

Dec. 9, 1947.

R. BLACK, JR., ET AL

2,432,083

HYDROPHONE

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2 Sheets-Sheet 1

FIG. 1

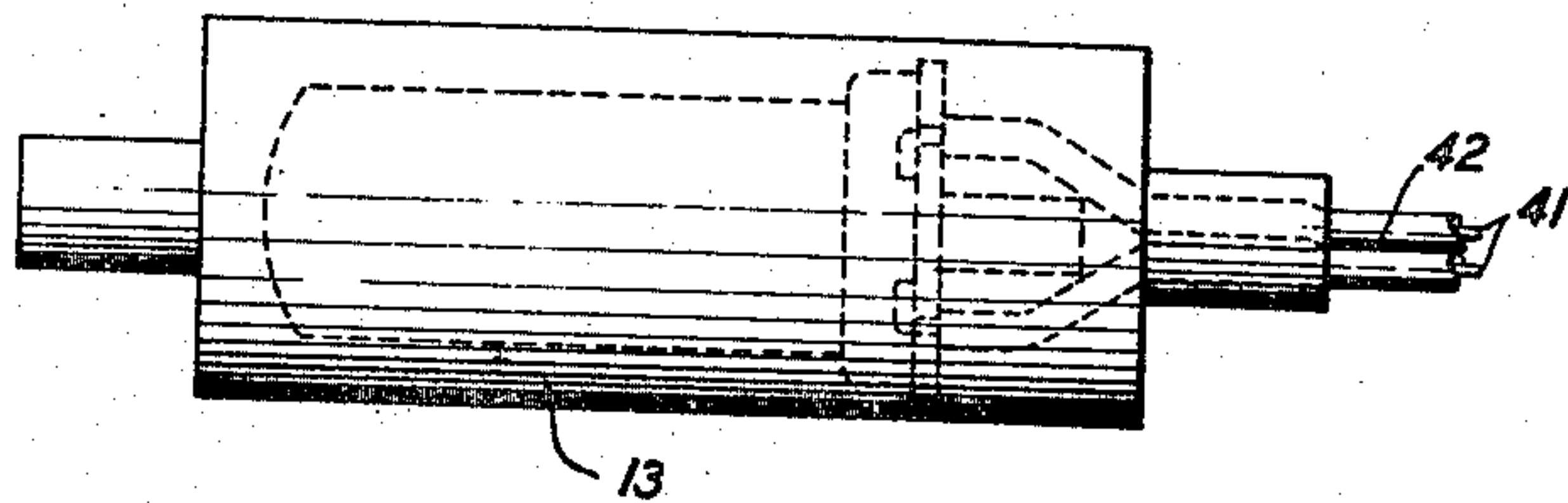


FIG. 2

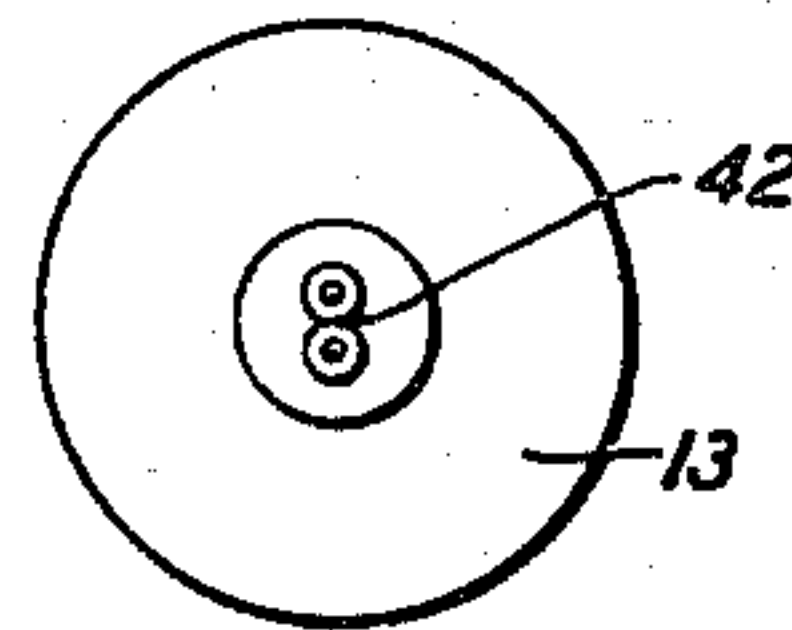


FIG. 3

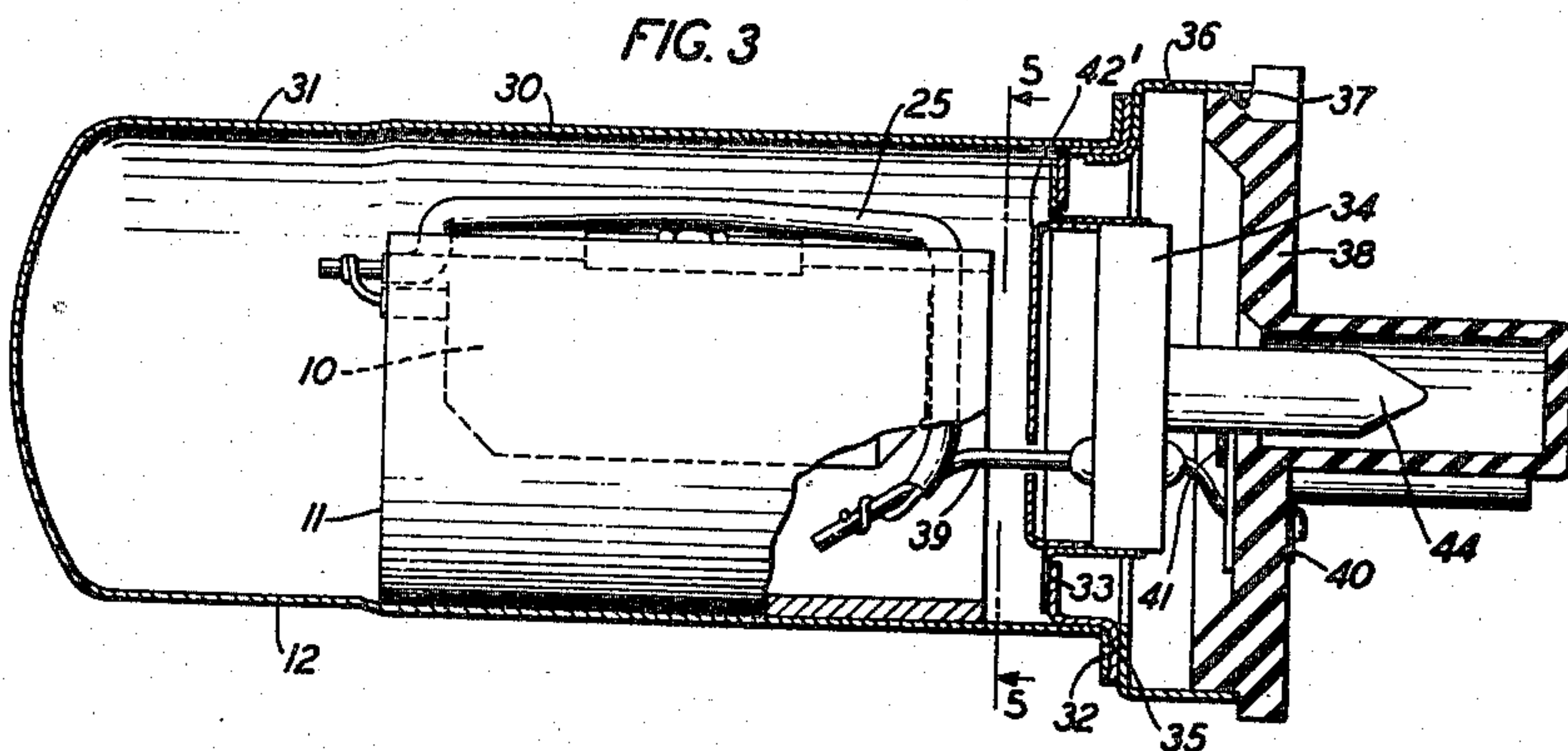


FIG. 4

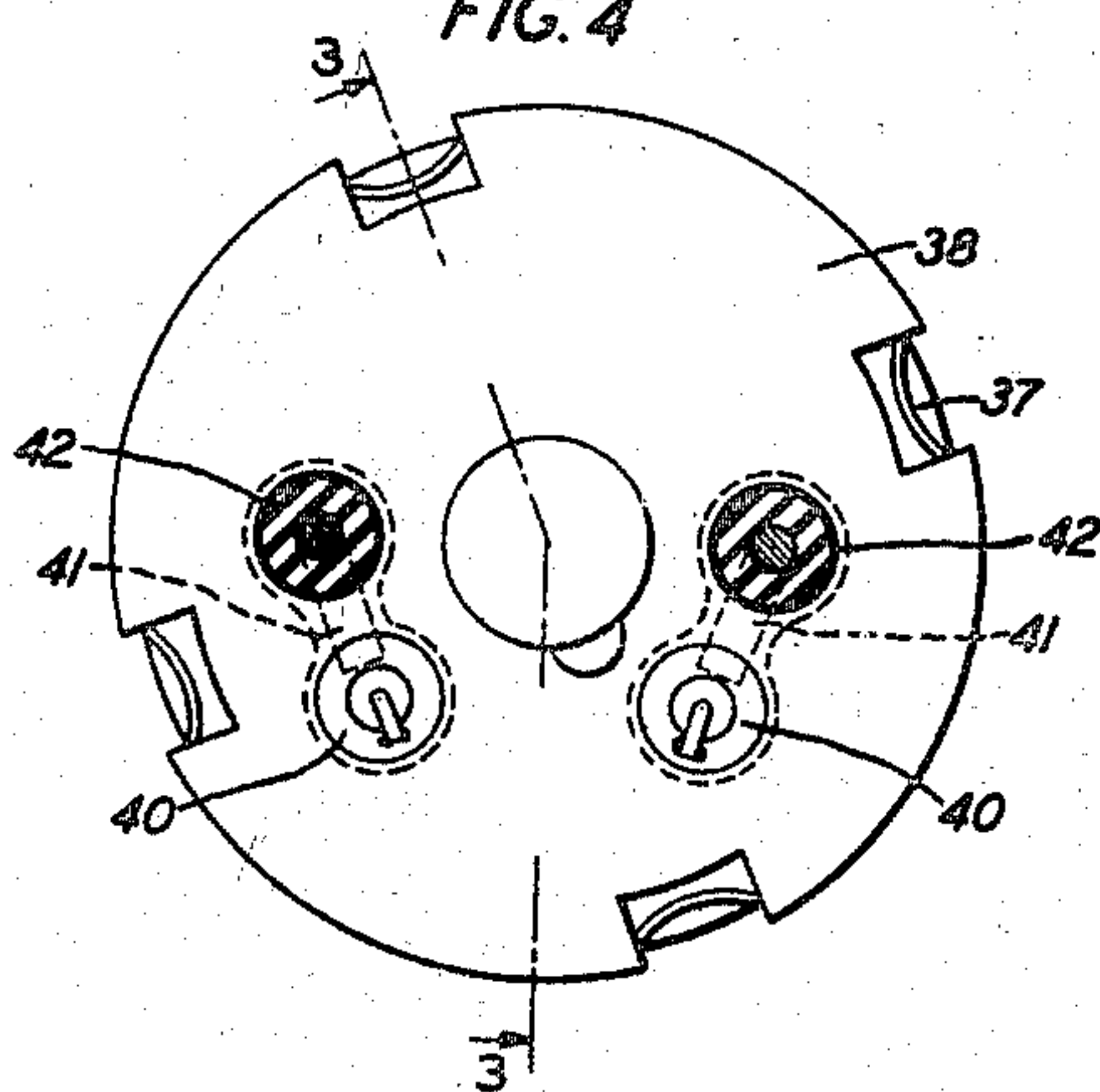
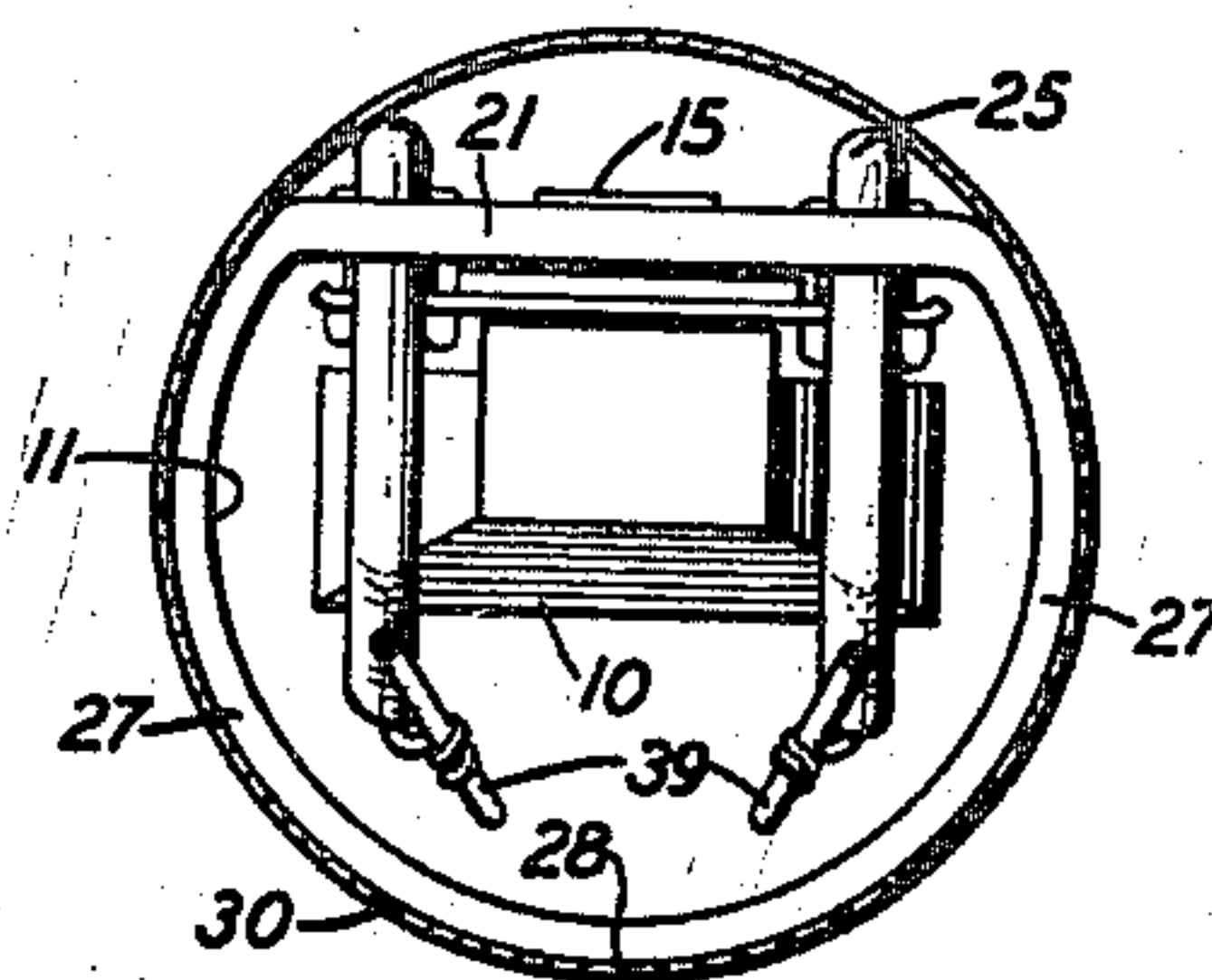


FIG. 5



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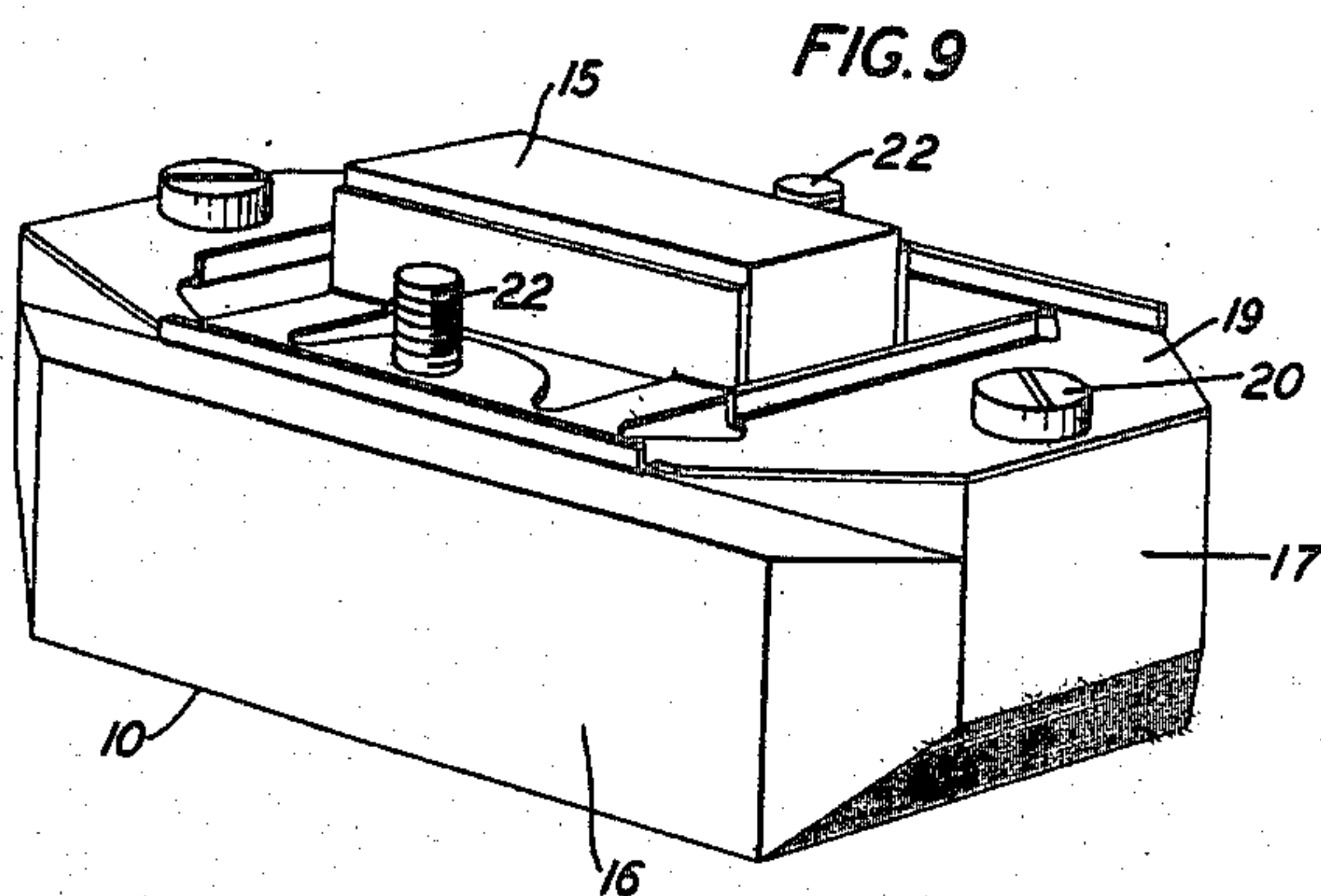
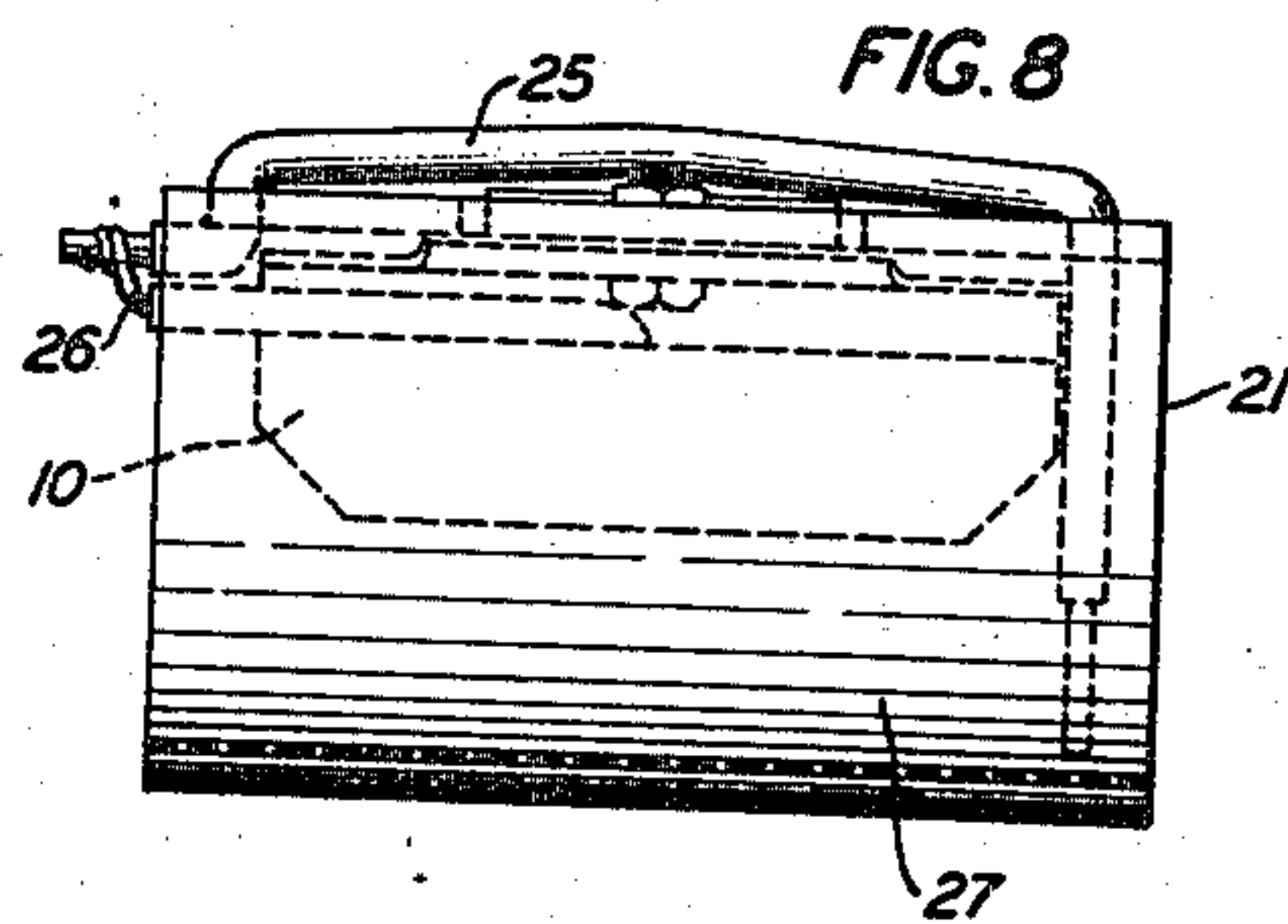
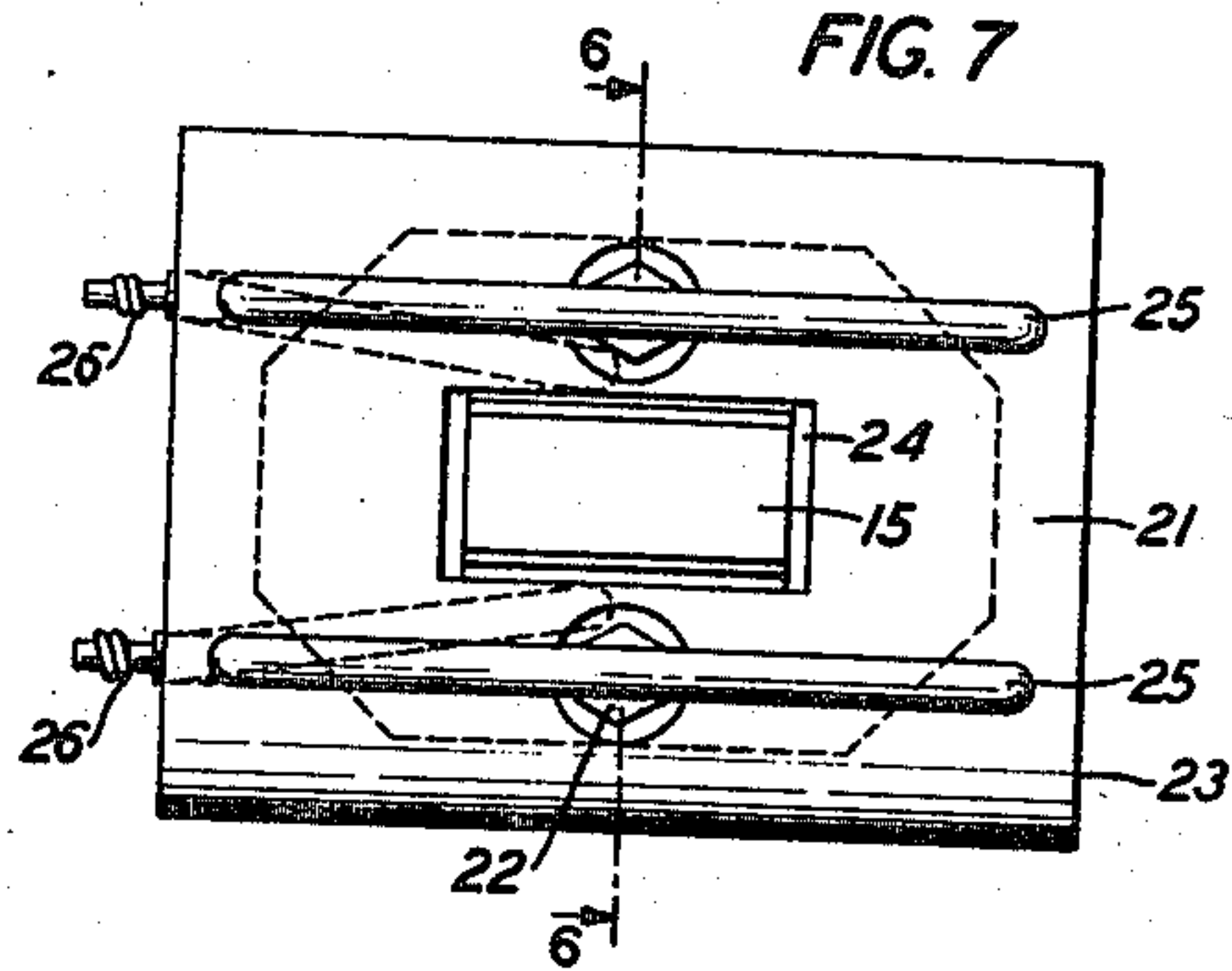
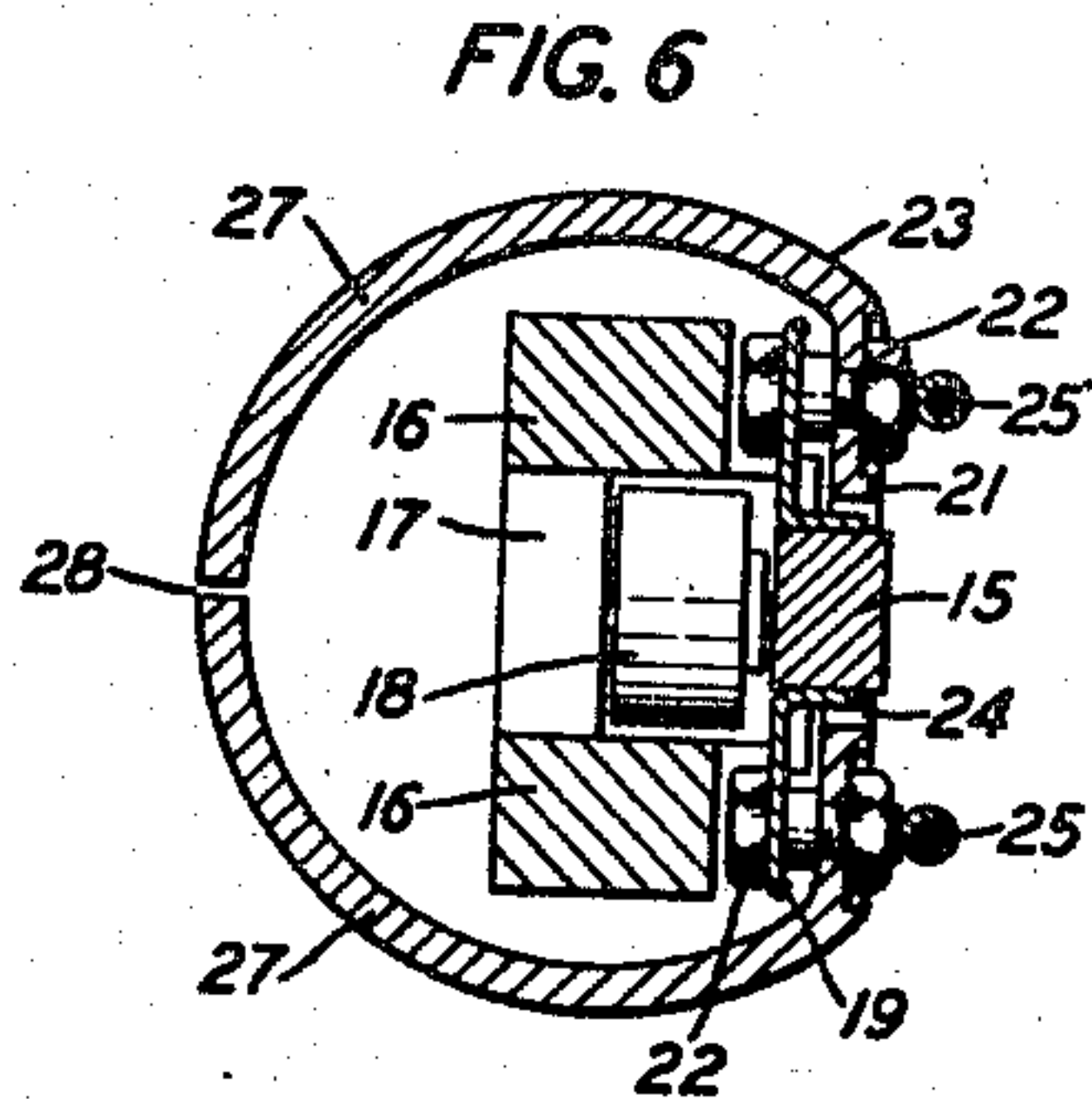
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2 Sheets-Sheet 2



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2,432,083

HYDROPHONE

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6 Claims. (Cl. 177—386)

1

This invention relates to submarine signal detecting devices or hydrophones.

An object of the invention is to improve the structure and the operating characteristics of hydrophones.

In accordance with the invention, a hydrophone or submarine signal detector may comprise a transducer unit so supported on a frame or carrier member as to function on the inertia principle, the carrier member being of such shape and resiliency as to make a substantially tight fit with a substantial area of the inner surface of a thin-walled hermetically sealed and water-tight container or enclosure. The outer surface of the container is covered with a substantially uniform thickness of rubber molded around the container. This general arrangement involves structural simplicity and ruggedness, protection of the mechanical and electrical parts against corrosion, a low order of distortion and attenuation in the signal transmission from the water to the transducer unit, and adaptability to quantity manufacture with reproducible response-frequency characteristics.

A more complete understanding of this invention will be obtained from the detailed description that follows taken in conjunction with the appended drawings, wherein:

Fig. 1 is a side view of a hydrophone embodying the invention;

Fig. 2 is an end view of the device of Fig. 1;

Fig. 3 is an enlarged side view, partly in section and partly broken away, of the electromechanical assembly included in the device of Fig. 1;

Fig. 4 is an end view of the assembly of Fig. 3;

Fig. 5 is a sectional view of the assembly of Fig. 3, along the line 5—5 thereof;

Fig. 6 is a sectional view along the line 6—6 of Fig. 7, Fig. 7 and Fig. 8 being plan and side views, respectively, of the transducer unit assembly included in the structure illustrated by Fig. 3; and

Fig. 9 is an enlarged perspective view of the transducer unit included in the hydrophone.

With reference to the drawings, the hydrophone is seen to comprise a transducer unit 10 included in an assembly 11 within a water-tight and hermetically sealed enclosure or container 12 that is completely covered or coated by a substantially uniformly-thick layer of rubber 13. The transducer unit assembly will be best understood by particular reference to Figs. 3 and 5 to 9.

The magnetic system of the transducer unit may be substantially the same as that of the telephone receiver of M. S. Hawley Patent 2,202,906 of June 4, 1940. It comprises an armature 15, a pair of bar permanent magnets 16, a pair of U-shaped pole-pieces 17, current coils 18 surrounding the inner arms of the pole-pieces, 60

2

and a spider member 19 providing a mechanical stiffness member coupling the armature to the other components of the magnetic system, the pole-pieces and magnets being welded together and the spider member being fastened to the pole pieces by screws 20, all of which is described in greater detail in the aforementioned Hawley patent. In the present arrangement, the magnetic system is fastened to the planar portion 21 of a D-shaped frame member or chassis 23 by fastening means 22, whereby, since the armature is soldered to the spider member, the armature, the other components of the magnetic system as a group, and the chassis are adapted for relative movement on vibration, for example, of the chassis. The planar portion of the frame member contains an appropriately shaped aperture 24 for the armature, and additional apertures through which insulated wires or leads 25 may be drawn for electrically connecting the ends 26 of the current coils with terminals on the container 12. The frame member may be of a non-magnetic metal, such as brass, and, except for its planar portion 21, substantially annular in cross-section. The curved portion of the frame member is divided into a pair of substantially similar but opposed arcuate portions 27 by a slot or slit 28 extending along the length of the frame member at a location substantially intermediate the junctions of the curved portion with the planar portion. When the transducer unit assembly is outside of the container 12, the arcuate portions 27 are sprung apart, for example, as illustrated by Fig. 6. When the assembly is inside of the container, the portions 27 are forced together, as illustrated by Fig. 5, the tendency of the arcuate portions to restore themselves to the condition of Fig. 6 resulting in an exceptionally tight fit between the frame member and a substantial area of the inner surface of the container, to provide an excellent vibration transmission relationship between the container and the frame member and, therefore, the transducer unit. In slidably inserting the assembly 11 in the container during manufacture of the hydrophone, the arcuate portions 27 would be forced together sufficiently for the purpose.

The container 12 comprises a thin-walled, metallic envelope 30 substantially cylindrical in shape, formed with a closed end portion 31 of slightly reduced diameter and an open end portion provided with an outwardly flaring annulus 32. The latter end portion may be closed by a closure assembly 33 having a central opening closed by a disc 34 of insulating material, a shoulder portion 35 that may be ring welded to the annulus 32 and an annular skirt 36 bent over portions 37 of which hold a terminal plate 38 of insulating material securely within the closure assembly. The disc 34 may be cemented in position

and supports a pair of connector wires 39 electrically connecting the leads 25 with the terminals 40 on the plate 38. The conductors 41 of the cable 42 for connecting the hydrophone with suitable electrical equipment (not shown) in a vessel or on shore are brought into the container through suitable apertures in the plate 38 and terminated at the terminals 40. All the metallic joints of the container assembly are water and air tight, the sealed-off tubing 44 being the remnant of a tube extending through the disc 34 for introducing, prior to the addition of the plate 38 to the container assembly, air at substantial pressure to test the hermetic character of the seals. The envelope 30 and all but the disc 34 of the closure assembly may be of a magnetic material, such as steel. A disc 42' of similar material, provided with suitable apertures for the connectors 39, may be inserted in the closure assembly opening over the disc 34 to provide a closed magnetic shield around the transducer unit to protect it against the effect of magnetic fields developed during the welding operations as well as against the effect of magnetic fields that may be present in the environment in which the hydrophone may be used.

During the assembly of the hydrophone, after the transducer unit assembly is inserted in the envelope 30, the latter may be forced slightly into the reduced diameter portion 31 to ensure rigid coupling between the frame member and the envelope. The air and water-tight character of the seals and joints of the container may be tested, prior to securing the terminal plate in position, by use of air under pressure introduced through the tubing 44 while the container is held under water or in carbon tetrachloride. The rubber layer 13 is molded around the container and the container end of the cable 42 as the last step of the manufacture. The response-frequency characteristic of the device may be measured at intervals to ascertain that it remains within permissible limits before the next assembly step.

In use, the hydrophone is submerged in water, for example in a lake, a river or the sea, at the end of a suitable suspension, or may be included with a number of similar devices at spaced intervals in a cable, for example, extending across the mouth of a river or the entrance to a harbor. Submarine signal waves or other underwater disturbances in the audio frequency range will cause the hydrophone to vibrate. These vibrations produce relative movement between the spring coupled armature and the remaining structure of the transducer unit magnetic system, whereby the variation in the reluctance of the magnetic circuit induces currents in the coils on the pole-pieces that correspond to the signal waves or disturbances. These currents are led over the conductors of the cable to suitable electrical indicating or translating equipment in a vessel or at a shore station. The outer rubber layer protects the container against the corrosive effects of the water, the thin-walled envelope efficiently transfers vibration to the D-shaped frame member and the latter effectively transfers the disturbance to the transducer unit.

Although the invention has been disclosed with reference to a specific structure, it is evident that modifications therein may be made by the skilled

in the art without departing from the invention.

What is claimed is:

1. A hydrophone comprising a water-tight hermetically sealed cylindrical container, a spring metal frame member adapted to be wholly included within said container, said frame member being slidably insertable in said container and expansible therein to make a tight fit with a substantial area of the inner surface of the latter, and an electromechanical transducer unit mounted on and supported solely from said member so as to respond to vibrations transmitted to said frame from said container.

2. The hydrophone of claim 1 in which said frame member is substantially D-shaped in section with the outer curved portion of the frame conforming closely to the inner surface of said container, said transducer being an inertia type transducer mounted inside said frame and resiliently supported from the flat portion of said D-shaped frame.

3. The hydrophone of claim 1 in which said frame member is substantially D-shaped in section with the curved portion of the D-shaped frame in close contact with the inner cylindrical surface of said container and the transducer unit supported from the planar portion of the frame member.

4. The hydrophone of claim 1 in which said frame member is substantially D-shaped in section, the curved portion of the D-shaped frame having approximately the same radius of curvature as the cylindrical container, said frame having a slot extending along the length of its curved portion.

5. The hydrophone of claim 1 in which said frame member is substantially D-shaped in section, the curved portion of the D-shaped frame having approximately the same radius of curvature as the cylindrical container, said frame having a slot therein extending along the length of its curved portion approximately intermediate the junctions of the planar and the curved portions of the member.

6. The hydrophone of claim 1 in which said frame member is substantially D-shaped in section, the curved portion of the D-shaped frame having approximately the same radius of curvature as the cylindrical container, said frame having a slot extending along the length of its curved portion approximately intermediate the junctions of the planar and curved portions of the member, the transducer unit being supported from the planar portion of the member.

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