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3,343,864

MATERIAL HANDLING APPARATUS AND THE LIKE

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2 Sheets-Sheet 1

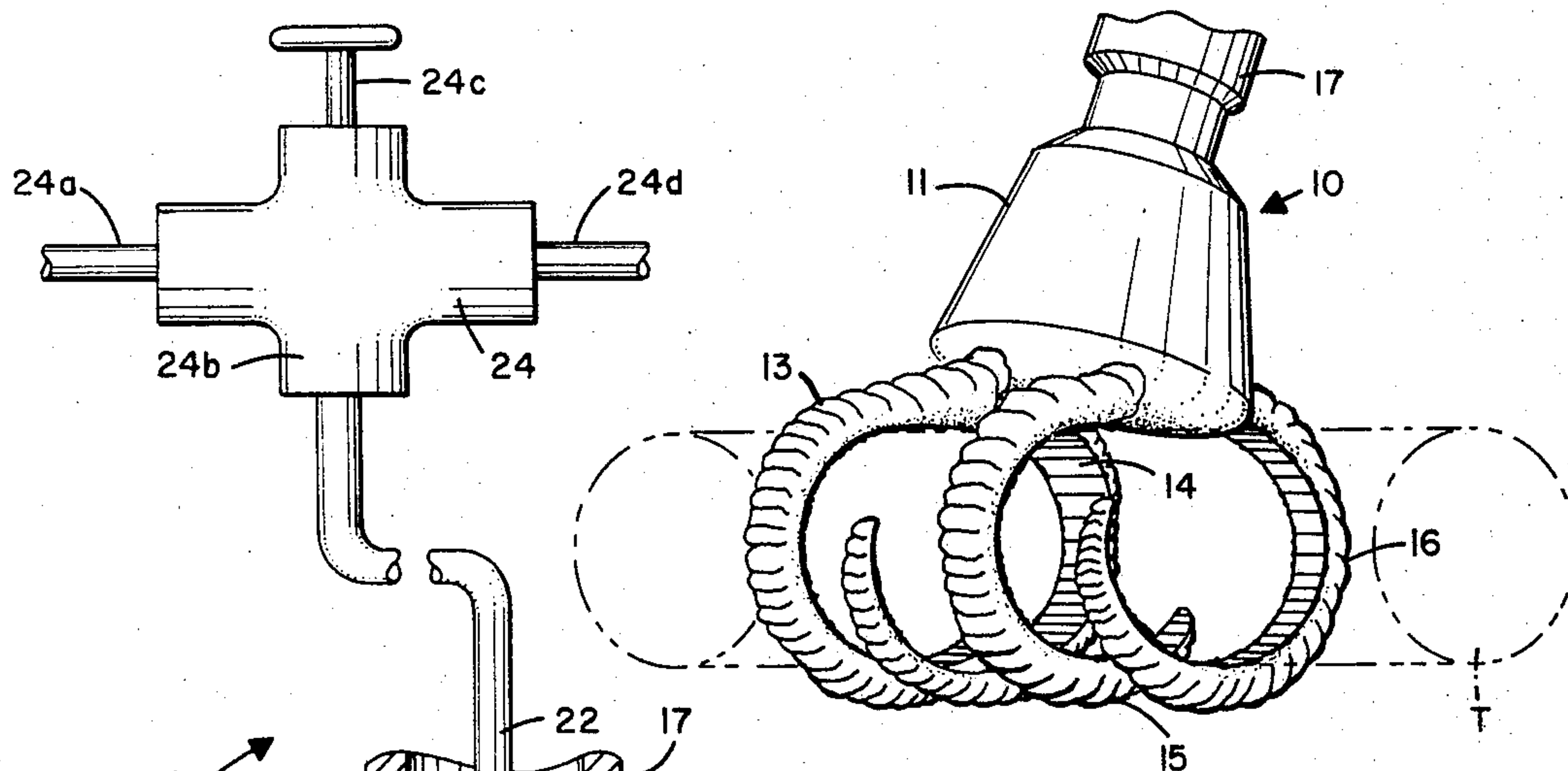


Fig. 1

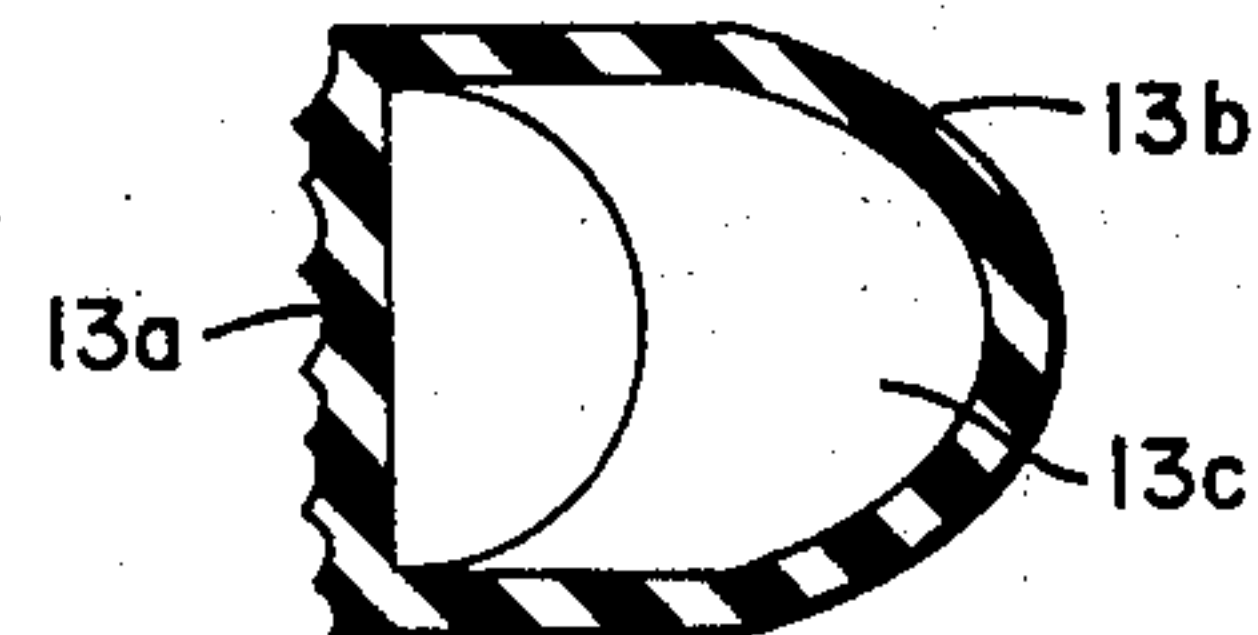


Fig. 3

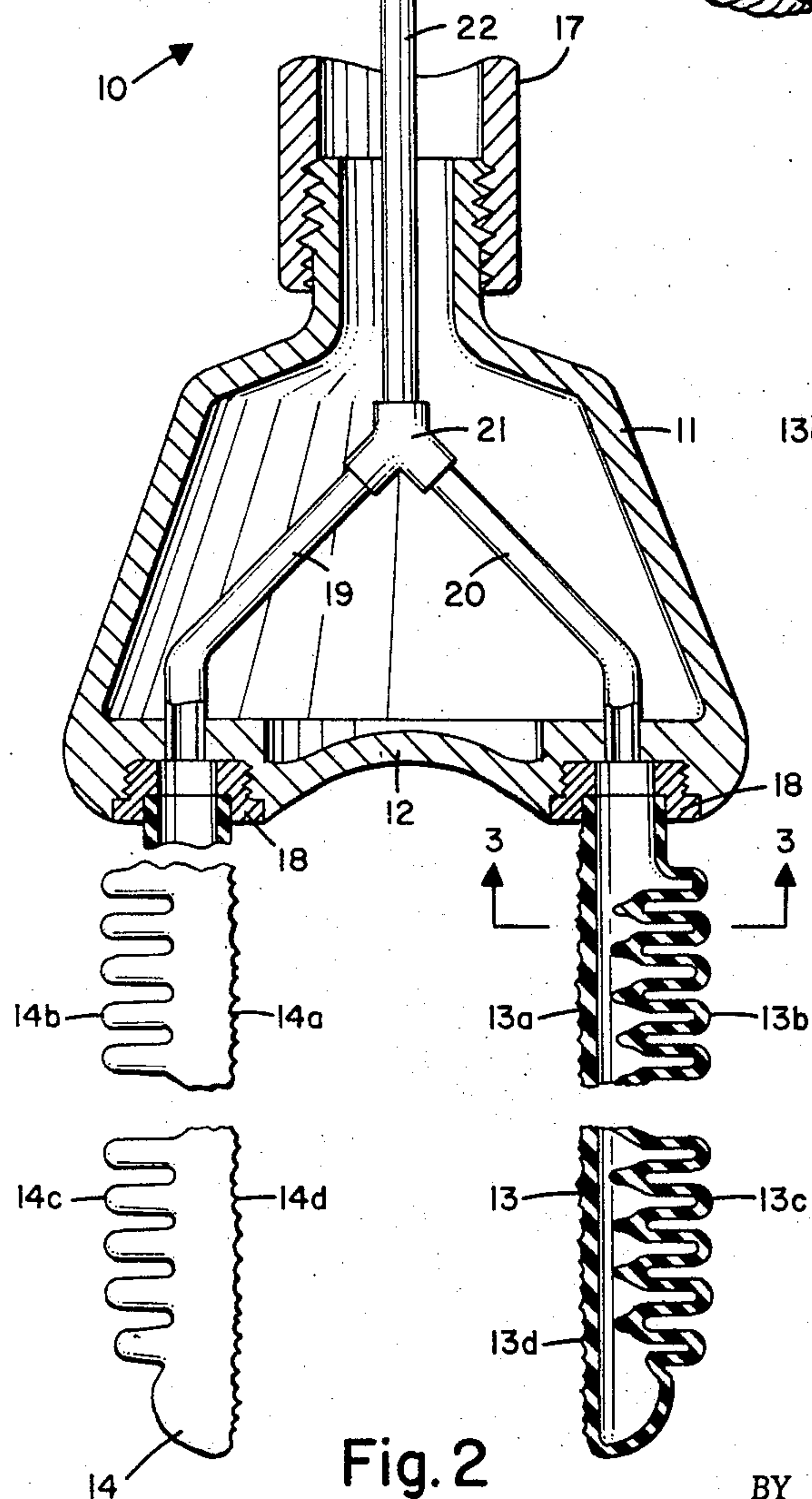


Fig. 2

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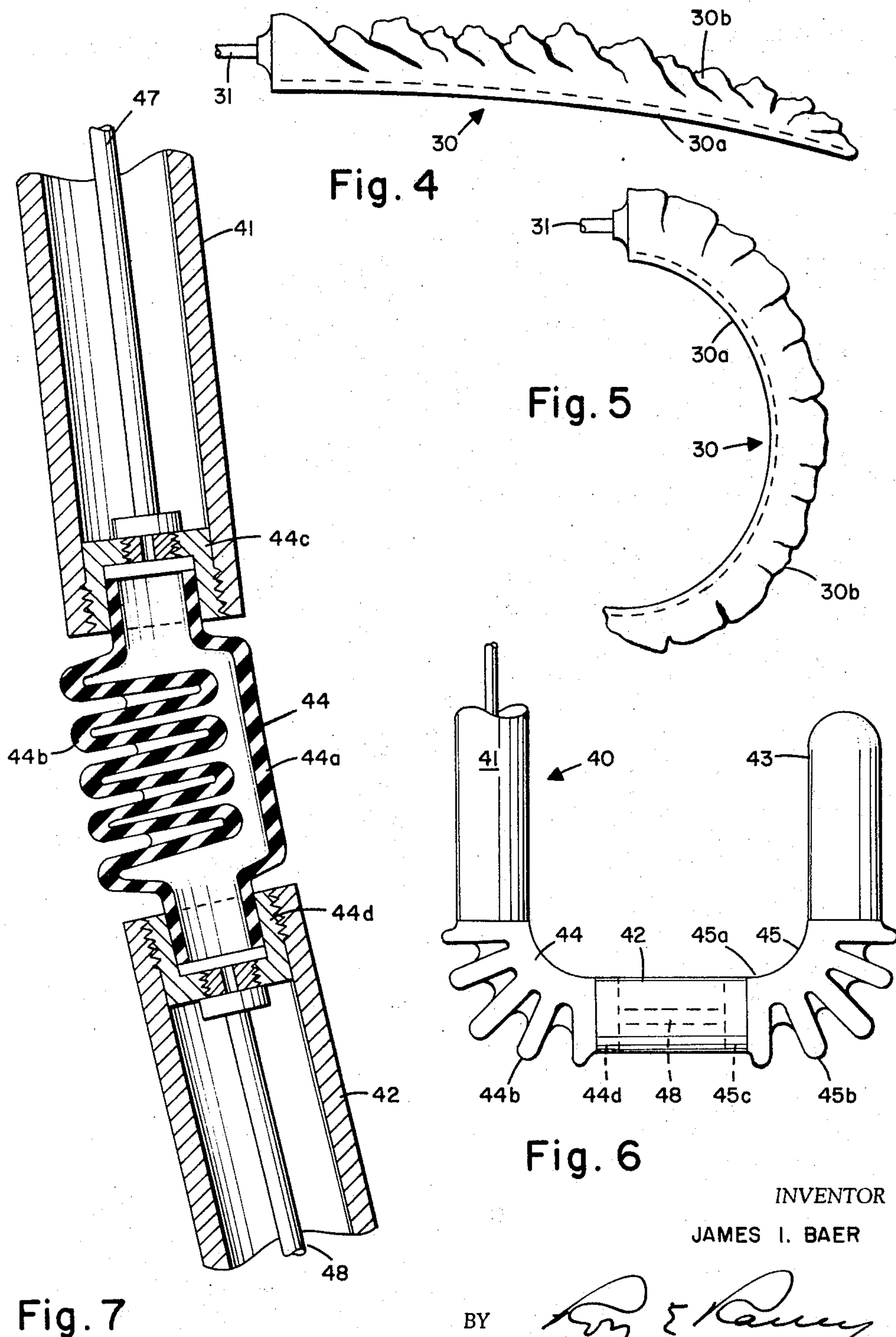
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## MATERIAL HANDLING APPARATUS AND THE LIKE

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The present invention relates to apparatus for handling material or objects, and more particularly to the type of apparatus which has a power actuated gripping or embracing action by which objects can be handled or manipulated by remote control.

The principal object of the present invention is the provision of a new and improved material handling apparatus and the like which is capable of gripping an object by an element which curls about the object in response to fluid pressure applied to the interior thereof to embrace the object for transportation or handling thereof.

Another object of the invention is the provision of a new and improved material handling apparatus of the character mentioned in which the pressure of the grip about the object can be readily regulated according to the fluid pressure.

A still further object of the invention is to provide an article of manufacture comprising an elongated flexible part attached between its ends to a second co-extending part which is flexible and which may elongate relative to the first part in response to pressure applied to the interior thereof so that the elongation of the second part produces curling of the relatively inelastic first part.

Other objects and advantages of the invention will be apparent from the following description of preferred forms thereof, reference being made to the accompanying drawings wherein:

FIG. 1 is a fragmentary perspective view of a material handling device embodying one form of the invention;

FIG. 2 is a fragmentary view, partly in section and drawn on a larger scale of the material handling device shown in FIG. 1, including a schematic control therefor;

FIG. 3 is a sectional view taken substantially along line 3-3 of FIG. 2;

FIG. 4 is a side elevational view of a gripping member embodying another form of the invention;

FIG. 5 is a view similar to FIG. 4, but showing the member in form for gripping;

FIG. 6 is a fragmentary side elevational view of a flexing member embodying still another form of the invention; and

FIG. 7 is a sectional view of the flexing member shown in FIG. 6 and on a larger scale.

Referring to FIGS. 1 to 3, a power operated apparatus 10 is shown for handling objects remote from the operator thereof, one of which objects is a tubular member T shown in broken lines. The objects handled by the apparatus may be of a type or in an environment in which it cannot be readily handled manually, for example. It is to be understood, however, that the invention could be utilized in many different forms and for handling objects for various purposes as well as providing merely animation or movements of figures, or for operation of control or indicators responsive to changes in conditions which may reflect changes in pressure of fluid.

The apparatus 10 comprises a base member or "hand" 11 having a concave surface 12 thereon against which a part of the tube T may engage, and two pairs of fingers 13, 14 and 15, 16 extend from opposite sides of the concave surface. The fingers are operable to curve inwardly and grasp an article therebetween, as is shown.

The hand member 11 may be formed of any suitable material, such as cast metal, and is attached to an arm 17 of a mechanism, not shown, by which the hand can be

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manipulated either manually or by suitable power means, for transporting or otherwise handling the objects gripped by the fingers 13-16 and held to the hand proper. The operation of the fingers to grip and release objects can be controlled by remotely located control means described hereinafter.

Referring to FIG. 2, wherein the apparatus is shown partly in section taken on a plane transversely of the axis of the object T so that the hand member 11 and finger 13 are shown in longitudinally cross-section and finger 14 appears in elevation, each of the fingers 13-16 comprises a tube of suitable imperforate flexible material, such as rubber or rubber-like plastic or the like, closed at its outer end and which has an open base end integral with a rigid coupling 18 which is threaded into an opening in the member 12 for connection with a fluid pressure source, described hereinafter. To simplify the explanation of the disclosure only fingers 13, 14 are described in detail and it should be understood that the fingers 15, 16 are like fingers 13, 14 in all respects. The fingers 13, 14 have inner side walls 13a, 14a which are flexible but inelastic, at least in the longitudinal direction of the fingers, and the edges of the inner walls are each integral with a flexible and elongatable outer wall 13b, 14b respectively. The outer walls 13b, 14b are elongatable by reason of transverse corrugations 13c, 14c and in a normal state, the fingers are approximately straight, or at least in a relaxed or non-gripping position. It will be apparent that if fluid is introduced into the fingers 13, 14 under pressure, the walls 13b, 14b tend to elongate, and because walls 13a, 14a are non-elastic or relatively non-elastic to the walls 13c, 14c the normally straight finger-like elements will curl about the non-elastic walls 13a, 14a and thereby cause a gripping action of the fingers, as is illustrated in FIG. 1. The fingers 13-16 are preferably molded of the material mentioned in a form so that when the internal pressure of the finger approaches that of the atmosphere the form of the fingers returns to a position in which the walls 13a, 14a are straight or nearly so. It will be understood that the fingers could be formed of other materials or in other forms having the characteristics of a non-elongated section co-extending with an extendable section.

Furthermore, the walls 13a, 14a are preferably formed of material which affords a suitable gripping surface and should be wear resistant. For example, it may be desirable to provide a roughened thread or surface which engages the article gripped thereby, as seen at 13d, 14d.

The gripping action of the fingers 13-16 is controlled by directing fluid under pressure into the fingers and the relaxing or release of the gripping action is effected by releasing the fluid from the fingers, all of which can be effected at any suitable location relative to the hand member 11. In the form of the invention shown, the openings in member 11 into which the finger couplings 18 are threaded receive the ends of branch tubes two of which appear at 19, 20, which tubes are connected with a manifold 21 at the end of a fluid supply conduit 22 which passes through arm 17 and is connected with a suitable three-way control valve 24 installed at a convenient control position. The valve 24 is connected to a convenient fluid pressure system, not shown, by a connection 24a and which directs fluid into the conduit 22 through an outlet 24b by operation of a control handle 24c. Fluid may be bled from conduit 22 into the low pressure side of the fluid system through a return line 24d by movement of the handle to a given control position. The details of valve 24 are not shown inasmuch as any suitable form of three-way valve could be employed, many of which are commercially available.

If desired, each finger or pair of fingers, i.e. opposite disposed fingers, could have its own source of controlled fluid pressure.



It will be seen that by manipulating arm 17 so as to position the surface 12 of the hand member 11 against an object with the two pairs of fingers 13, 14 and 15, 16 along opposite sides thereof, and directing fluid under pressure into the fingers the fingers will curl about the object and grip it according to the pressure of the fluid in the fingers.

The arm 17 may then be manipulated to transfer the object gripped by the fingers to its desired destination or to otherwise manipulate the object whereupon the fluid may then be exhausted from the fingers and cause them to return to their normally straight positions and release the object. The fluid pressure for actuating the fingers can be supplied through flexible tubing so as to permit freedom in the manipulations of the hand member 11 in its movements of the gripped object.

It will be appreciated that by limiting the fluid pressure admitted to the fingers, the gripping pressure applied to the object can be controlled and either a pressure gauge or a pressure limiting control could be employed in the fluid pressure system.

It will be apparent that the invention is readily suitable for handling of objects by grasping the same and that the movement of the fingers 13-16 could as well be utilized for actuating various types of mechanisms including, control devices, signaling devices and the like, and that remote control of the apparatus is easily effected through the fluid tubing and control valving. Likewise, it will be appreciated that elements embodying the invention could be employed to simulate the movable joints of members of animated animals, for example.

The elongated sides of the fingers need not be corrugated but may be of a material which assumes a random shape when it is collapsed by the reduction of fluid pressure inside the fingers. Referring to FIGS. 4, 5, a finger 30 is shown comprising a flexible but relatively inelastic wall 30a which normally assumes a straight form, and which is integrally joined along its edges and outer end to an expansible elongated side wall structure 30b which has no particular form and lies in random folds when the portion 30a of the finger is straight. By applying fluid under pressure into the finger through a suitable tube 31, the elongation of the part 30b and the inability of the side 20a to elongate, results in a curling of the element 30, as seen in FIG. 5. The finger 30 could be attached to any suitable apparatus or device to utilize its capacity for movement as described.

Referring to FIGS. 6 and 7, another form of the invention is disclosed in which an arm 40 is shown which comprises a plurality of sections of rigid tubular members 41, 42, 43 interconnected by flexing joints 44, 45 which impart swinging movement to the arm sections. The flexing joints 44, 45 comprise tubular sections having flexible but inelastic side walls 44a, 45a in the longitudinal direction and elongatable wall portions 44b, 45b, connected therewith in the form of corrugations, similar to the walls 13c, 14c of the fingers 13, 14. The walls 44a, 44b, 45a, 45b are formed of suitable material such as described with reference to the fingers 13-16. The ends of the sections 44, 45 have threaded discs attached thereto and for the sake of simplicity only the discs 44c, 44d of section 44 are shown. These discs 44c are threaded into the adjoining ends of the rigid members 41, 42 and fluid under pressure is conducted to and exhausted from the joint 44 by tubing 47. The tube 47 is connected with a suitable fluid source including a valve arrangement, not shown, which could be similar to that described hereinbefore, and is attached in an opening through the disc 44c through which fluid is fed into the joint 44. One end of a tube 48 is attached in an opening through the disc 44d and the other end is attached in an opening through a disc 45c at the joint 45, which disc is like disc 44c, so that fluid from joint 44 passes into joint 45 through tube 48. It will be seen that when fluid pressure is applied to line or tube 47 the joints 45, 44 will flex and cause the

rigid portions 41, 42, 43 to move to a partially closed form for supporting material or the like.

It will be understood that although I have described three forms of the invention it is to be understood that other forms, modifications and adaptations thereof could be made without departing from the spirit and scope of the claims which follow.

I claim:

1. An apparatus for gripping objects and the like comprising a base member, a pair of tubular members each supported at one end to said base member and normally extending relatively straight, each of said tubular members being closed at its extended end and each comprising a yieldable extendable side wall connected along the edges thereof with a relatively non-extendable side of said member, and means to direct fluid into said tubular members under pressure for causing extension of said extendable walls thereof thereby curving said non-extendable sides, said tubular members being disposed with the non-extendable sides facing toward the other whereby said members curve in response to fluid pressure therein toward one another.

2. An apparatus for supporting objects and the like comprising, two elongated rigid members arranged in end to end relation and connected by joint means comprising a tubular member having one side of flexible relatively non-extendable material and the opposite wall formed of flexible material and extendable in the direction said tubular members extend, means normally tending to maintain said members at a relatively substantial angle, and means for applying fluid pressure to said tubular member whereby said elongated wall thereof is extended and about said non-extendable wall thereby causing relative angular movement between said members to decrease the normal angle therebetween.

3. A structure for gripping objects comprising a relatively rigid support element, a flexible hollow member having one end secured to said support element and the remainder thereof being free to flex, means to supply fluid under pressure to the interior of said member, said flexible hollow member having an extendable wall adapted to elongate in response to fluid pressure applied inside said member, and flexible gripping means extending along one side of said extendable wall and connected therewith, said flexible gripping means being non-elongatable relative to said extendable wall whereby fluid pressure applied to the interior of said flexible member causes said extendable wall to elongate and flex about said gripping means and curve said gripping means away from said extendable wall for embracing an object, and means normally urging said member and flexible means toward a non-curving position to release an object embraced by said gripping means.

4. A structure as defined in claim 3 in which said hollow member comprises a finger-like element closed at the end remote from said support element, and said flexible gripping means comprises a side wall of said finger-like element formed of relatively non-elongatable flexible material which tends to assume a substantially straight attitude when fluid pressure in said hollow member is relatively low.

5. A structure as defined in claim 4 in which the exterior of said side wall has an outer surface adapted to grip articles.

6. A structure as defined in claim 3 in which said extendable wall comprises a corrugated section having the corrugations thereof extending transversely of the direction of elongation thereof.

7. A structure as defined in claim 4 in which said extendable wall is comprised of corrugations extending transversely of said extendable member.

8. An apparatus for gripping objects and the like comprising a support member including a base portion, a flexible tubular member supported at one end on said base portion and having the opposite end closed and free



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to swing by flexing, said tubular member being normally disposed in a relatively straight attitude, means forming a yieldable extendable side wall of said tubular member connected along the edges thereof with a relatively non-extendable side of said member, and means to direct 5 fluid into said tubular member under pressure for causing extension of said extendable wall thereby curving said non-extendable side.

9. A structure as set forth in claim 3 in which said extendable wall comprises flexible material having ran- 10

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dom folds therein when said member is in a relatively straight attitude.

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