Aug. 27, 1963 R. E. SMITH 3,101,519

DUCT FORMING CORE

Filed Nov. 29, 1961

Fig. 1

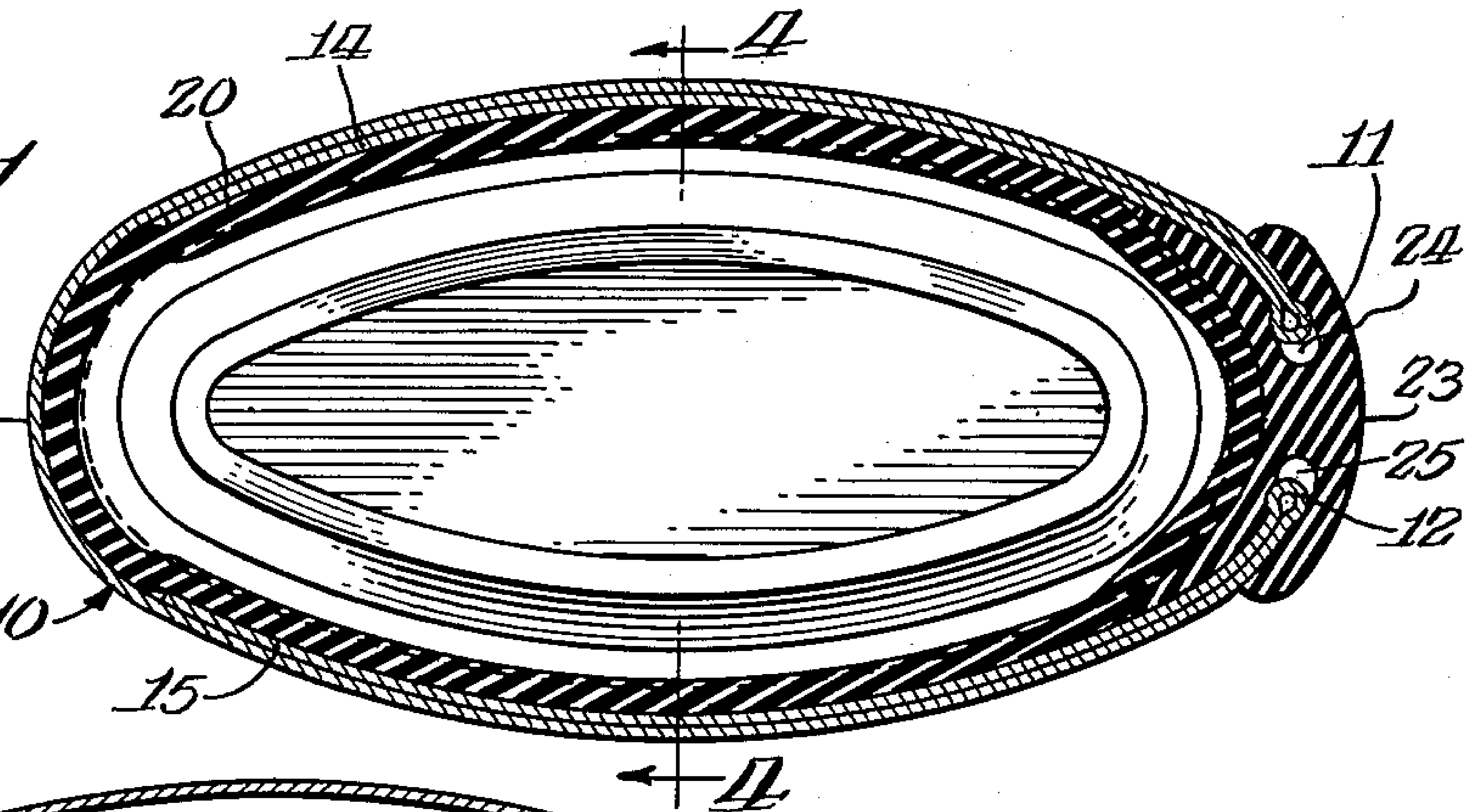


Fig. 2

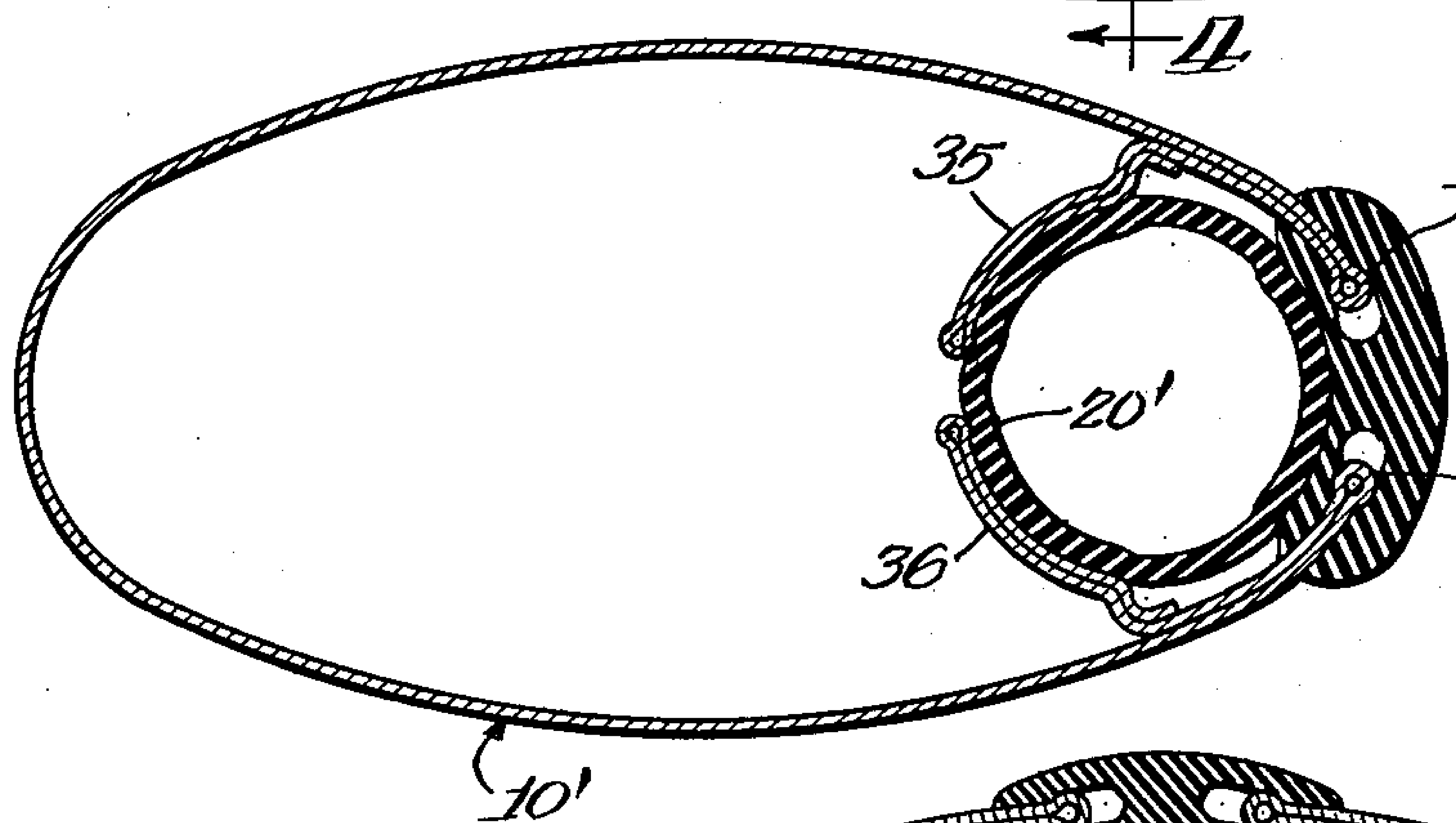


Fig. 3

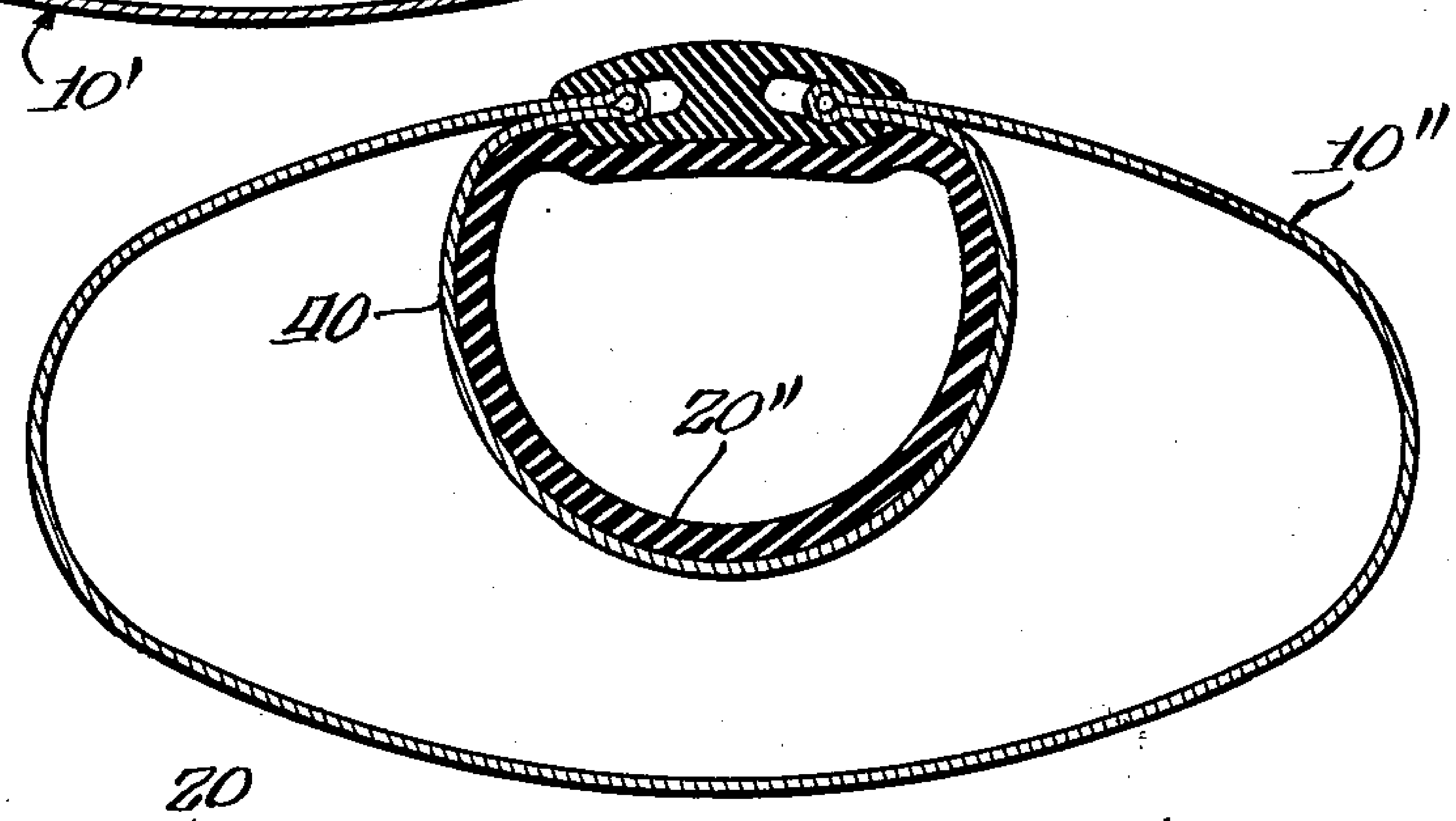
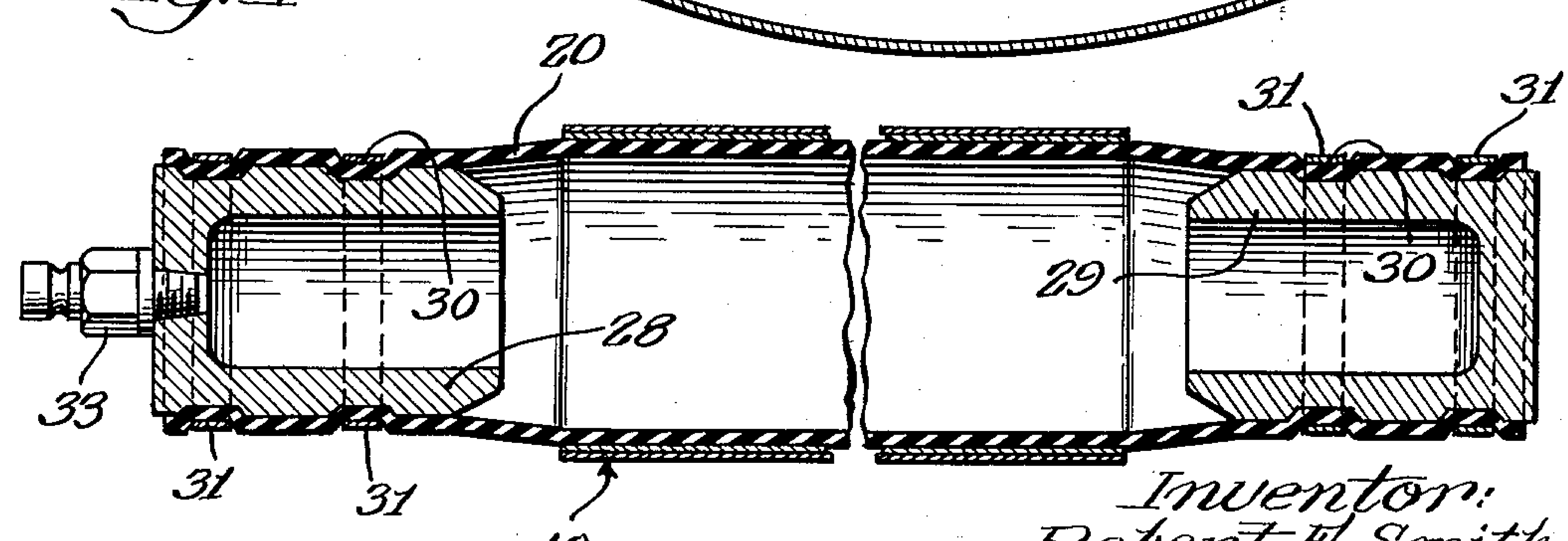


Fig. 4



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DUCT FORMING CORE

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This invention relates to a duct forming core for defining ducts during the casting of concrete slabs. The slabs in which these ducts are provided are cast in lengths ranging from about 20 feet to as much as 50 or 60 feet, while the height of the slab is generally small in comparison to the length thereof. As a rule, the width of the slab may also be small in comparison to the length, but the width is generally greater than the height or depth of the slab. In slabs of this character, it is advantageous to provide ducts of circular or non-circular cross section extending the full length of the slab. Such ducts not only save on concrete mix, but impart desirable characteristics to the slab as a whole.

For many years, slabs of this type, such as, for example, disclosed in United States Patent No. 2,299,111, have been manufactured with ducts having a generally circular cross section. The cores for forming such ducts have conveniently been of rubberized fabric or similar material arranged to be expandable. Such cores are convenient because of their deflated condition they can be folded as they are pulled out and can be stored without taking too much room. In use, such cores are expanded by compressed air and serve to define a duct having the desired length and sectional area.

One disadvantage of such fabric cores is based upon the fact that the cores when inflated do not have substantial rigidity. A core must be positioned at frequent intervals along the length thereof to maintain it accurately within the casting mould. In casting long slabs, it is necessary that a duct be true and be accurately located throughout the entire length of the slab. Unless such a flexible fabric core is positioned at intervals of, say every two or three feet, it is difficult to maintain the length of the core in desired predetermined position.

This invention provides a core construction, principally of metal or stiff material, having substantially greater strength and stiffness than a tubular fabric core, as previously described. A rigid core for forming ducts has some substantial advantages over a core made of textile material or rubberized fabric. As an example, the metal or rigid material constituting the core transmits efficiently high frequency vibrations generally used in compacting the mix in the casting form. High frequency vibratory energy is generally relied upon for compacting the mix and permits the use of a drier mix than might normally be the case.

It is understood of course, that a minimum amount of water must be provided for setting the concrete. However, beyond this minimum amount of water, additional water is unnecessary for setting and does not provide any advantages. The drier the mix, the more quickly the concrete will cure, and the stronger the finished material. Hence a rigid tubular member, such as of metal, for providing a duct is highly desirable because of the improved high frequency compacting action. In particular, the mix can be poured over the core and into the casting form much faster since the high frequency energy reflected from the side of a core causes the mix to flow past the core and settle to the form bottom quicker.

In addition to the above, metal may be made thick enough so that a long rigid core can be quite stiff in comparison to cores of rubberized fabric. It is true that a rigid core with no intermediate positioners is not stiff enough to be properly located between ends when lengths of 30 or more feet are considered. It is therefore necessary that even a metal core will require some means to properly position it along the length thereof in the casting mould. However, the greater stiffness of a rigid core will make it unnecessary to space said means as closely as with fabric cores.

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Attempts have been made to use metal cores, with indifferent success. Some metal cores have consisted of fluid tight tubular metal members which were expanded under high pressure. During casting, the pressure is maintained in the core. To remove the core, it is necessary to relieve the pressure whereupon the core contracts and pulls away from the concrete enough so that the core may be pulled out lengthwise.

A metal core as described above is not desirable for the reason that high pressures require costly equipment and limit the pressure medium within the core to a liquid in order to avoid danger. Furthermore the core expansion is microscopic. Another serious drawback to such a core resides in the fact that the entire core must be tight against high pressure.

It has also been proposed to use metal cores in the form of a slotted tube having a rubber moulding wedged between the edges and maintaining the core in expanded condition. To remove such a core from a cured casting, a rope attached to the moulding at the far or dead end of the core is pulled to strip the moulding forcibly from the edges of the metal core, whereupon the natural spring of the metal results in the core contracting to permit withdrawal thereof. A drawback to this is the expense due to the requirement that the moulding be put into position for each casting operation, with the rope positioned in the core inside from the dead bulkhead end toward the live bulkhead end so that the rope may be pulled for stripping. Such a procedure can be tolerated for short cores of the order of 20 or 25 feet, and even then, the time consumed makes such a procedure expensive. For long cores of the order of 50 or 60 feet, such a procedure becomes so expensive as to be prohibitive. In addition, there is substantial wear and tear on the moulding.

This invention provides a rigid core construction utilizing a slotted rigid tube and having an inflatable flexible tube for expanding the metal core member.

The new core involves a strong, resilient duct forming core member, preferably of metal, and having a continuous slot or opening along the length thereof. The core member is preset so that it tends to assume a normal, free contracted shape, which shape is designed to be somewhat smaller laterally than the final duct shape to be moulded. In accordance with the present invention, a laterally expandable, elastic tubular airtight member is provided along the full length of the core member within the same and making a complete core assembly therewith. Means are provided for utilizing the laterally expansive force of the elastic tube to expand the core member by widening the slot along the core member. The core member when thus laterally expanded, together with a small part of the elastic tube, is used for defining a duct in a slab during casting.

After casting, the entire core assembly must be removed from the casting. This can be accomplished by deflating the airtight elastic tube and permitting the core member to assume its normally contracted shape, in which condition, a substantial portion of the core assembly is forcibly separated from the adjacent surface of the concrete. This permits the entire core assembly to be pulled out as a unit.

The new core may be easily adapted for various duct shapes, either circular or non-circular, symmetrical or otherwise.

In order that the invention may be understood, reference will now be made to the drawings wherein:

FIGURE 1 is a transverse section of a core assembly embodying the present invention.

FIGURES 2 and 3 are transverse sections of modified core assemblies embodying the present invention.

FIGURE 4 is a section along line 4—4 of FIGURE 1.

Duct forming core member 10 may be of steel or other suitably strong, elastic material. As an example, steel having a thickness of about 3/32" may be used. Steel thinner than about 1/16" may be used, but has the disadvantage of being too easily deformed in the shop or plant where the core may be used. The duct forming core member may be made in any desired length and usually will be made in a length great enough to accommodate the longest slab to be cast in a slab casting mould. In practice, the duct forming core member will be about one or two feet longer than the longest casting, since the duct forming core member must project through apertures or openings in bulkheads in a casting form. Thus such a core can be as long as 62 feet in length. Cores in tandem however, may be used if desired. The casting form disclosed in United States Patent No. 2,614,309, issued on October 21, 1952, may be used in conjunction with these cores.

Duct forming core member 10 may have any desired cross sectional shape and may be circular, elliptical, rectangular, polygonal, or any irregular shape. For simplicity, duct forming core member 10 is here illustrated as having a generally elliptical shape. This, however, is exemplary.

Duct forming core member 10 is tubular for the length thereof and has a longitudinal slot or opening extending the full length of the tube. As illustrated here, duct forming core member 10 has edges 11 and 12 defining the slot or opening extending the full length thereof. For convenience, edges 11 and 12 may extend straight along the length of the core. The location or orientation of the core slot with reference to the transverse shape of the core member may be varied. For example, FIGURE 1 illustrates the slot or opening between edges 11 and 12 as being disposed substantially at the end of the long diameter of the core member. This slot, however, may be located elsewhere.

The transverse dimension of the slot between edges 11 and 12 of the tubular core can generally be of the order of about 1/2" in the normally contracted position. In the expanded condition of the core member, this slot width may increase from about 1/2" up to as much as 1" depending upon how much expansion is desired.

The length of the long diameter in a practical core may range from about five or six inches to as much as 15 or 20 inches, or even more if desired. The length of the short diameter may range from as little as about two inches to as much as 12 inches or more.

In the core member illustrated in FIGURE 1, the metal, such as steel, making up core member 10 may conveniently be bent back at portions 11 and 12 to provide inside layers 14 and 15 extending transversely toward portion 16 of the core member which is at the end of the long diameter removed from edge portions 11 and 12. Portion 16 of the core member may be considered as the hinge portion, while inner layers 14 and 15 of the metal are useful for reinforcing the core member and stiffening the same against being distorted during the springing of the core member.

In the particular form of the invention illustrated in FIGURE 1 where the transverse shape is such that one transverse dimension is longer than another transverse dimension, it is possible to dispose within core member 10 resilient tube 20 of rubber or other resilient material. Tube 20 should be airtight and in practice may have a thickness of about 1/4", but it may be smaller or somewhat larger. As a rule, the air pressure within tube 20 may go up as high as 40 or 50 pounds per square inch, but will generally be in the neighborhood of 20 pounds per square inch. The actual air pressure required will depend upon the thickness of metal member 10 and the

stiffness thereof and the amount of expansion of transverse dimensions. Tube 20 may be of any suitable material which will hold air and can withstand some wear and tear.

No attempt is made to show proportions of the slot between edge portions 11 and 12 with respect to the transverse dimensions of the entire core assembly. In practice, as pointed out previously, the distance between edge portions 11 and 12 will normally be about 1/2" and can expand up to as much as 1". Elastic tube 20 may be sufficiently stiff so that there will be little, if any, tendency for elastic or resilient tube 20 to bulge or blow out through the slot. Some tendency for the inner tube 20 to project through the slot may result in a slight bulge, which bulge in practice, may be relied upon as part of the duct defining surface. However, moulding 23 of rubber or similar resilient material can be provided for closing the slot in the duct forming core to lock inner tube 20 within core member 10. Moulding 23 has slots 24 and 25 therein for accommodating edge portions 11 and 12 of the core member. Preferably, moulding 23 is wide enough transversely of the length of the core so that slots 24 and 25 can be deep enough to permit edge portions 11 and 12 of the core metal to move from a contracted to an expanded position and still remain in the slots.

Referring to FIGURE 4, a simple means for closing the ends of tube 20 is illustrated. Tube 20 can be a simple rubber tube of generally uniform diameter having any desired length. The end portions of tube 20 extend beyond core members 10 if desired and are disposed over metal members 28 and 29. Metal members 28 and 29 are preferably of the same elliptical shape as core member 10 except that the transverse dimensions of metal members 28 and 29 are sufficiently smaller than that of core member 10, so that even with the thickness of elastic tube 20, the outside dimensions of the end portions of the entire assembly will be somewhat less, and at the most, will be no greater than the tranverse dimensions of core member 10 when expanded. If desired, core member 10 may actually extend over metal portions 28 and 29. Metal members 28 and 29 have grooves 30 formed therein, and at these grooves, metal bands 31 are tightly stretched over the outside of tube 20 to lock the tube in position. Metal members 28 and 29 are generally similar except that 28 has fitting 33 for permitting air to pass in or out while metal member 29 simply provides a dead end for the assembly. Grooves 30 for accommodating bands 31 are deep enough so that fixtures 28 and 29 with the tube wall around the same and with the metal bands can be pulled through an opening in the bulkhead for accommodating core member 10.

Inasmuch as the core assemblies will generally be pulled out of the casting mould and slab in one direction at all times, it is possible to have only one of the end portions, for example, the rear end portion containing fitting 29, small enough to pull through the bulkheads. The front end containing fitting 28 can be as large as desired in such case, since it will always be outside of the bulkhead at the live end of the casting form and will never have to be pulled through an opening shaped to fit core member 10. Core member 10 is preferably long enough to extend between bulkheads and is preferably somewhat longer to extend up a bit beyond the bulkheads on both ends so that there will be no trouble in pulling the core assembly out of the casting. If core members 10 extend through the bulkhead, it will be understood that the openings in the bulkhead will have to be shaped to accommodate the core member in its expanded position.

Fitting 33 preferably contains a valve similar to those used in automobile tires so that tube 20 may be filled with compressed air that may be retained for any desired length of time and may thereafter be deflated when desired.

In order to use the core assembly illustrated in FIGURES 1 and 4, it will be necessary to dispose the core assembly in a casting form that is ready to receive the concrete mix. As a rule, the mix is poured into the open top of the mould at a number of regions along the length of the mould and it is expected that the mix will drop toward the bottom of the mould and pack around the duct forming assembly or assemblies. As is well known in the art, a casting mould is generally subjected to vibration. The vibration functions to aid the flow of the mix into position. The metal making up core member **10** will readily transmit such vibrations along the length of the mould. The metal of core member **10** functions as an excellent transmitter and reflector of such vibratory energy and permits the use of concrete having a slump of less than three inches and also speeds the flow of the mix into the mould.

Preferably, though not necessarily, before concrete mix is poured into the casting mould, air is introduced into elastic tube **20** to cause this to expand laterally. This may however, be done after the mix has been added. In any case, the lateral expansion of tube **20** exerts force against the inside wall of core member **10** and results in the core member being sprung outwardly. The expansive force will result in increased separation of edge portions **11** and **12**. This will have the effect of increasing the short diameter of the ellipse by a suitable amount, such as, for example, a quarter of an inch. At the same time, there will be a tendency for core member **10** to be straightened out somewhat and thus increase the long diameter of the ellipse. This latter tendency will be reinforced by the tendency of tube **20** to push moulding **23** outwardly somewhat. The change in dimension need not be great and can be as little as about ¼″.

The compressed air in tube **20** is maintained there while the casting mould with its load of cement mix is curing. The curing is generally effected in a steam room for a period of eight or ten hours at a temperature of 140° to 150°. When the curing is done, the casting mould and the contents are removed from the curing room. The duct forming assembly is deflated by letting air out of tube **20**. The entire core assembly may now be pulled out from the casting through one bulkhead, after which the finished casting may be removed from the casting mould.

Instead of having an inflatable tube filling the entire space within core member **10**, it is possible to use a substantially narrower or smaller tube insofar as transverse dimensions are concerned and concentrate the expansive force upon the portions of the core member adjacent the slot. For example, there is shown in FIGURE 2 a modification wherein core member **10′** has the same general construction as core member **10** of FIGURE 1 except that substantially rigid operating members **35** and **36** are disposed within core member **10′** and attached to edge or slot forming portions of **11′** and **12′**. Inflatable tube **20′** is disposed within members **35** and **36**. Operating members **35** and **36** do not completely form an enclosure for inflatable tube **20′**.

In the modification illustrated in FIGURE 2, air pressure inside of tube **20′** will result in creating a force tending to spread edge portions **11′** and **12′** apart. In this modification, tube **20′** is so much smaller laterally than core member **10′** that there will be no difficulty with regard to fittings at the ends of the tube. Thus, generally circular metal fittings can be used to form closures at the ends of tube **20′** and there would generally be no trouble in extending tube **20′** and the fittings through the bulkheads. As a rule, the bulkheads in the casting form will have an opening therethrough for accommodating duct forming member **10′** in its expanded condition.

In the construction illustrated in FIGURE 2, the operating members **35** and **36** can be as rigid as desired.

Referring now to FIGURE 3, a modification generally similar to FIGURE 2 is illustrated, except that in FIGURE 3, the slot along member **10″** is at the end of the short diameter rather than the long diameter as in FIGURE 2. In FIGURE 3, operating member **40** extends continuously to form a complete enclosure for elastic tube **20″**. Member **40** need not necessarily be of metal in FIGURE 3 and could be of some strong non-stretchable but flexible material such as heavy canvas or reinforced plastic. In such case, the tendency of tube **20″** to expand would be limited and the expansive force of tube **20″** would be directed toward spreading the edges of the metal making up core member **10″**. If operating member **40** is of metal, then it should be no heavier and preferably should be more flexible than core member **10″**.

The modification as illustrated in FIGURES 2 and 3 using a relatively small diameter inflatable tube and applying the expansion force directly to the slot edges of the core member may be used for core members having shapes other than elliptical. In particular, a core member having a transverse generally circular shape may be used. In such case, a relatively small inflatable tube operates only on a small part of the core defining member. The rigidity of the metal making up the duct forming core portion can be relied upon for use in pulling the metal away from the concrete side wall even if the force is only applied adjacent the slot. So long as there is some change in the lateral dimensions of metal member **10** or the corresponding metal members in FIGURES 2 and 3, it will suffice to pull the metal away from the concrete even if the movement is quite small. So long as the bond between the metal and the concrete is broken, there will be little trouble in removing the duct forming core assembly. With regard to the moulding portion which may contact the concrete, this will be of rubber or plastic, to which concrete does not adhere. The exact shape of operating members **35** and **36** of FIGURE 2 is not too important.

With reference to FIGURE 3, member **40** is of metal and can be quite thin. This metal is subjected to a tensile force. The non-circular shape of portion **40** in FIGURE 3 is provided to cause tube **20″** to stretch and open up the slot forming portions of **11″** and **12″**.

What is claimed is:

1. A core assembly for defining a duct throughout the length of a concrete slab during casting, said core assembly having a length great in comparison to any transverse dimensions thereof, said core assembly including an elongated slotted tubular metal member, said member being straight and long and having a transverse shape which remains uniform throughout the active length thereof and in transverse section defines an area which is almost but not completely surrounded by a section of said member so that said member has a generally tubular shape with a slot extending the full length thereof, a moulding covering said slot and tending to keep said slot closed even though the slot width is increased by deforming said member, an airtight, flexible tube within said member and having the property of lateral expansion in response to fluid pressure, and laterally expandable means disposed over said flexible tube and coupled to said slotted tubular member only at regions adjacent the slot, said air-tight tube exerting its expansive force directly against the laterally expandable means which in turn exerts force upon slot bordering regions of said tubular slotted member to widen the slot and spread the slotted member, said tubular member having sufficient elasticity to contract and restore the slot to normal width in the absence of any expansive force in said air-tight tube whereby said air-tight tube can have substantially smaller lateral dimensions than said slotted tubular member.

2. A core assembly for defining a duct throughout the length of a concrete slab during casting, said core assembly having a length great in comparison to any transverse dimensions thereof, said core assembly including an elongated slotted tubular metal member, said member being straight and long and having a transverse shape which remains uniform throughout the active length thereof and in transverse section defines an area which is almost but not completely surrounded by a section of said member

so that said member has a generally tubular shape with a slot extending the full length thereof, means attached to said tubular member at the interior thereof at regions adjacent the slot defining edges for providing an elongated tubular laterally expansible enclosure and an airtight resilient tube within said last named enclosure for creating force in response to air pressure for spreading said tubular member to increase the normal slot width, said tubular member having inherent elasticity and tending to return to its normal condition providing a normal slot width upon the release of said air in said tube.

3. The construction according to claim 2 wherein said slotted tubular metal member is of steel having a thickness of about 3/32" and wherein the transverse width of said slot is of the order of about ½".

4. The construction according to claim 3 wherein said enclosure for said resilient tube is of metal.

5. The construction according to claim 2 wherein said means attached to said tubular member at the interior thereof includes a pair of substantially rigid members extending inwardly of said tubular metal member and extending toward each other.

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