June 5, 1934. R. R. A. HOFFMANN ET AL 1,961,149

LOUD SPEAKER DIAPHRAGM

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Fig. 1.

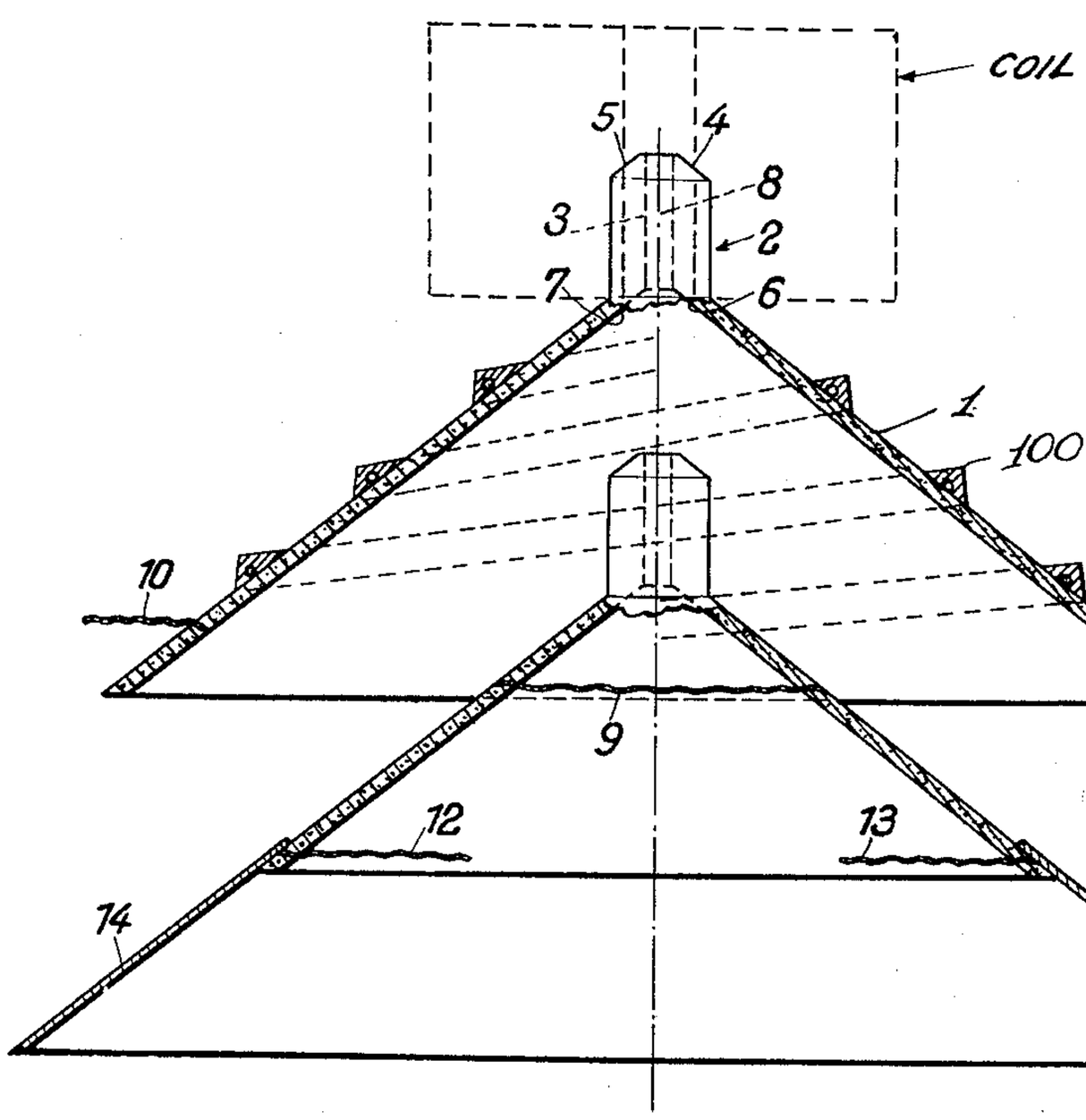

Fig. 2.

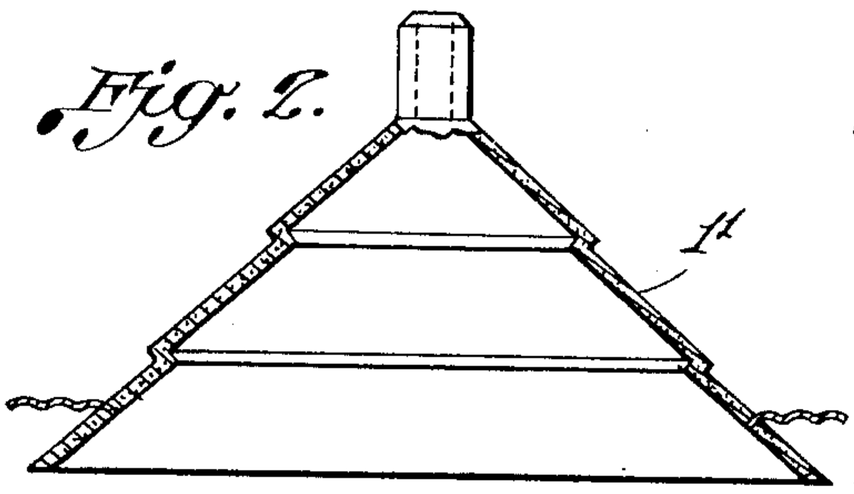

Fig. 3.

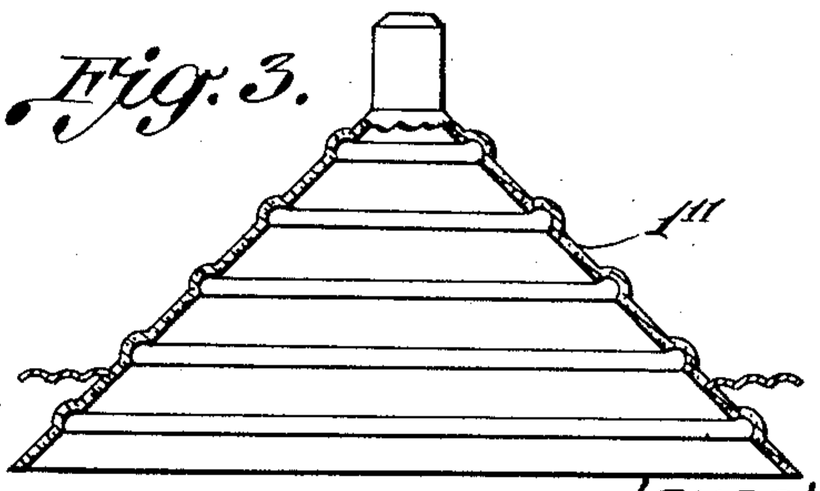

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Fig. 4,

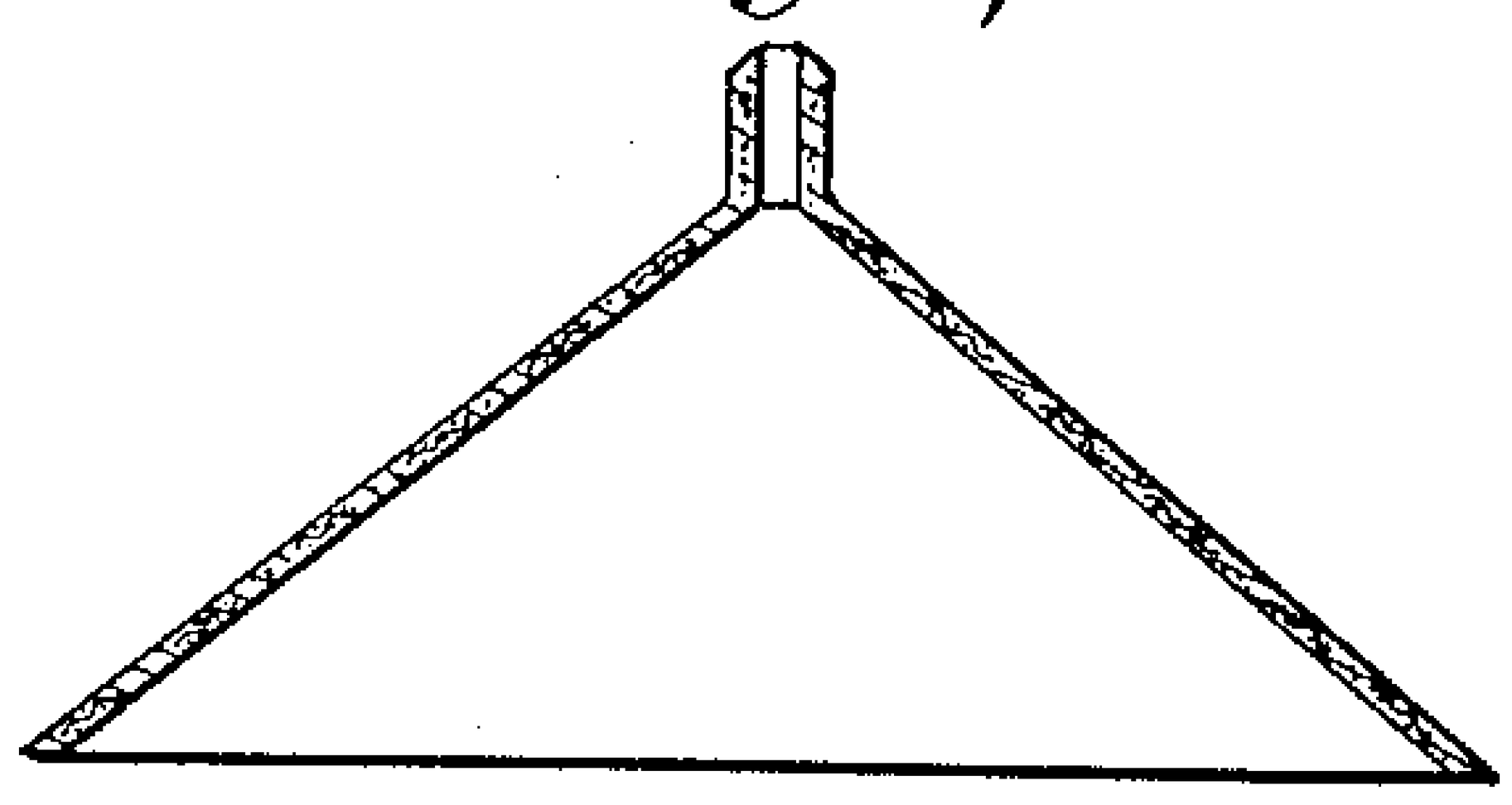


Fig. 5

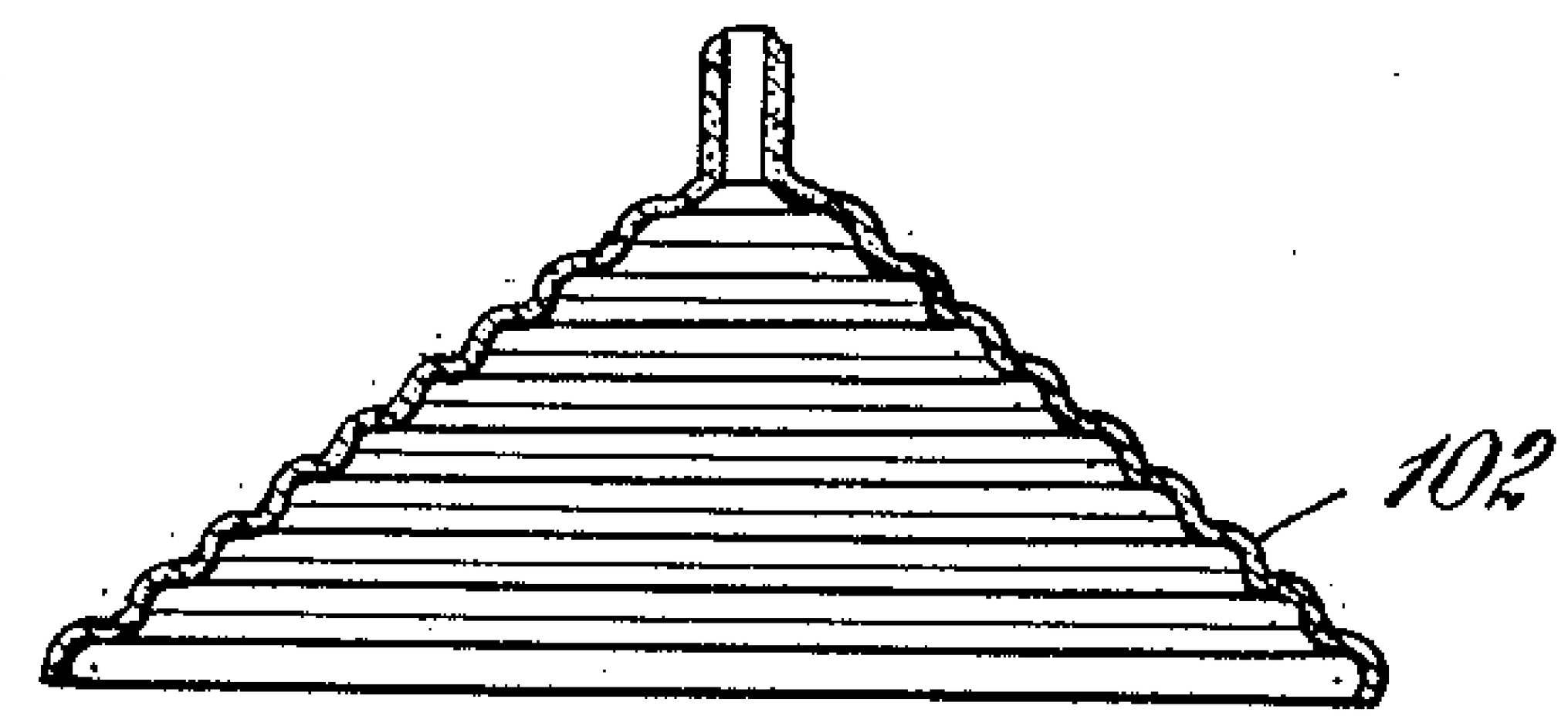


Fig. 6,

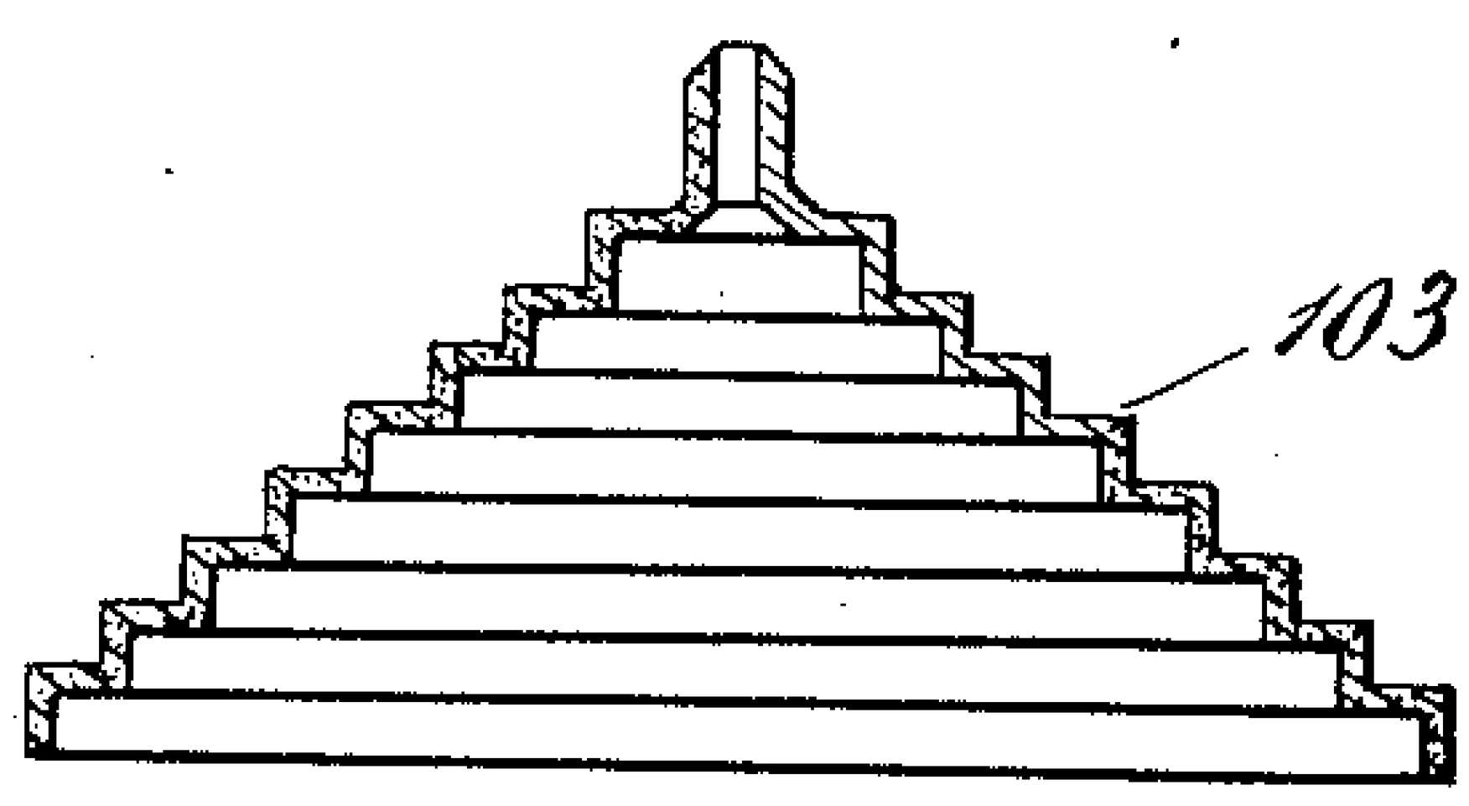


Fig. 7,

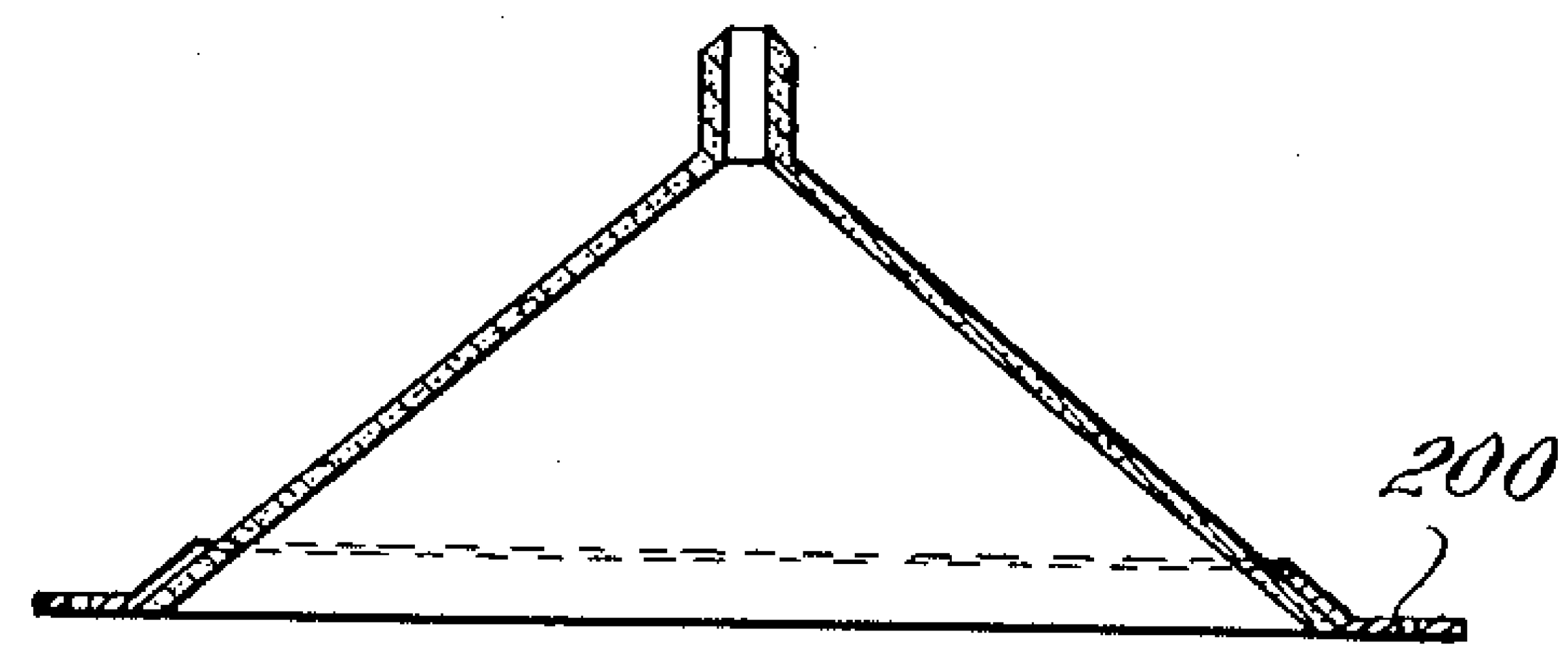


Fig. 8,

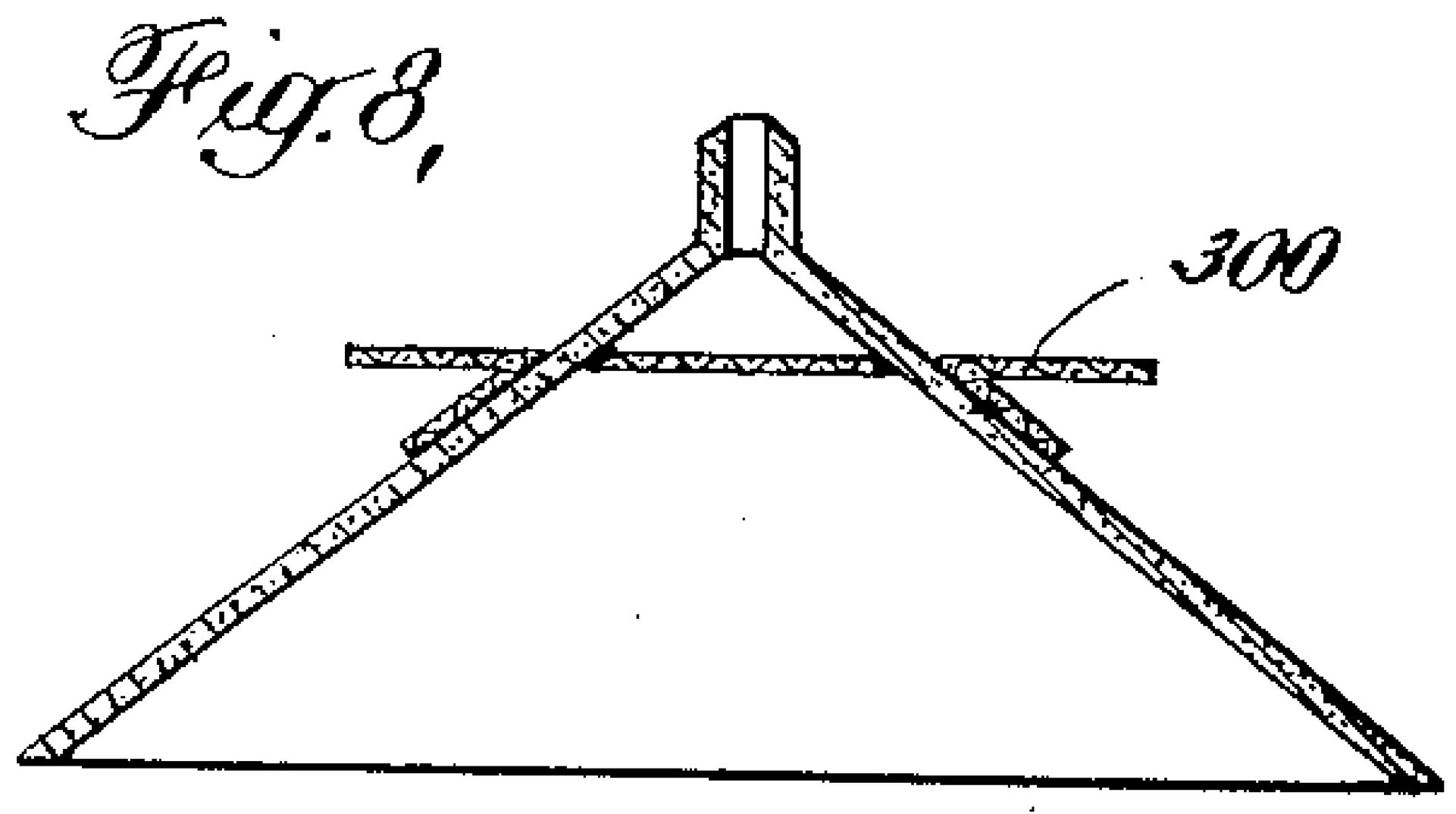


Fig. 9,

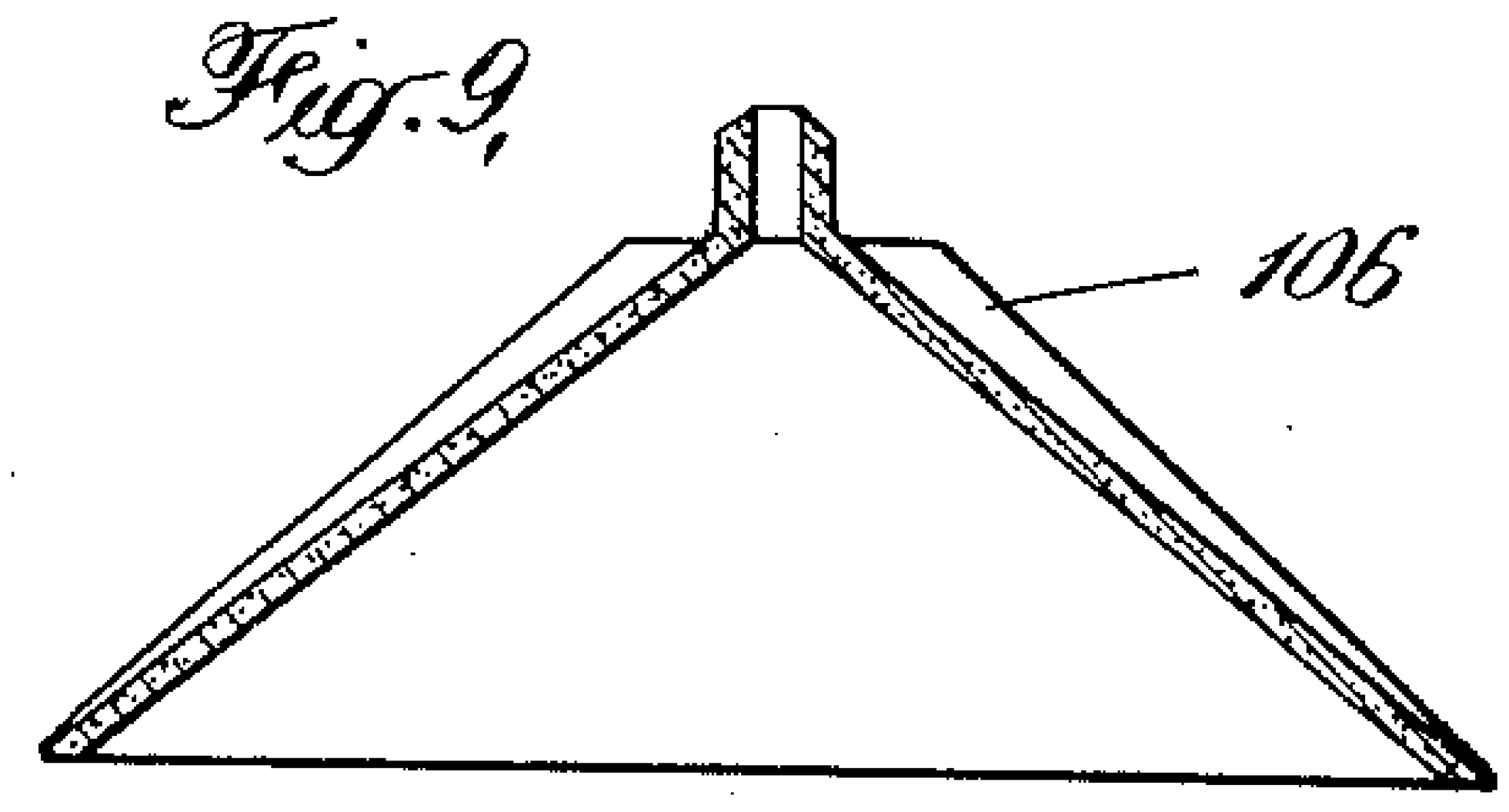


Fig. 10,

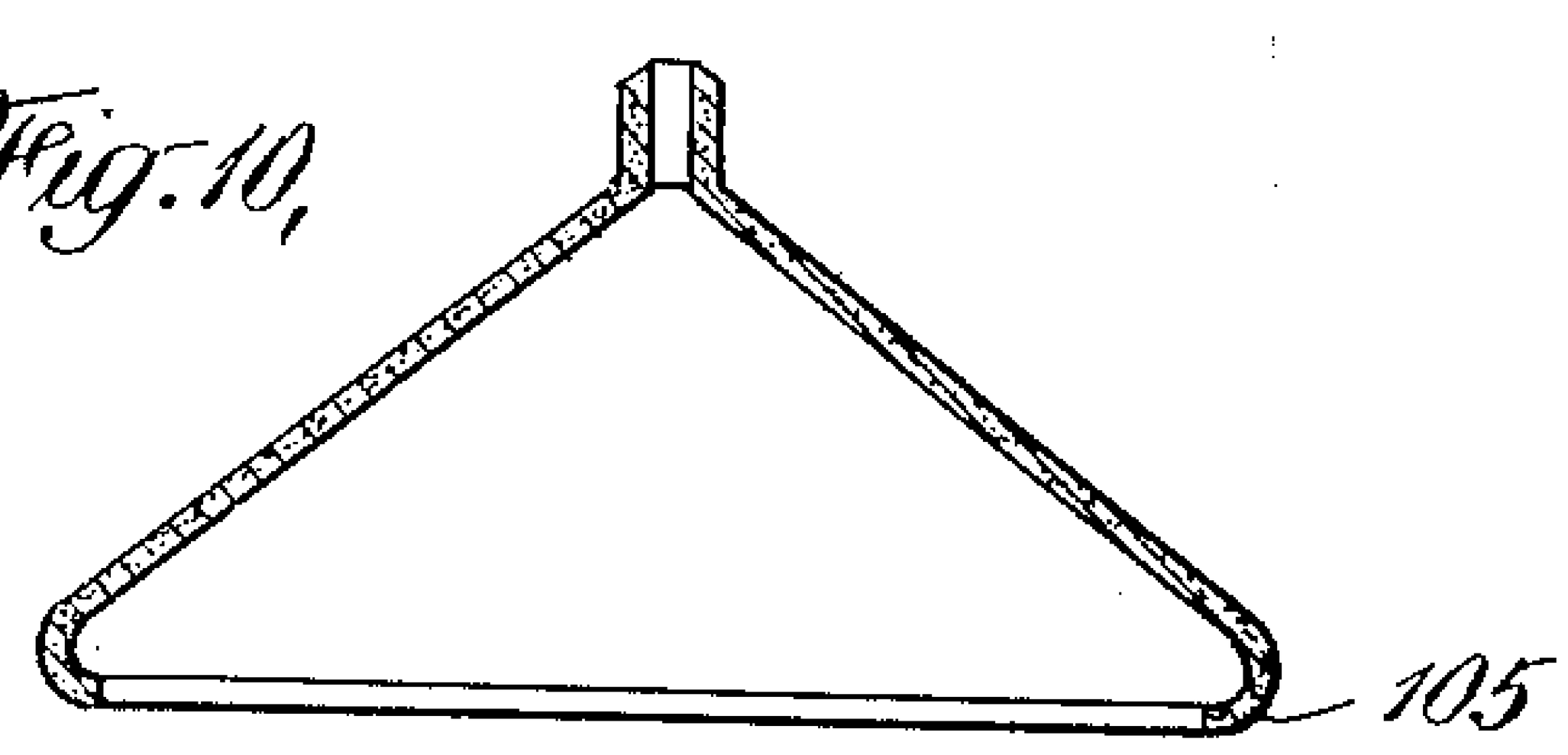


Fig. 11,

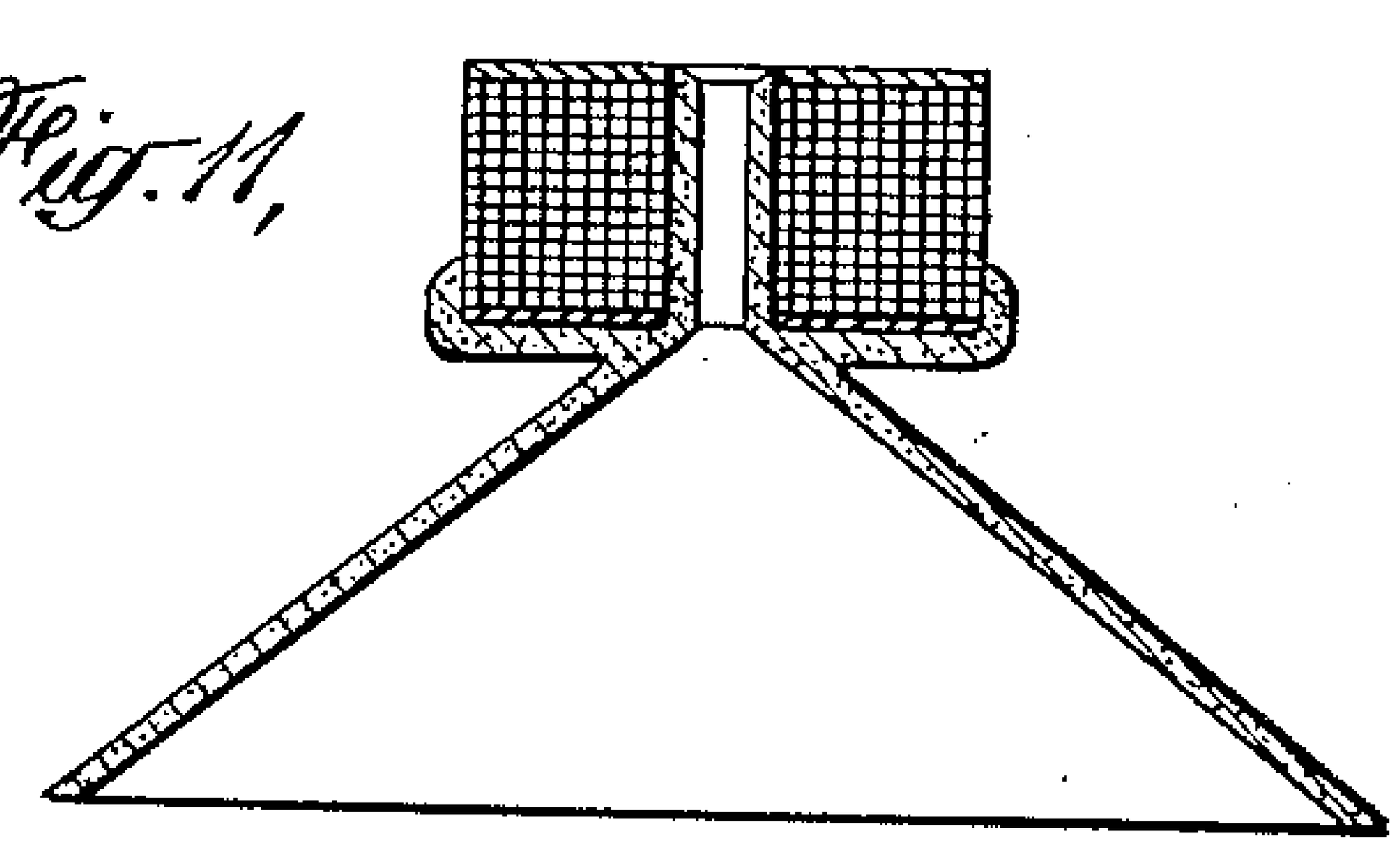


Fig. 13,

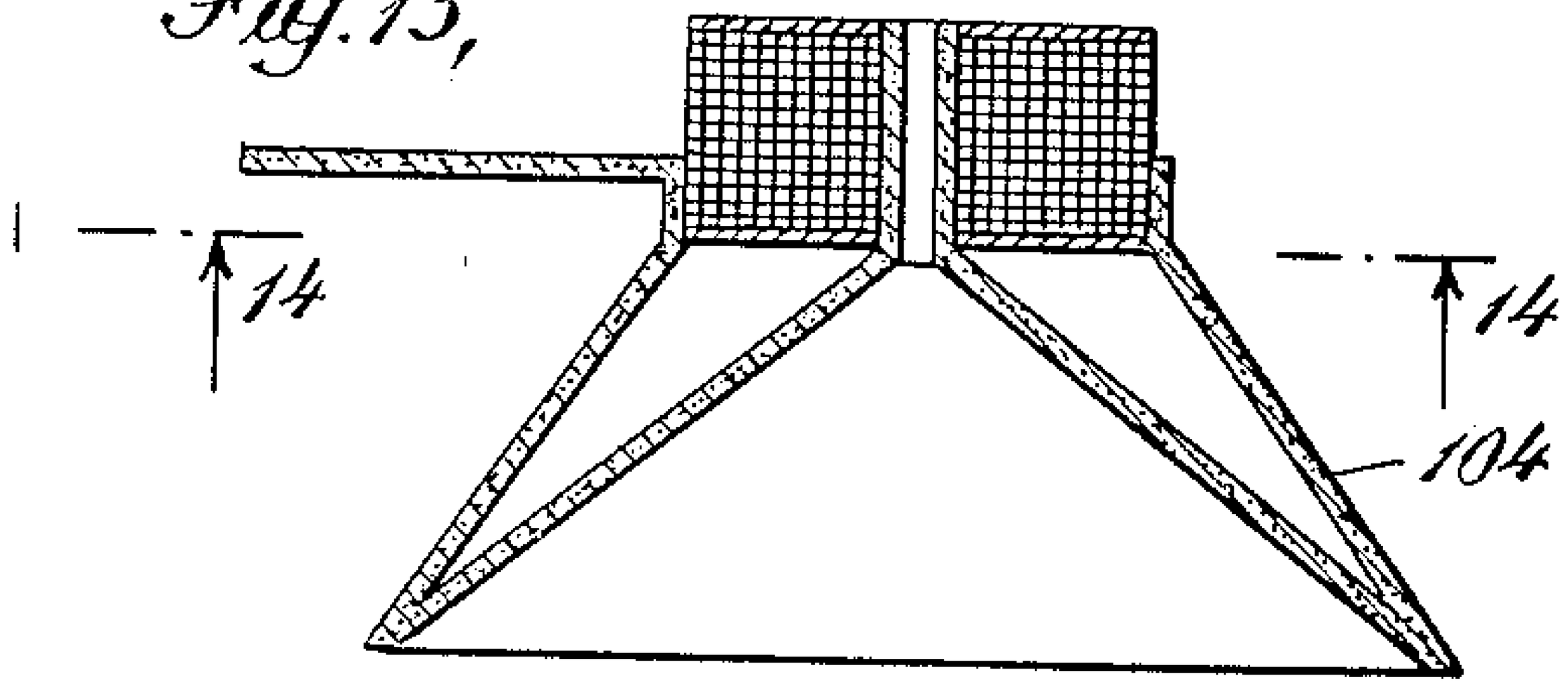


Fig. 12,

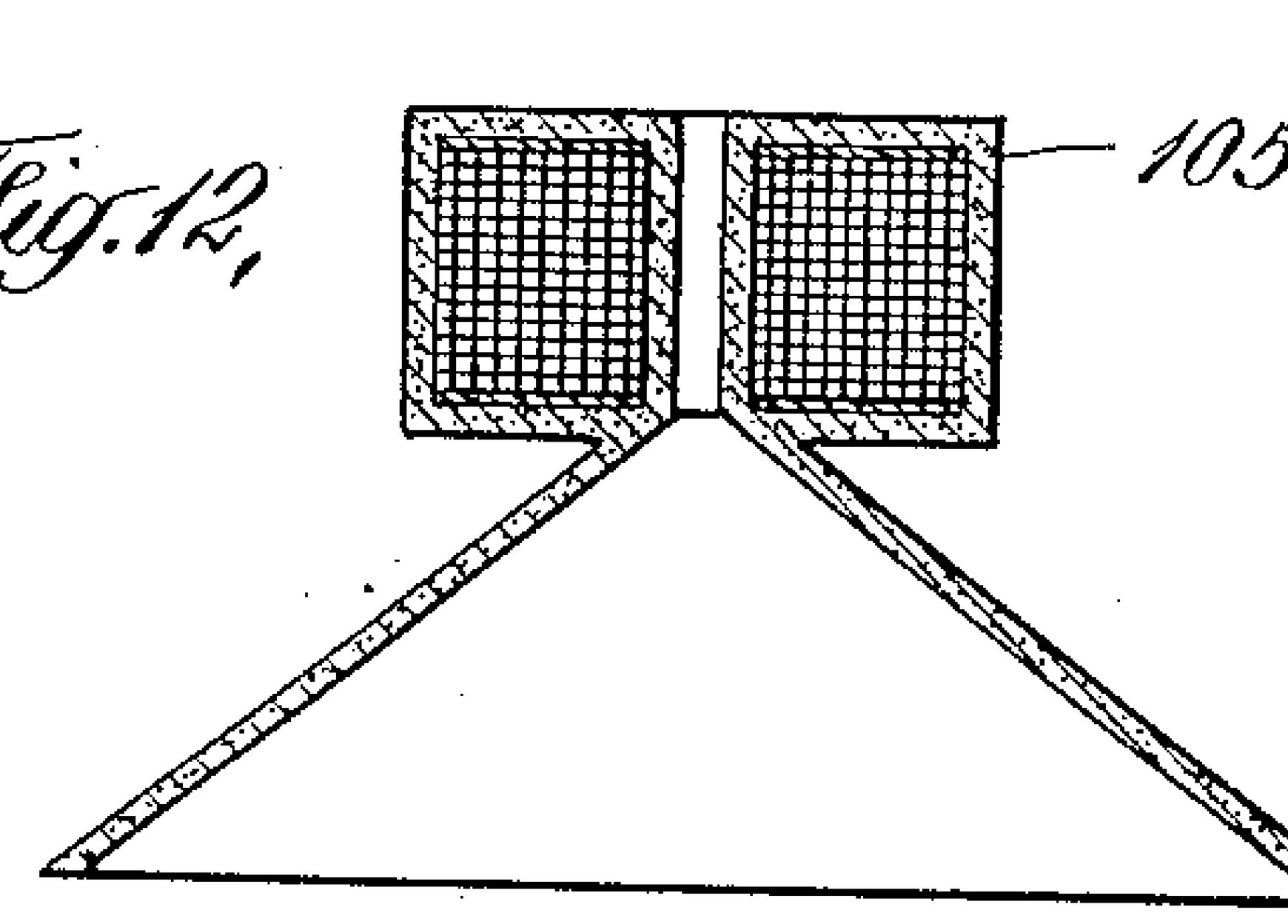
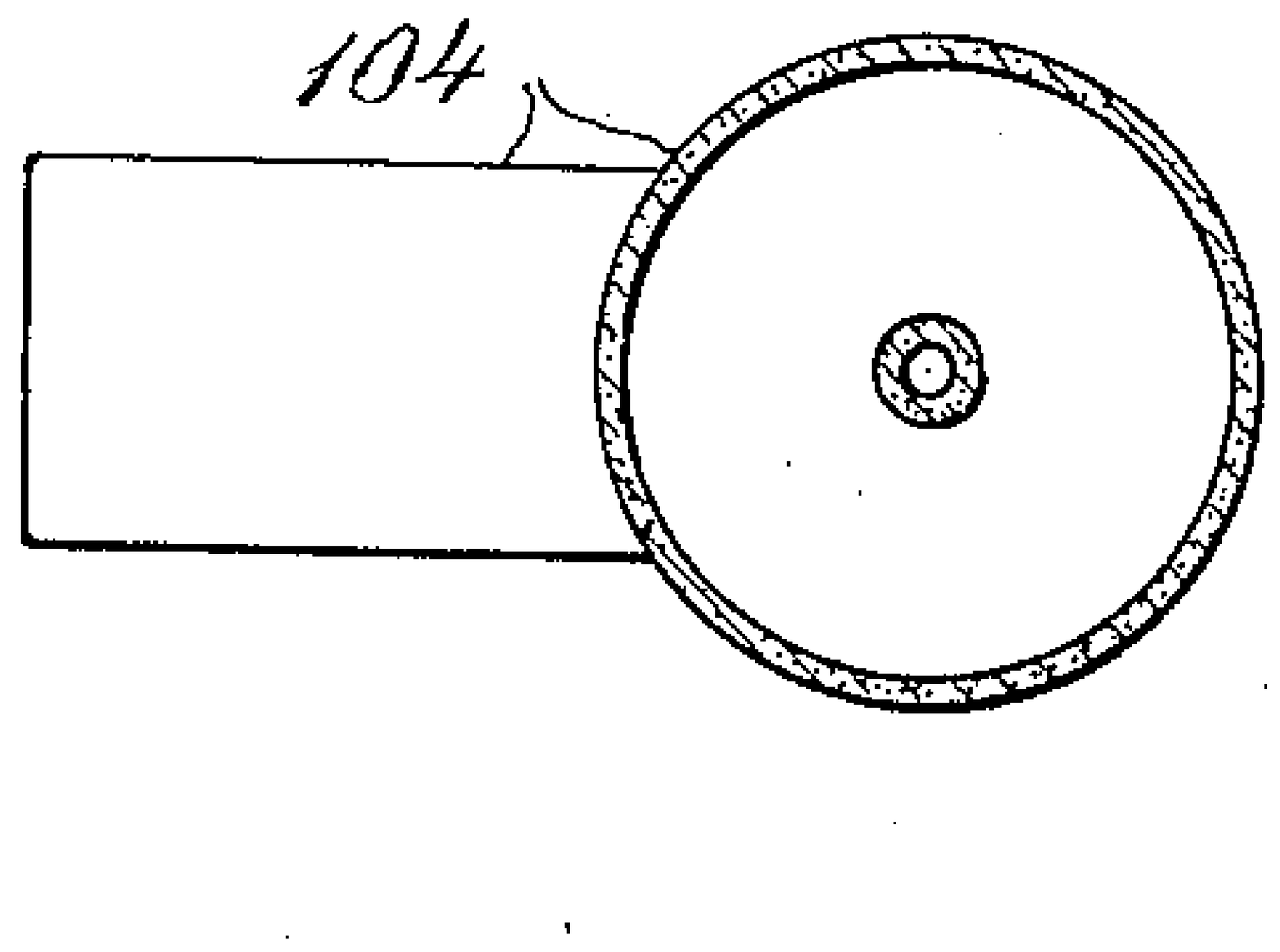


Fig. 14



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THEIR ATTORNEYS.

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UNITED STATES PATENT OFFICE

1,961,149

LOUD SPEAKER DIAPHRAGM

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Application July 15, 1932, Serial No. 622,626
In Germany July 18, 1931

22 Claims. (Cl. 181—31)

In the construction of loud speakers, care has to be taken that the diaphragm is as nearly as possible aperiodic relatively light in weight, of relatively large area and rigid in the direction of movement.

A conical shape has been found very favourable for the diaphragm. It has been constructed of light metal but this has been given up on account of its tendency to vibration. It has also been made of paper-like material but this is unfavourable on account of its resilience and hydroscopic properties, and often has to be impregnated, stitched or glued. Diaphragms of asbestos impregnated with shellac or other varnish have also been proposed. Such diaphragms, however, are too thick and therefore too heavy and they are also too complicated and too expensive in manufacture.

The diaphragm according to the invention has acoustic, mechanical and economical advantages which could not be obtained with any known diaphragm.

It has been found that by using very high pressure and very strong moulds, unusually thin walled articles consisting principally of a condensation product of formaldehyde and phenol or of substances of the carbanide series can be made.

This method can be employed according to the invention for making diaphragms of a thickness of less than a millimetre by formaldehyde and phenol or carbanides in broken or powdered form being placed in a mould which is of great strength and adapted to the shape of the diaphragm and being converted into the solid form by the use of a very high pressure.

Several constructional examples of the new diaphragm are illustrated in the accompanying drawings, in which Figs. 1 to 13 are sectional views, and Fig. 14 is a top plan.

1 is the wall of the conical diaphragm 2, the vertex of which has a reinforcement 3. This reinforcement has, for example, surfaces, 4, 5 which run parallel to the surfaces 6, 7 lying inside the conical diaphragm so that diaphragms placed one upon another are supported on the surfaces and the danger of breakage is considerably reduced. The reinforcement may have a boring 8 which may receive the armature pieces and may also be employed for centering diaphragms which are placed one above another for storage or dispatch. 9 is a disc which may serve for guiding the diaphragm. It is, however, also possible to provide guiding means outside, as shown at 10 and 11, or inside as at 12 and 13. 14 is a conical ring of a different material from that of the diaphragm. This ring can be fastened, pressed, glued or otherwise secured to the diaphragm. The ribs 100 are reinforcing ribs here shown as helical. In Figs. 2 and 3, diaphragms 1′ and 1″, respectively stepped and corrugated, are shown.

As illustrated, the reinforcement can, if desired, be made substantially thinner than 1 mm.

Such diaphragms, in addition to being extremely thin, have properties which are favorable from the economic viewpoint and also mechanical and acoustic properties which conform to the most stringent requirements. These properties can be influenced in a given direction by adding to the material of the diaphragm chippings of material, sawdust, fabric insertions 101, Fig. 4, or other filling agents which have a damping effect.

Fig. 2 shows a diaphragm cast as a series of integral, successively larger, truncated cones 1′;

Fig. 3 shows a diaphragm having spaced annular protuberances 1″.

The diaphragm surface can be of any desired shape, for example, it may be corrugated or may have bulges 102, Fig. 5. It may also be made more or less step-like 103, Fig. 6, so that relatively small discs or cylindrical or conical surfaces are formed, the natural frequencies of which lie so high as to be practically negligible.

Securing means 200, Fig. 7, (holders, pins, screws, eyes, channels, projections or the like) stiffening means 100, Fig. 1, (reinforced cone tip ribs in radial, circular, spiral or other form bent over edges of any desired shape) holding and guiding means 300, Fig. 8, also means for transmitting oscillations such as iron pieces, coil carriers, more particularly in diaphragms for electro-dynamic loud speakers may be combined with the diaphragm during its manufacture or during a subsequent condensation process so as to be integral with it.

The wire of the coil can, as in Fig. 11, be pressed with the material of the diaphragm in such a manner that the diaphragm body acts at the same time as the coil carrier.

It is also possible, as shown in the lower part of Fig. 1, to press a relatively small rigid conical diaphragm out of the material according to the invention and at its edge to secure a ring, a cylinder, a conical frustrum or the like of other material in a suitable manner.

The thickness of the diaphragm may be diminished towards the edge in order to simplify manufacture or to obtain special acoustic effects

and the diminution in thickness may occur in steps.

The diaphragm may also have reinforcing ribs 106 which taper towards the edge and run in straight lines, circles or spirals. These stiffening ribs, which may be replaced or assisted by a stiffening edge on the diaphragm, give the effect that in spite of its thin wall, which is, for example 0.1 mm. thick, the diaphragm suffers no deformation or practically none in operation and acts as a rigid piston.

Since a diaphragm made of the condensation product according to the invention is relatively stiff and has a brittle glass-like skin, when it is deformed at right angles to the axis of the cone it has the tendency with reference to its bell-like shape to act acoustically like a bell, that is, to oscillate in a fundamental tone and several overtones. This property is almost eliminated by suitable stiffenings, for example by a suitably bent over edge 105, Fig. 10.

In diaphragms which are made from condensation products according to the invention, by a pressing process perforations can be provided which may have any form which is suitable for constructional, mechanical and acoustic reasons.

If specially thin diaphragms are required, for example membranes having such thin walls as cannot be obtained in the present process, a sandblast may be employed in order to break off the finest particles of material.

Of course a membrane which is pressed in a thickness of 1 mm. can also be subjected to the action of a sandblast and thereby made thinner.

A particularly favourable acoustic effect is obtained if the electro-dynamic or electro-magnetic system of a loud speaker is surrounded by a covering of it, 105 in Fig. 12, or is provided with a supporting construction 104, Fig. 13, consisting of the same condensation product as that from which the diaphragm is made.

Since the modern pressing processes allow of the manufacture of pressed articles with an accuracy of 0.01 mm. and the interchangeability of the pressed articles is ensured and also since, especially in electro-dynamic loud speakers, the guiding of the diaphragm must be very exact and constant, the proposal to make the diaphragm and the covering of the unit to which the diaphragm is secured or in which it is guided from the same material gives advantages from a technical and economic standpoint in addition to the acoustic effect.

What we claim is:

1. A large area diaphragm for loudspeakers having a sheath formed in an optional manner whose thickness is less than 1 mm. and the basic material of which consists of a solid artificial rosin.

2. A large area diaphragm for loudspeakers having a sheath formed in an optional manner the thickness of which is less than 1 mm., and the basic material of which comprises a condensation product of formaldehyde and phenol.

3. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm., and the basic material of which is made of a substance of the carbide series.

4. A large area diaphragm having a sheath formed in an optional manner, the thickness of which is less than 1 mm., and the basic material of which is made of an artificial rosin which is permeated with filling material that has an attenuating effect.

5. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm., and the basic substance of which is made of an artificial rosin and is connected unitarily by binding means.

6. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm., and the basic substance of which is made of artificial rosin and is integrally provided with means of transmitting oscillations.

7. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm., and the basic substance of which is made of an artificial rosin and is provided with stiffening means.

8. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm., and which tapers toward the ends and the basic substance of which is made of artificial rosin.

9. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm., which tapers in steps toward the ends and the basic material of which is made of artificial rosin.

10. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm. that is provided with stiffening ribs and the basic material of which is made of artificial rosin.

11. A large area diaphragm for loudspeakers having a sheath formed in an optional manner, the thickness of which is less than 1 mm., that is provided with transverse section bulges and the basic material of which is made of artificial rosin.

12. A large area diaphragm for loudspeakers which is provided with a conically formed sheath, the tip of which receives a reinforcement, which is thinner than 1 mm., and the basic substance of which is made of artificial rosin.

13. A large area diaphragm for loudspeakers which is provided with a conically formed sheath, the tip of which is reinforced and which shows reinforcement areas one of which at least is parallel to an area which is inside the conical diaphragm.

14. A large area diaphragm for loudspeakers which is provided with a conically shaped sheath, the tip of which shows a reinforcement and has a bore in the direction of the axis of the cone, and the basic material of which is artificial resin.

15. A large area diaphragm for loudspeakers having a sheath formed in an optional way, to which a coil is integrally connected and the thickness of which is less than 1 mm. and the basic material of which is made of artificial rosin.

16. A large area diaphragm for loudspeakers having a sheath of optional form, the rim of which is provided with indifferently shaped extensions of other material and the basic substance of which is made of an artificial rosin.

17. A large area diaphragm for loudspeakers having a sheath of optional form, the thickness of which is less than 1 mm., and the basic material of which is made of an artificial rosin, and which is provided with a cover made of the same basic material which envelops the diaphragm on one side.

18. The process of producing a large area diaphragm for loudspeakers having an optional form

of sheath the thickness of which is less than 1 mm., comprising introducing an artificial rosin, formaldehyde and phenol in powder form into a pressing mold of high strength and corresponding to the shape of the diaphragm, and converting same therein by an excessively high pressure and heat into a liquid, and subsequently allowing same to solidify.

19. The process of producing a large area diaphragm for loudspeakers having a sheath of an optional form the thickness of which is less than 1 mm., comprising introducing an artificial rosin, formaldehyde and phenol in powder form into a particularly resistant pressing mold corresponding to the shape of the diaphragm, converting same therein by applying unusually high pressure and by heat into a liquid, subsequently allowing same to solidify, and connecting, securing, stiffening, holding and guiding devices and means of transmitting oscillation energy therewith by a condensation process.

20. The process of producing a large area diaphragm for loudspeakers having a sheath of optional shape the thickness of which is less than 1 mm. comprising introducing an artificial rosin, formaldehyde and phenol in powder form into a pressing mold corresponding to the shape of the diaphragm and of particularly great resistance, converting same therein, by employing unusually high pressure and application of heat, into a fluid, subsequently allowing same to solidify, and subjecting the diaphragm to the action of a sand blast.

21. The process of producing a large area diaphragm for loudspeakers having a sheath of optional shape the thickness of which is less than 1 mm., comprising introducing an artificial rosin, formaldehyde and phenol in powder form into a pressing mold which is highly resistant, converting same by the use of extremely high pressure and application of heat into a fluid, and subsequently allowing same to solidify, and connecting, securing, stiffening, holding and guiding means for the transmission of the oscillation energy thereto during the production of the diaphragm, inserting the means of transmitting the oscillation energy into the pressing mold and washing same by the condensation product during the production of the diaphragm so that the wire windings are solidly embedded into the diaphragm after conversion of the condensation product from the fluid into the solid form.

22. The process of producing a loudspeaker diaphragm, comprising introducing an artificial resin, formaldehyde and carbide in lump form into a pressing-mold of great resistance, converting same into a fluid, and allowing same to solidify therein.

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