Dec. 28, 1948. J. J. SNOKE 2,457,504

METHOD AND APPARATUS FOR FORMING WOOD VENEER PLYWOOD TUBES

Filed March 9, 1944 4 Sheets-Sheet 1

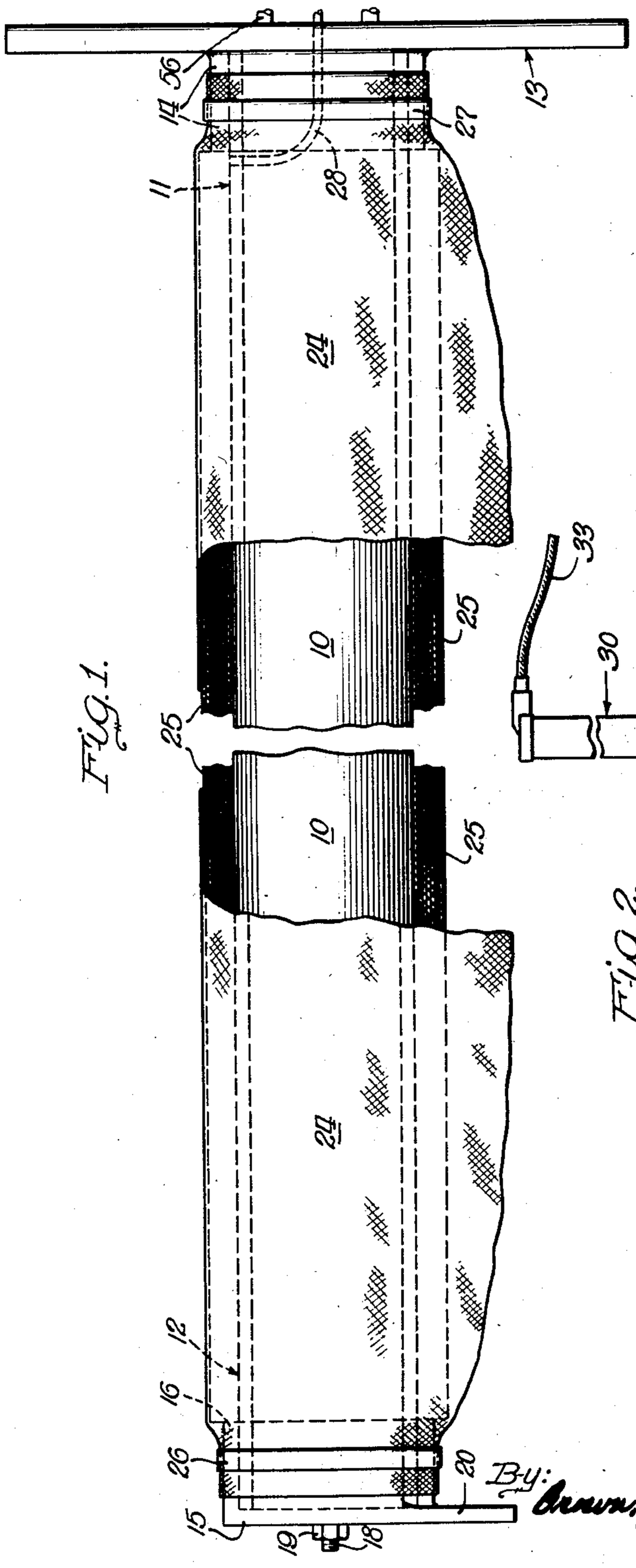


Fig. 1.

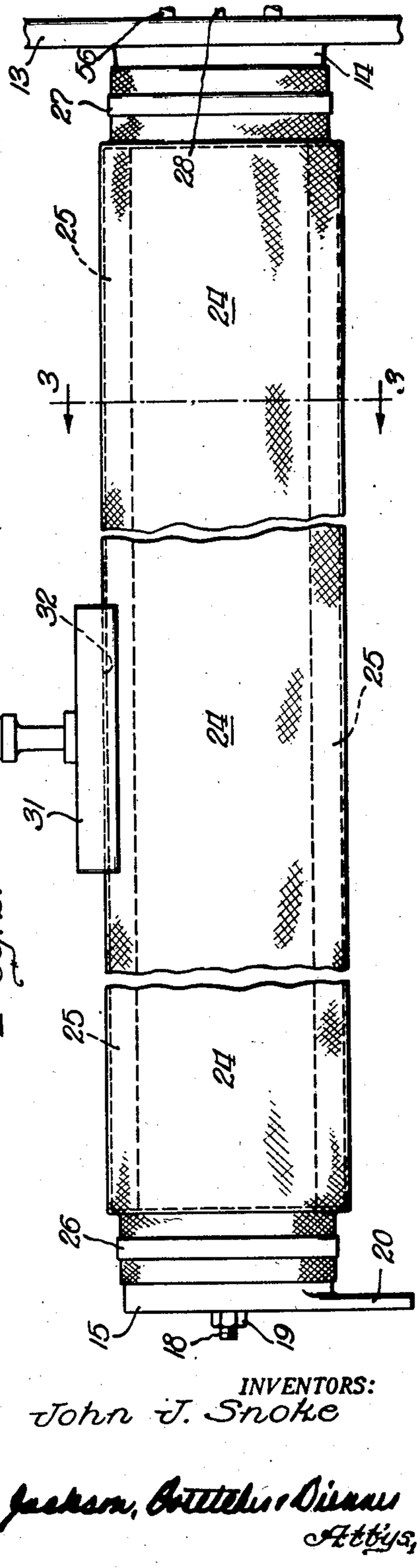


Fig. 2.

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Filed March 9, 1944 4 Sheets-Sheet 2

Fig. 3.

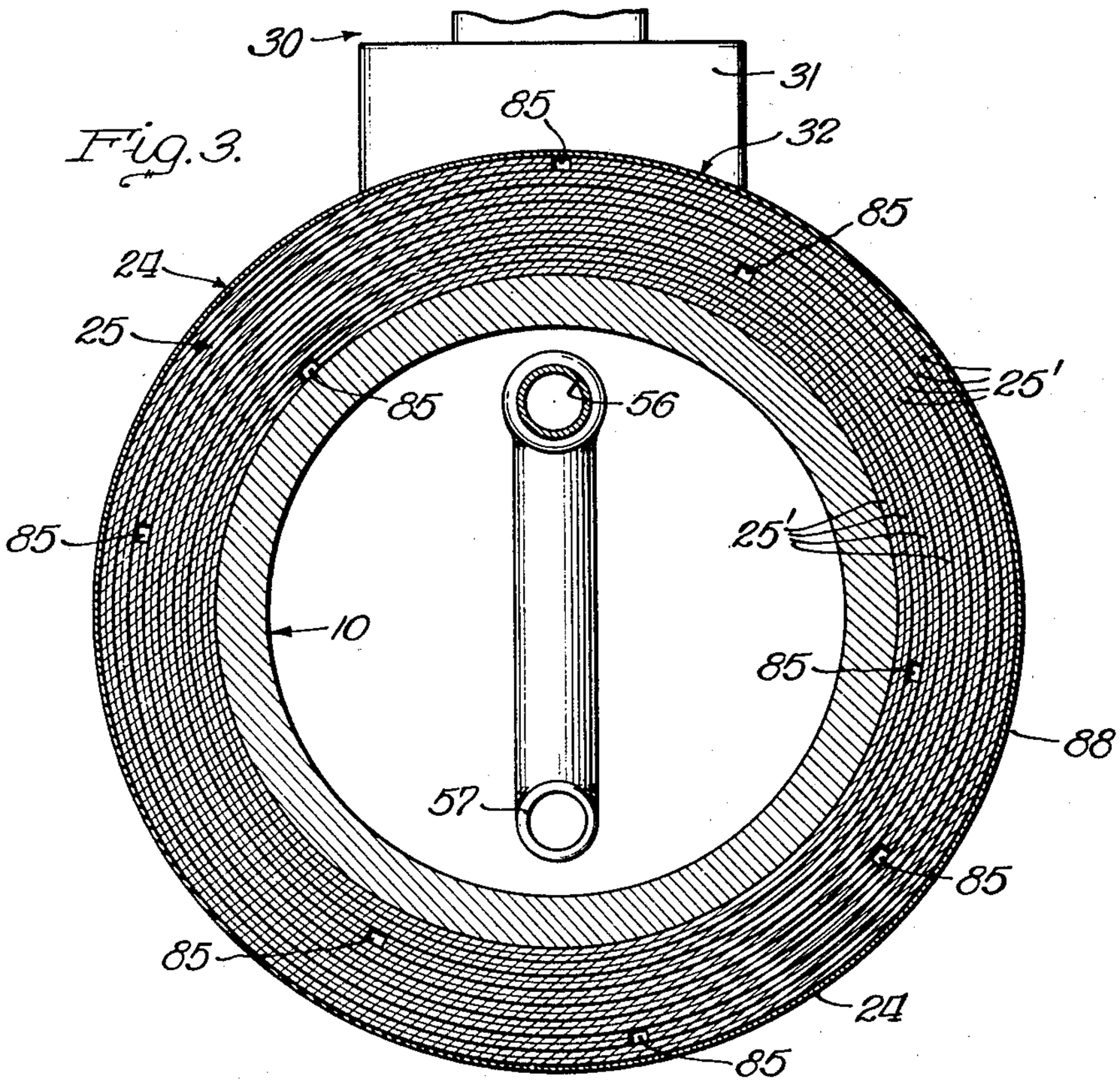
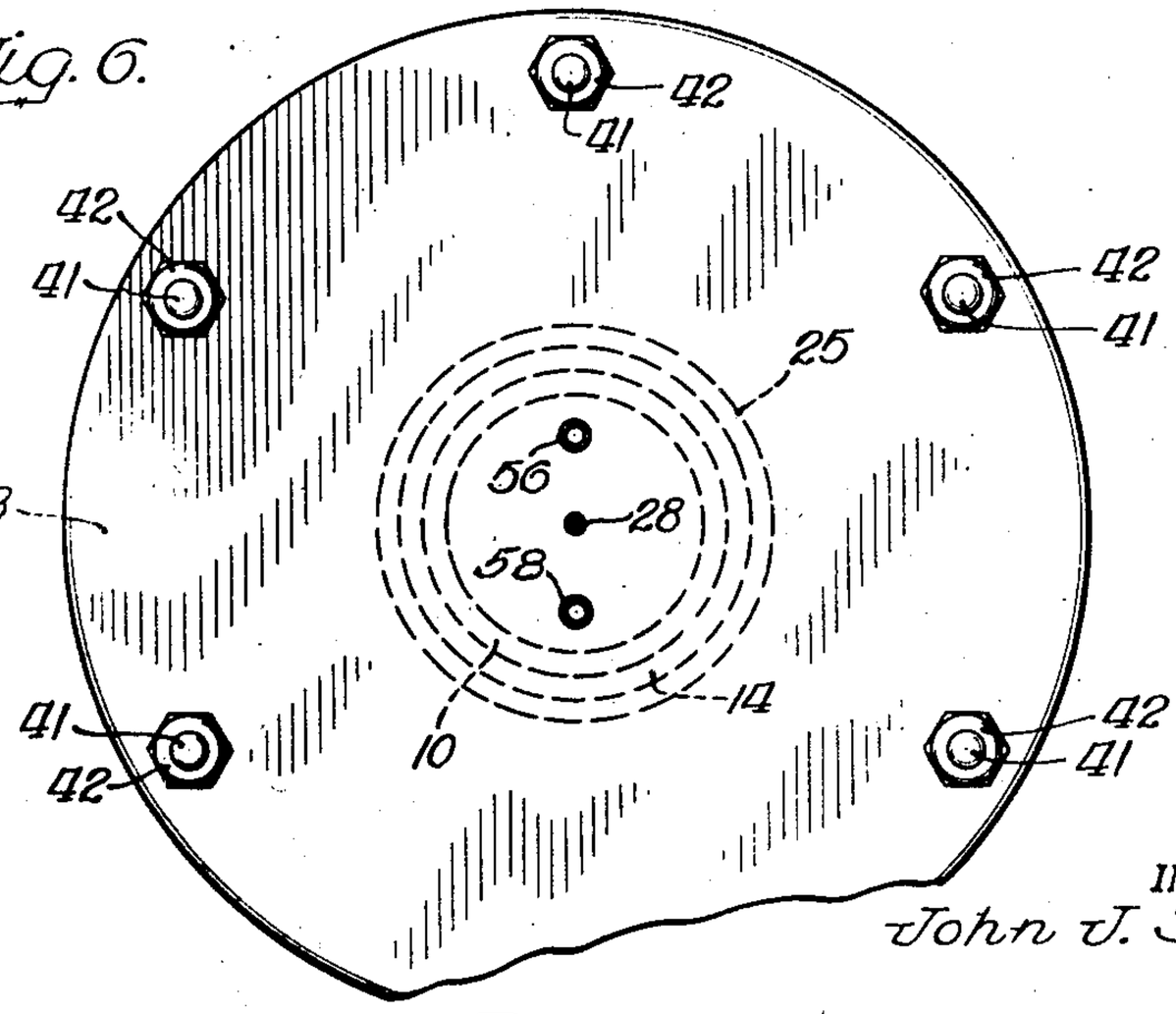


Fig. 6.



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Filed March 9, 1944 4 Sheets-Sheet 3

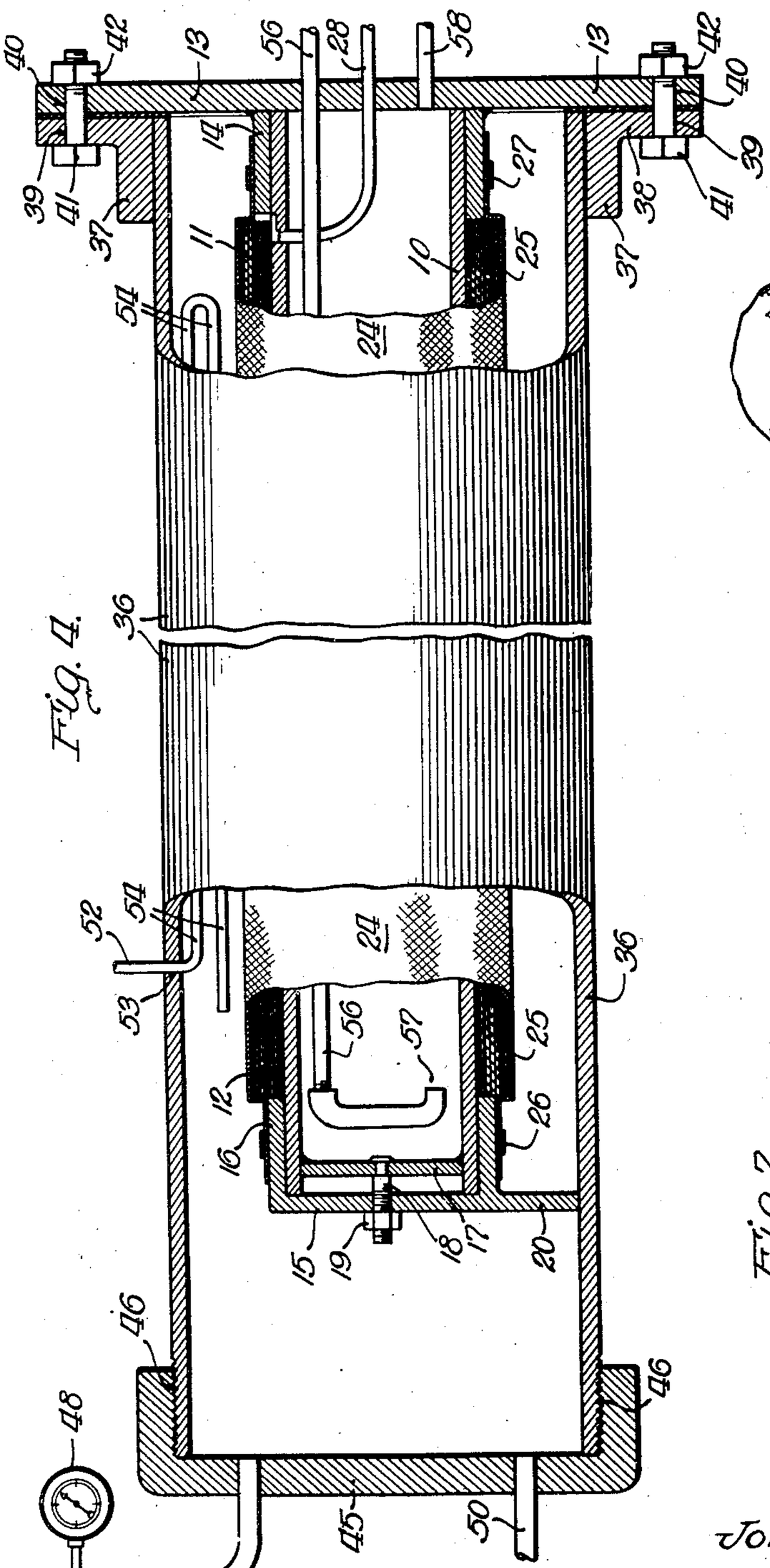


Fig. 4.

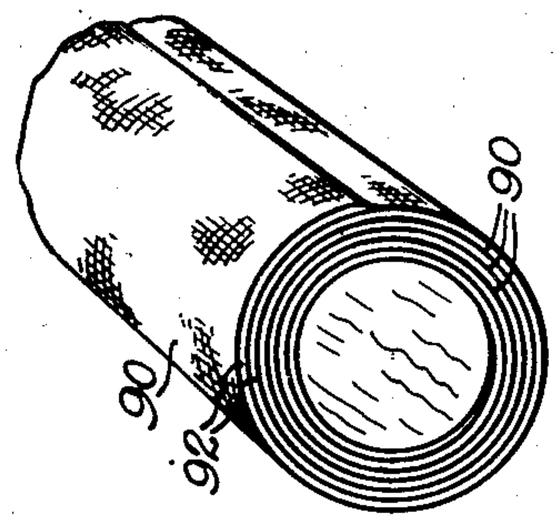


Fig. 8.

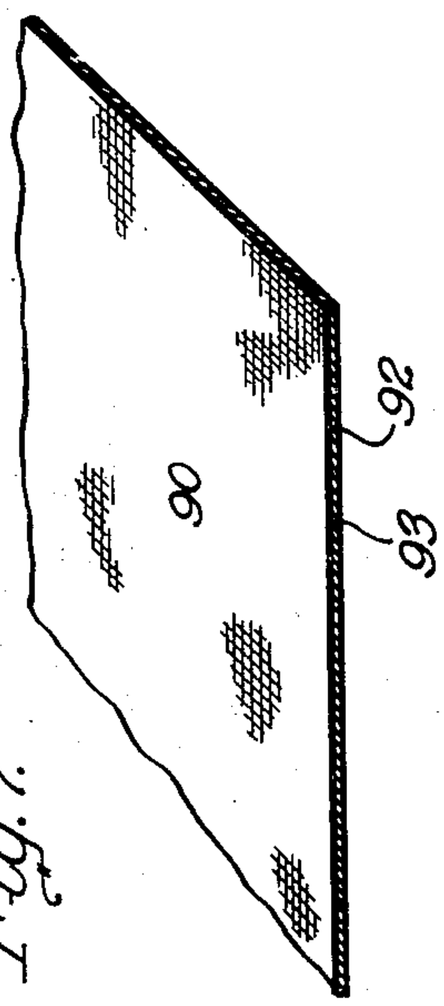


Fig. 7.

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Dec. 28, 1948. J. J. SNOKE 2,457,504

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Filed March 9, 1944 4 Sheets-Sheet 4

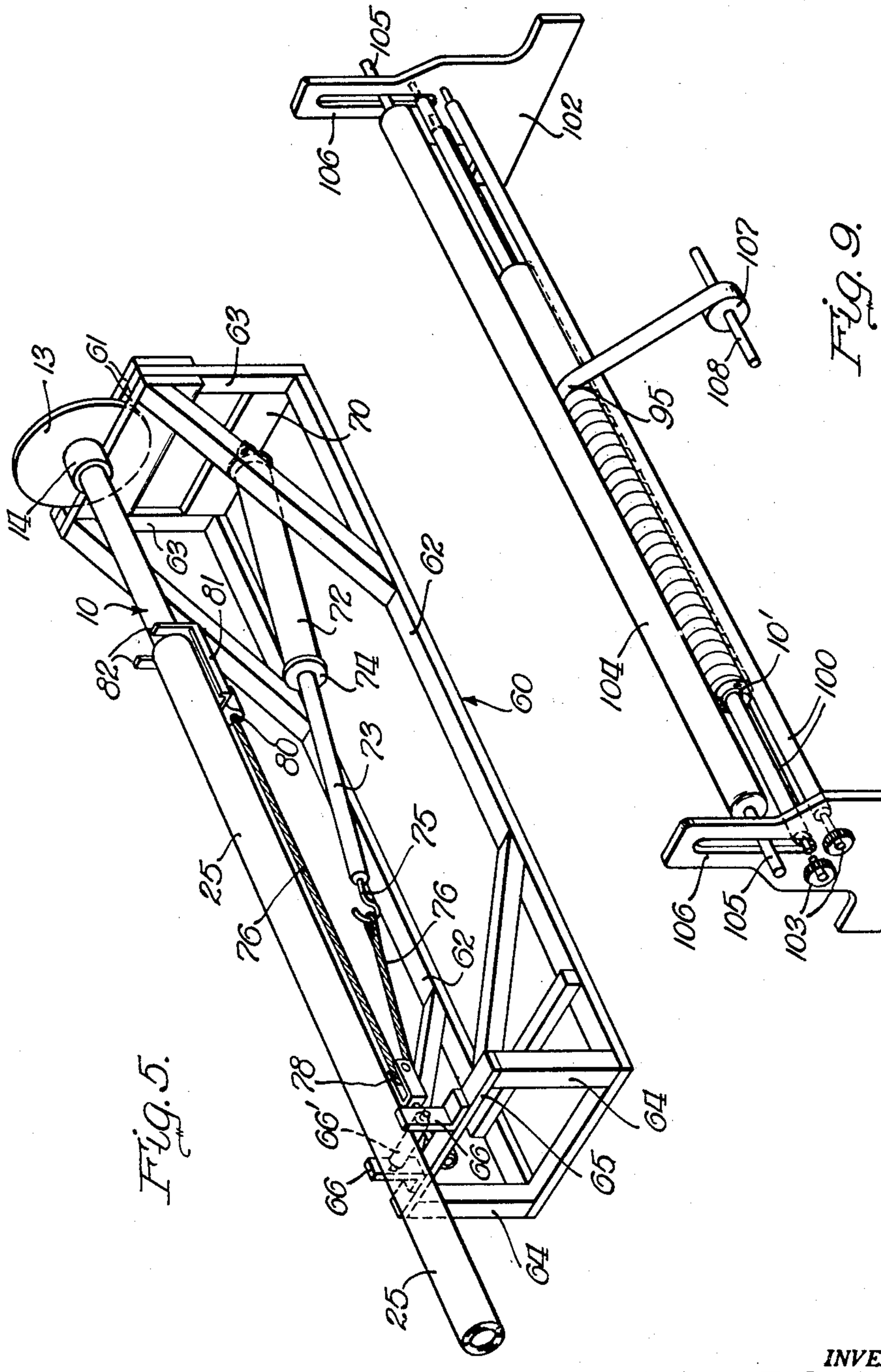


Fig. 5.

Fig. 9.

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Patented Dec. 28, 1948

2,457,504

UNITED STATES PATENT OFFICE

2,457,504

METHOD AND APPARATUS FOR FORMING WOOD VENEER PLYWOOD TUBES

John J. Snoke, Goshen, Ind.

Application March 9, 1944, Serial No. 525,672

3 Claims. (Cl. 154—117)

1

This invention relates to wood veneer and/or plywood tubes, and method of and means for forming same.

These tubes are adapted for use as radio signal masts, fuel pipes, oil pipes, telephone and telegraph posts; also as tubular spars or other tubular structural parts for aircraft, ships and buildings, and for numerous other purposes as suitable or desired.

Tubes of the character set forth have many advantages over cylindrical metal tubes. They have long durability without expensive maintenance. Metals are heavier and more costly, and they must be frequently sprayed, painted, greased or otherwise maintained. By the use of a thermosetting adhesive the tubes of the present invention become proof against fungi, mold, termites, salt water, boiling water, and have other advantages.

The invention comprises, in general, applying the wood veneers and/or plywood around and against a mandrel with a thermosetting resin or other suitable adhesive between the plies or layers of veneer or plywood. In one embodiment of the invention this assembly is then placed inside a fluid-tight collapsible or flexible bag or container which may be evacuated to press the plies of veneer or plywood tightly and uniformly together and into tight and uniform conformity with the contour of the mandrel. The layers of wood veneer or plywood may be pounded through the enclosing bag by means of an air hammer, hand hammer or other suitable tool further to press the plies of veneer or plywood tightly and uniformly together and into tight and uniform conformity with the surface of the mandrel. The entire assembly is then placed in a sealed vessel or autoclave, and heat and pressure are applied to press the plies of veneer, plywood or other material firmly together and into conformity with the mandrel, and to set, harden, or cure the thermosetting adhesive to bind the plies securely and uniformly together. The assembly is then removed from the vessel, whereupon the flexible bag is removed and means, which forms a part of the present invention, is applied and the finished tube removed endwise from the mandrel.

Where the tube is formed to a small radius the wood veneers will tend to crack and break if too thin, and if the wood veneers are too thick it is impossible to wind the same spirally and continuously around the mandrel to form a tube wall of the desired thickness.

I contemplate therefore, according to another embodiment of my present invention, the use of

2

a composite sheet comprising a thin sheet of wood veneer and a sheet of fabric, such as muslin, or even a sheet of suitable paper or the like, having relatively great flexibility and the other characteristics desired, laid and secured together by a thermosetting adhesive. The thin wood veneer and the fabric or paper are of a character to conform readily to small radii, thus permitting winding the sheet spirally and/or continuously about the mandrel, and the fabric or paper sheet has the ability to hold the thin wood veneer together in spite of cracking or breaking thereof. This enables the use of thinner wood sheets, although it is to be understood that thicker wood sheets may be used and that the layers of fabric, paper or the like may be omitted within the scope of my present invention.

Where a composite piece of wood veneer and fabric or paper is employed, I preferably wind the same spirally and/or continuously about the mandrel to provide a tube wall of the desired thickness, applying a suitable thermosetting adhesive between the composite windings to bind the same securely together. In this case, instead of using the collapsible or flexible bag, a fabric wrapping, such as canvas or other suitable material, is wrapped, preferably under tension, about the wrapped composite tube forming windings to press the same firmly and uniformly together and into firm and uniform conformity with the surface of the mandrel. This assembly is then placed in the sealed vessel or autoclave and treated as herein described.

In order to acquant those skilled in the art with the manner of forming wood veneer and/or plywood tubes in accordance with my invention and with the resulting tubes, I shall now describe, in connection with the accompanying drawings, certain preferred embodiments of the invention.

In the drawings:

Figure 1 is an elevational view partially broken away and partially in section to show the tube forming layers of plywood on the mandrel and the fluid-tight bag or collapsible container enclosing the same and in loose or expanded condition before deflation of the bag;

Figure 2 is an elevational view similar to Figure 1, showing the bag or collapsible container in deflated condition, and suitable hammer means for pounding the layers of veneer or plywood through the wall of the enclosing bag to conform the veneer or plywood to the mandrel;

Figure 3 is a transverse sectional view taken on the line 3—3 of Figure 2;

Figure 4 is a longitudinal sectional view showing

the mandrel with the plywood or veneer applied thereto and the enclosing bag in the sealed vessel or autoclave wherein heat and pressure are applied to press the layers of veneer or plywood firmly together and into conformity with the mandrel, and to cause the thermosetting adhesive to be set, hardened or cured to bind the plies securely and uniformly together;

Figure 5 is a perspective view showing the fixture for removing the laminated, veneer or plywood tube from the mandrel, the fixture being shown as applied to the mandrel and in the process of removing a tube therefrom;

Figure 6 is an end view looking toward the right hand end of Figure 4;

Figure 7 is a fragmentary perspective view showing a composite sheet of thin wood veneer and fabric, such as muslin or paper or the like, for making a cylindrical tube of alternate layers of wood veneer and fabric or paper;

Figure 8 is a fragmentary perspective view of a tube formed of the composite sheet shown in Figure 7 and in accordance with my present invention; and

Figure 9 is a fragmentary perspective view of one suitable form of tube rolling machine for applying an outer pressure applying wrapping about the spirally and/or continuously wound wrappings shown in Figure 8.

Referring to the drawings, the reference character 10 designates the mandrel which is of generally cylindrical tubular form. This mandrel 10 is preferably formed of steel and has a polished external surface which tapers from its larger diameter end 11 to its smaller diameter end 12. I find that in a mandrel for forming wood veneer or plywood tubes approximately 11 feet in length and having an external diameter of approximately 4 inches, or for a tube of similar length with an external diameter of 5¼ inches, a taper of approximately $\frac{1}{32}$ of an inch from one end of the mandrel to the other end is suitable. These dimensions are merely illustrative, and I do not intend to limit the wood veneer or plywood tube formed according to the present invention to any particular length, diameter, or wall thickness, nor do I intend to limit the taper of the external surface of the mandrel 10 to the amount set forth. The particular amount of taper and the particular material forming the mandrel may vary.

The right hand or larger diameter end of the tubular mandrel 10 is closed by circular plate or disc 13 integrally or rigidly fixed to the mandrel, for example, by a short collar or sleeve 14 integrally or rigidly fixed to the plate or disc 13 and telescoping over and integrally or rigidly secured to the adjacent end of the mandrel, for example, by welding, brazing or otherwise as desired. The opposite end of the mandrel 10 is closed by an end cap 15 having an annular flange 16 telescoping over the adjacent end of the mandrel 10.

The closure cap 15 may be removably secured to the end of mandrel 10 in any suitable or preferred manner. In the illustrated embodiment of the invention, a disc 17 fits internally within the mandrel, and is integrally or fixedly secured therein as, for example, by welding, brazing, or otherwise securing its outer periphery to the interior of the mandrel. The disc 17 has a central stud 18 extending out through an opening in the closed end of the cap 15 and screwed through a nut 19 which clamps the cap 15 in place on the end of the mandrel. The closure cap 15 has a depending flange 20 for supporting the adjacent

end of the mandrel in proper position within the housing of the autoclave or other vessel for applying heat and pressure, as will hereinafter appear. The attachment of the closure cap 15 to the smaller diameter end of the mandrel 10, as shown and described, provides for ready detachment or removal of the closure cap 15 from the mandrel to permit removal of the finished wood veneer or plywood tube endwise from the mandrel in the manner to be hereinafter described.

The fluid tight collapsible sleeve or container 24 is adapted to receive and cover the mandrel with the layers or plies of wood veneer and/or plywood 25 wrapped or applied to the mandrel. The sleeve 24 is formed of suitable flexible material, such as rubber, rubberized cloth, or other freely flexible material impervious to the passage of air so that it can be deflated tightly about the wood veneer and/or plywood tube by exhausing the air from the interior of the bag. The end of the sleeve 24 at the smaller diameter end of the mandrel 10 is clamped air-tight about the flange 16 of the closure cap 15 by clamp means 26. The opposite end of the sleeve 24 is clamped air-tight about the sleeve or collar 14 fittting over the larger diameter end of the mandrel 10 by clamp means 27.

For the purpose of pounding or hammering the plies or layers of wood veneer and/or plywood through the wall of the sleeve 24 to conform the wood veneer and/or plywood to the mandrel 10, I have shown an air hammer 30 the head or pounding member 31 of which is shown as having a concave surface 32 conforming to the contour of the tube. It is to be understood that instead of using an air hammer, a hand hammer or other suitable tool may be employed for this purpose. The air hammer 30 selected for illustration is shown as having an air duct or tube 33, as well understood in the art.

The sealed vessel or autoclave for receiving the mandrel 10 with the layers or plies of wood veneer or plywood wrapped thereon or applied thereto and for applying heat and pressure to press the plies of wood veneer and/or plywood firmly together and into conformity with the polished outer surface of the mandrel and to cause the thermosetting adhesive to be set, hardened or cured to bind the plies securely and uniformly together, comprises a tubular housing 36. The right hand end of the housing 36, as viewed in Figure 4, has a collar 37 integrally or fixedly secured thereto by welding, brazing or otherwise. The annular radial flange 38 of the collar 37 has circumferentially spaced apertures 39 which are adapted to register with corresponding circumferentially spaced apertures 40 in the plate or disc 13 when the mandrel with the wood veneer or plywood tube thereon is placed in the autoclave. Bolts 41 are adapted to have their shanks inserted through the registering apertures 39 and 40, and nuts 42 screwed upon the shanks of the bolts clamp the plate 13 tightly against the collar 37 to close the adjacent end of the autoclave housing 36, with the adjacent end of the mandrel supported in proper position within the housing of the autoclave.

The opposite end of the housing 36 is closed by an end member 45 which may, for example, be screwed at 46 upon the end of the housing 36, or otherwise applied thereto. An inlet pipe or tube 47 opens into the interior of the autoclave housing 36 through the end member 45 for supplying, for example, air under pressure into the interior of the housing 36. The inlet tube or

pipe 47 is shown as provided with a pressure gauge 48 and a safety valve 49. An outlet tube or pipe 50 opens outwardly from the interior of the housing 36 through the end member 45 for discharging or venting the air from the interior of the housing 36. The outlet pipe or tube 50 may be provided with a suitable outlet control valve (not shown).

A pipe 52 is shown entering the housing 36, at 53, and coiled within the housing at 54 for supplying steam for auxiliary heat. A further pipe 56 is shown extending into the interior of the hollow mandrel 10 through the end plate 13 and having an outlet at 57 for supplying steam into the interior of the mandrel 10. An outlet tube or pipe 58 opens outwardly through the plate 13 from the interior of the mandrel 10 for discharging the steam therefrom.

While I have referred to the use of steam for applying heat simultaneously with the application of pressure within the autoclave or housing 36, it is to be understood that this may be varied. I contemplate, for example, the use of radio frequency or any other suitable or preferred means for applying heat inside the housing 36.

The fixture for removing the finished wood veneer and/or plywood tube 25 from the mandrel 10 comprises a frame 60 having at one end a pair of spaced boards or plates 61 for receiving between them the radially extending flange provided by the plate 13. In this way the mandrel 10, with the wood veneer and/or plywood tube thereon, is fixed to the frame 60 against longitudinal displacement thereon. The boards or plates 61 are supported above the base 62 of the frame 60 by uprights 63. At its opposite end the frame 60 has uprights 64 carrying a cross piece 65 for supporting the mandrel with the wood veneer and/or plywood tube thereon at opposite end of the frame. Spaced brackets 66, secured to the cross piece 65, have upstanding flanges which form stops for preventing lateral displacement of the mandrel and tube from the cross piece 65.

At their lower ends the uprights 63 have a board or plate 70 to which one end of an air cylinder 72 is secured. The cylinder 72 extends obliquely upwardly toward the opposite end of the frame 60, and has internally thereof a piston or plunger (not shown). The piston or plunger has a rod 73 which extends for reciprocation through the end closure 74 of the cylinder 72, and the outer end of the rod 73 has a hook 75 or other means for connecting one end of a flexible cable 76 or other suitable flexible element, such as a chain or tightly coiled spring or the like, thereto.

The flexible element 76 is trained about and its direction reversed by a sheave or other suitable means 78 carried, for example, by the cross piece 65. The opposite end of the element 76 is connected at 80 to a tube ejector 81 having a forked upright flange 82 which is adapted to straddle the mandrel 10 and engage the adjacent end of the wood veneer and/or plywood tube 25. When the tube ejector 81 is engaged with the end of the tube 25, as shown in Figure 5, and the cylinder 72 is exhausted, or vacuum applied to one end thereof, or pressure applied to its opposite end, the piston rod 73 is moved inwardly into the cylinder, pulling the ejector 81 to the left, as shown in Figure 5, to force the tube 25 longitudinally from the tapered mandrel in a direction toward the smaller diameter end thereof.

In carrying out my invention as thus far described, the wood veneer and/or plywood is formed in flat sheets and may be of any desired

wood. I further contemplate the use of wood veneer and/or plywood alone, paper alone, or a combination of paper and wood, fabric and wood, paper, wood, or fabric, and metal, or any other desired materials or combinations thereof.

For purposes of illustration I have shown in Figure 3 layers or plies of wood veneer 25' applied circumferentially about the tapered and polished surface of the mandrel 10, preferably with the joints 85 between the ends of each layer or ply overlapped by the succeeding layer or ply. The layers or plies may be of any desired thickness suitable to be wrapped or applied about the mandrel. Where wood veneer or plywood is employed the grain of the wood of succeeding plies or layers may be disposed circumferentially or longitudinally of the tube, or the grain of the wood of succeeding layers or plies may be disposed crosswise of each other according to the characteristics desired in the finished tube.

In winding or applying the layers or plies of wood veneer and/or plywood about the mandrel 10 to build up the desired wall thickness of the tube, an adhesive, resin, or plastic, preferably of thermosetting character, is applied between the plies or layers. The Resinous Products and Chemical Co. of Philadelphia, Pa., supplies a thermosetting resin or plastic suitable for this purpose. This is referred to merely for purposes of illustration, it being understood that any other suitable or preferred thermosetting adhesive, resin, or plastic may be employed within the scope of the present invention. Further to illustrate the invention without limiting the same thereto, it is to be understood that tubes according to the invention may be made up in sections and joined endwise and processed to form tubes of any desired length. As one illustrative example of this, I form tubes approximately 6 feet in length and, scarving the adjacent ends thereof, join these tubes together and process the same to form a unitary tube.

Upon completing the wrapping or application of the plies or layers 25 to form a tube of the desired wall thickness, this assembly, comprising the mandrel 10 with the plies or layers 25' thereon and the thermosetting adhesive, resin or plastic between the plies or layers, is placed inside the fluid-light collapsible or flexible bag 24 which is clamped air-tight at one end about the flange 16 by clamp means 26, and the opposite end is clamped air-tight about the sleeve or collar 14 by the clamp means 27. The bag 24 is then deflated tightly about the wood veneer and/or plywood tube 25 by applying suction, for example, to the interior of the bag 24 through the duct or tube 28. This deflation of the bag 24 presses the plies of veneer or plywood, with the adhesive therebetween, tightly and uniformly together and into tight and uniform conformity with the contour of the mandrel.

With the tube formed about the mandrel and enclosed within the bag 24, the layers of veneer and/or plywood may be pounded through the wall of the bag 24—as, for example, by means of the air hammer 30. The air hammer shown more or less diagrammatically in the drawings is illustrative of one suitable pounding or conforming means. As already pointed out, a hand hammer or other suitable tool may be used. The hammering of the layers of veneer or plywood through the wall of the bag 24 in this manner further presses the plies of veneer or plywood, with the adhesive therebetween, tightly and uniformly together and into tight and uni-

form conformity with the surface of the mandrel.

The entire assembly is then placed in the sealed vessel or autoclave 36, with the plate 13 carried by the larger diameter end of the mandrel clamped to the collar 38 and closing the adjacent end of the housing 36 and the opposite end of the mandrel supported approximately centrally within the opposite end of the housing 36 by the flange 20.

In the illustrated embodiment of the invention, steam is introduced through the pipe 52 and air under pressure is introduced through the pipe 47 simultaneously to apply heat and pressure to the outside of the tube 25. Steam is also introduced into the interior of the mandrel 10 through the pipe 56 to heat the inside of the mandrel. The application of heat and pressure presses the plies or layers 25' of the tube 25 tightly together and in tight conformity with the outer surface of the mandrel 10 and, at the same time, sets, hardens, or cures the thermosetting adhesive to bind the plies or layers of the tube securely and uniformly together. As already pointed out, instead of using steam, radio frequency heat or any other suitable or desired heating means may be employed.

When the plies or layers 25' of the tube are thus pressed tightly together and into tight conformity with the outer surface of the mandrel 10 and the thermosetting adhesive is set, hardened, or cured to bind the plies securely and uniformly together, the assembly is removed from the vessel or autoclave 36. The bag 24 and end cap 15 are then removed, and the mandrel, with the completed tube 25 thereon, is placed on the tube removing fixture shown in Figure 5, with the flange or plate 13 placed between the boards or plate 61. Then, by applying air or suction to the cylinder 72, the piston is moved inwardly into the cylinder and with the tube ejector 81 engaged with the end of the tube 25 the ejector is moved outwardly or to the left, as viewed in Figure 5, and forces the finished tube endwise from the tapered and polished surface of the mandrel 10. The tube is then ready for use for the purposes already set forth or for any other purpose as suitable or desired. The polished and tapered outer surface of the mandrel 10 permits the tube to be removed from the mandrel in the manner described, and the tube removing apparatus shown and described provides means which is highly suitable for this purpose.

The composite sheet for making a tube in accordance with the present invention, as shown in Figure 7, comprises a sheet 90 of thin wood veneer and a sheet 92 of fabric, such as muslin, or a sheet of suitable paper or other material which is extremely flexible and has the ability to hold the wood sheet together in spite of cracking or breaking thereof. These sheets 90 and 92 are secured tightly and uniformly together by a thermosetting adhesive, resin or plastic 93. This enables the use of thinner wood veneer, thereby increasing the ability of such wood veneer to conform readily to mandrels of small radii. As an example, I find that the wood veneer in this case may be of a thickness of the order of approximately $\frac{1}{32}$, $\frac{1}{48}$, or $\frac{1}{60}$ of an inch. These thicknesses are given for purposes of illustration, and I do not intend to be limited thereto. This ability to use thinner wood is due to the fact that the fabric or paper sheet 92 secured to the wood veneer 90 will, as already

pointed out, hold the wood veneer together in spite of cracking or breaking thereof in applying the same to the mandrel 10.

As a result of the greater flexibility of the composite sheet 90, 92, I preferably wind this form of sheet spirally and/or continuously about the mandrel 10 to form a tube having a wall of the desired thickness, applying a suitable thermosetting adhesive between the composite windings as they are wound around the mandrel to bind the windings securely together. Then, as already pointed out, instead of using the collapsible or flexible bag 24 of the previous embodiment of the invention, a fabric wrapping, such as canvas or other material having the desired characteristics, is wrapped under tension about the wrapped composite winding 90, 92 with the tension sufficient to press the composite windings firmly and uniformly together and into firm and uniform conformity with the surface of the mandrel. This assembly is then placed in the sealed vessel or autoclave 36 and treated as before, and when the thermosetting adhesive is set, hardened, or cured to bind the plies securely together the assembly is removed from the autoclave and the mandrel may then be applied to the fixture shown in Figure 5 and the completed tube removed from the polished and tapered surface of the mandrel, as previously described.

One suitable form of machine for applying an outer pressure applying wrapping 95 of suitable material, such as canvas, about the composite tube forming wrappings 90, 92, is illustrated in Figure 9. It comprises a pair of drive rolls 100 journaled at opposite ends in upright supports 101, 102, each roll being provided at one end with means, such as a gear 103, for rotating or driving the mandrel 10' with the tube forming wrappings thereon from a suitable source of power or driving means (not shown). The mandrel 10', with the spirally continuous composite tube forming wrappings 90, 92 thereon, is supported on the driving rolls 100 to be rotated by frictional driving engagement of the rolls 100 with the outer surface of the windings on the mandrel. A free roll 104 rests, by gravity, on the wrappings on the mandrel 10' and acts as a weight for pressing the outer pressure applying wrapping 95 tightly about the tube-forming wrappings, as it is applied about the same, and the wrappings on the mandrel 10' firmly against the drive rolls 100.

The roll 104 has free up and down movement, and is guided in such movement by pins 105 extending from the opposite ends thereof through vertical slots 106 in the upright supports 101, 102. The outer pressure applying wrapping 95 is delivered from a roll 107 rotatable, for example, about the axis of a shaft 108. The web of material forming the pressure applying wrapping is preferably under suitable tension. In applying this material the web is supplied to the outer surface of the tube-forming wrappings 90, 92, and the rolls 100 are rotated in a direction to draw the web onto the wrappings 90, 92 and to wrap the pressure applying wrapping thus formed spirally and/or continuously about the wrappings 90, 92, the tightness or tension under which the outer wrapping is applied pressing the tube-forming wrappings 90, 92 tightly and uniformly together and into tight conformity with the mandrel 10'.

The tube may be formed of other combinations of the materials mentioned, and I contemplate wrapping the outside of the tube not only with

canvas or canvas-like material, but with other fabrics or paper, or an aluminum screen may be wrapped on the outside of the tube.

I do not intend to be limited to the precise details or to the precise modifications shown and described, as variations in the details and other modifications are contemplated within the scope of the appended claims.

I claim:

1. The method of forming a veneer plywood tube which comprises applying successive wrappings of veneer plywood around a mandrel with a thermosetting adhesive between the plies, applying a flexible air-tight sleeve over the mandrel and tube and exhausting said sleeve to press the plies tightly together and into close conformity with the mandrel, clamping the end of said flexible sleeve air-tight to the mandrel, placing the mandrel with the tube thereon in an autoclave and simultaneously applying heat and pressure to the interior of the autoclave and externally of the flexible sleeve, tube and mandrel to press the plies together and into close conformity with the tube and to set, cure, or harden the thermosetting adhesive.

2. The method of forming a veneer plywood tube which comprises applying successive wrappings of veneer plywood around a mandrel with a thermosetting adhesive between the plies, applying a flexible air-tight sleeve over the mandrel and tube and exhausting said sleeve to press the plies tightly together and into close conformity with the mandrel, placing the mandrel with the tube thereon in an autoclave, simultaneously applying heat and pressure to the interior of the autoclave and externally of the flexible sleeve, tube and mandrel to press the plies together and into close conformity with the tube and to set, cure or harden the thermosetting adhesive, and simultaneously with the application of heat and pressure to the interior of the autoclave applying heat to the interior of the mandrel.

3. In apparatus of the class described, in combination, a mandrel having a generally cylindrical outer surface adapted to have successive plies of tube forming material applied thereto to form a tube, the outer surface of said mandrel being polished and tapered for removal of the tube endwise from the mandrel, a flexible air-tight sleeve adapted to be placed about the mandrel and the tube-forming plies thereon, a plate secured to the larger diameter end of the mandrel beyond the end of said flexible sleeve and extending radially from the mandrel, an autoclave, said plate being adapted to support the larger diameter end of said mandrel in said autoclave also to close the adjacent end of the autoclave and to hold the mandrel against endwise movement on a tube removing fixture, a closure cap on the inner end of the mandrel having an integral part extending radially from the mandrel beyond the inner end of the flexible sleeve for supporting the inner end of the mandrel at the axis and spaced from the inner end of the autoclave, and means for clamping the outer end of said flexible sleeve to said mandrel adjacent said plate and the inner end of said flexible sleeve to said closure cap.

JOHN J. SNOKE.

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