portions of the material extended over the original long edge portions of the sheet. A suitable thermoplastic material for the purpose is cellulose acetate. It is obvious, however, that other thermoplastic materials may be used instead of cellulose acetate and that the invention is not limited to the use of cellulose acetate. It will be assumed, however, merely for the purpose of explaining the invention that such material is used in the construction of the card-type support.

Fig. 7 shows a sheet 35 comprising an inner layer 36 coated on opposite faces 37 with thermoplastic material which may be cellulose acetate or other suitable thermoplastic material.

From the sheet 35 a card is cut of desired form such, for instance, as the card 38 shown in Fig. 8. This card has a long straight edge portion 39 and a curved edge portion 40 and after being impressed with the groove pattern of the plates 27 and 28 in the press 29 will become a card-type support on which resistance wire may be wound, the turns of wire being guided into and being held in grooves formed, in the pressing operation, on the edge portions 39 and 40, the grooves being provided to prevent the wire from slipping along the long edge portions of the card-type support.

To make a card-type support having the required groove pattern the card 38 is placed between the plates 27 and 28 in the press 29, the plates 27 and 28 are heated to a sufficient temperature to soften the thermoplastic coatings and the press 29 is operated to squeeze the plates 27 and 28 against the thermoplastic surfaces on the card 38. The temperature should be only sufficient to soften the thermoplastic material and not high enough to make the material run freely.

As shown in Figs. 9 and 10, a card-type support 41 has been made from the card 38 in the manner above described. It will be seen by looking at these figures that some of the thermoplastic material has been extruded as indicated at 42-43 beyond the original edge portions 39 and 40 of the card, that the extruded portions 42 and 43 turn inwardly toward each other on each edge portion of the card-type support 41 and that the groove pattern continues in the extruded portions 42 and 43, as indicated at 44, in the extruded portion 42 shown in Fig. 10. The extruded portions 42 and 43 are, in effect, spaced ridges extending along the edges of the card-type support, the ridges cooperating to form a channel along each long edge of the card-type support.

When a wire 45 is wound on the card-type support 41 as shown in Fig. 11, the portions of the wire 45 extended around the long edge portions of the card-type support 41 rest in the grooves 44 in the extruded portions 42 and 43 so that the turns of the wire are held in required spaced relation and are prevented from slipping along the long edge portions of the card-type support 41. This is of particular advantage in making a so-called tapered resistance when the required taper is obtained by winding the wire on a tapered form card-type support having a relatively steep curve along one of its edge portions. The wire cannot slide down the curved edge portion of the card-type support.

I have made card-type supports by the method

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above described and have found that even when the edge portions are formed to provide relatively steep curves the turns of wire wound on the card-type support will remain in their required positions. Also that the turns of wire will remain in their required positions on the card-type support when the wire-wound card is bent into the form of a ring suitable for forming part of a potentiometer in which the resistance unit is a ring type support wound with wire and a wiper contact is rotated over and in contact with an edge portion of the wire-wound resistance unit.

Since the thermoplastic material is on opposite faces of the card-type support and some of the thermoplastic material is extruded so that portions overhang the original long edge portions of the support the sheet 35 from which the card-type support 41 is cut may be a laminated structure in which the inner layer 36 is made of either metal or sheet insulating material. In some cases I may make the card-type support entirely of thermoplastic material and control the heat and pressure applied by the press 29 so that the outer flat surfaces will be softened and molded by means of the plates 27 and 28 to the required groove pattern and there will be some of the outer surface material extruded beyond the original long edge portions of the card and the groove pattern will be continued into the extruded portions.

In the modification shown in Figs. 13 and 14 the card-type support 46 is made in the same manner as the card-type support 41 above described. In this modification, however, each long edge portion of the card-type support 46 is provided with an impressionable insulating thread. The threads 47 and 48 may be made of cellulose acetate or other insulating material sufficiently soft at normal room temperature to allow the wire 45 to partly sink into the thread when the wire 45 is wound on the card-type support. The thread 47 is laid in a channel 49 resulting along the curved edge of the card-type support 46 when the extruded portions 42 and 43 are formed, the channel 49 being defined by the original curved edge of the card and the extruded portions 42 and 43 of thermoplastic material.

The thread 48 is laid in a channel 50 resulting along the long straight edge of the card-type support 46 when the extruded portions 42 and 43 are formed, the channel 50 being defined by the original long straight edge of the card and the extruded portions 42 and 43 of thermoplastic material. The thread 51 shown in Fig. 13 is, in effect, a continuation of the thread 47 and is provided at the point indicated when the card-type support 46 is made in the general form shown and is abruptly widened on an end portion of the structure.

When the wire 45 is wound on the card-type support 46 the wire 45 binds the threads 47, 48

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and 51 into the channels formed by the extruded portions 42 and 43 along edge portions of the card-type support. The diameter of the threads 47, 48 and 51 is slightly greater than the depth of the channels and the threads are indented under the tension of the wire 45, the indentations made in the threads being, in effect, continuations of the groove pattern formed in the extruded portions 42 and 43, one of the grooves of which is illustrated at 44 in Fig. 10.

It will be seen, as illustrated in Figs. 13 and 14, that the grooves formed in the extruded portions 42 and 43 of the thermoplastic material and the indentations made in the threads 47 and 48 will prevent the turns of wire 45 from slipping along the card-type support 46.

The wire-wound resistance formed in accordance with this invention may be mounted on a suitable support in a resistance device in which a wiper contact is provided to successively engage the turns of resistance wire. The wire-wound card may be bent into the form of a ring and mounted on an annular support and the wiper contact may be arranged to operate over and in contact with the turns of wire extending over the long straight edge portion of the resistance. In the case of the structure shown in Figs. 13 and 14 the thread 48 will provide a backing for the turns of resistance wire where the wire is engaged by the wiper contact and prevent undue distortion and displacement of the turns of the resistance wire by the action of the wiper contact.

What is claimed is:

The method of making a wire-wound resistance of the type shown in Figs. 13 and 14 comprising making a card of the general form required to support the wire winding, said card having surfaces of thermoplastic material, placing said card between two plates having surfaces facing said card representing a required groove pattern to be impressed in said card, heating said plates to a temperature sufficient to soften the thermoplastic surfaces on said card, pressing said heated plates against said card until said thermoplastic surfaces are impressed with the groove pattern represented on said plates and until some of the thermoplastic material in said surfaces is extruded beyond original edge portions of said card in the form of spaced ridges defining in cooperation with the original edges of said card channels extending lengthwise along edge portions of said card, placing threads in the channels formed along the edges of said card and winding a wire around said card so that turns of the wire winding engage in the grooves formed in the extruded portions of said thermoplastic material and so that the turns of wire indent said threads where the turns of said wire extend over edge portions of said card.

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