Sept. 16, 1947. C. FIELD 2,427,644

METHOD OF AND APPARATUS FOR ROTARY EXTRUDER

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Fig. 1.

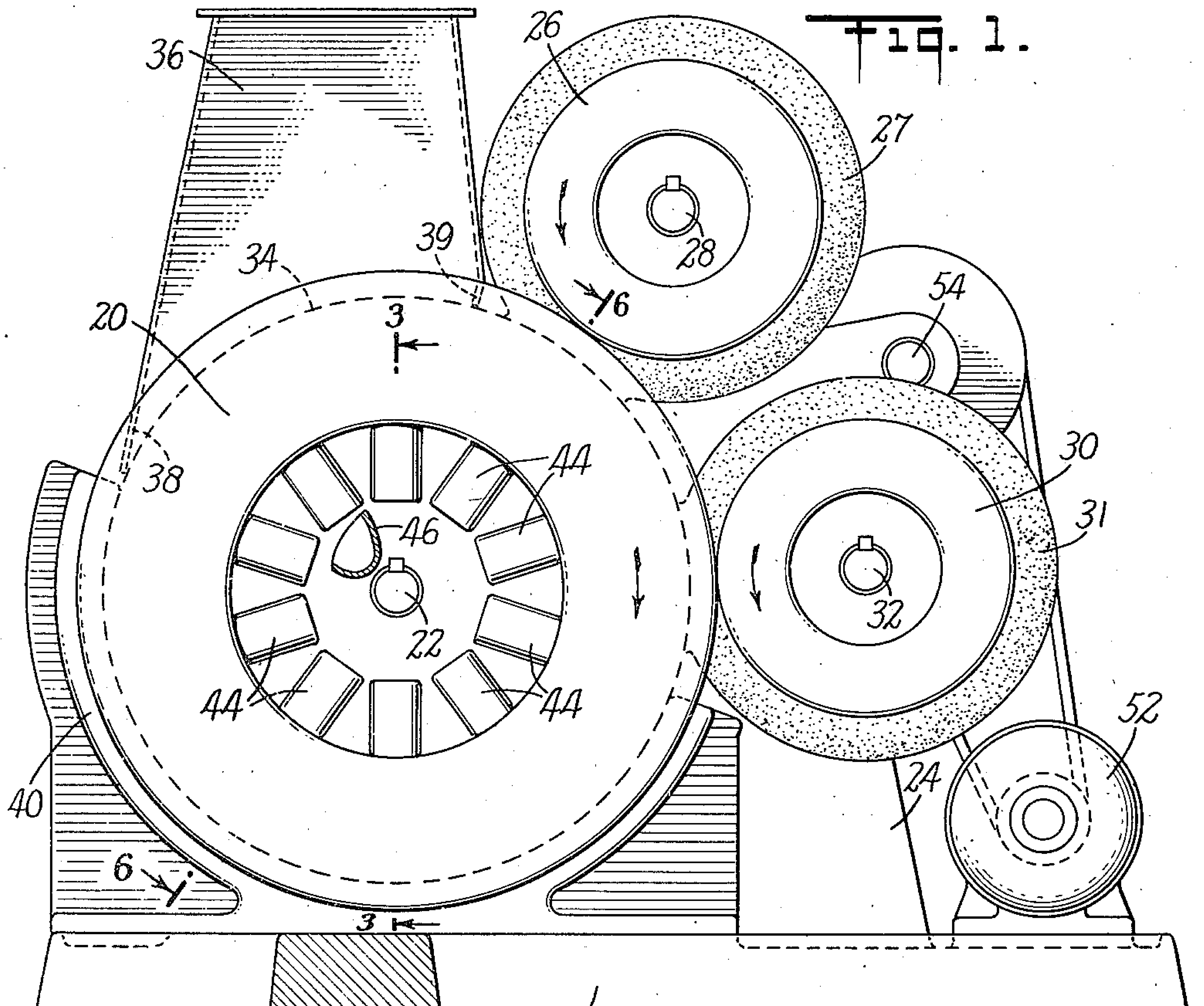

Fig. 2.

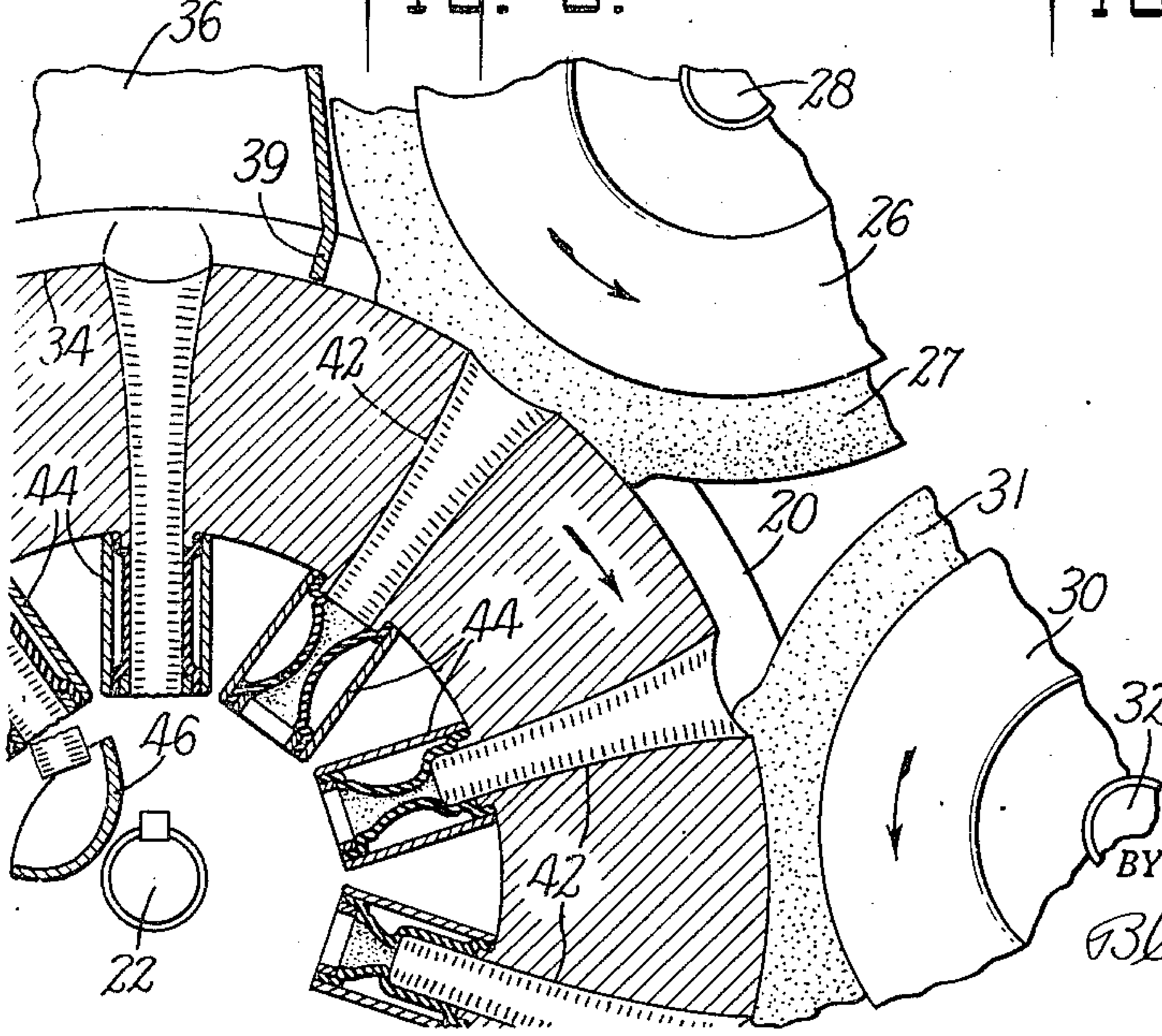

Fig. 3.

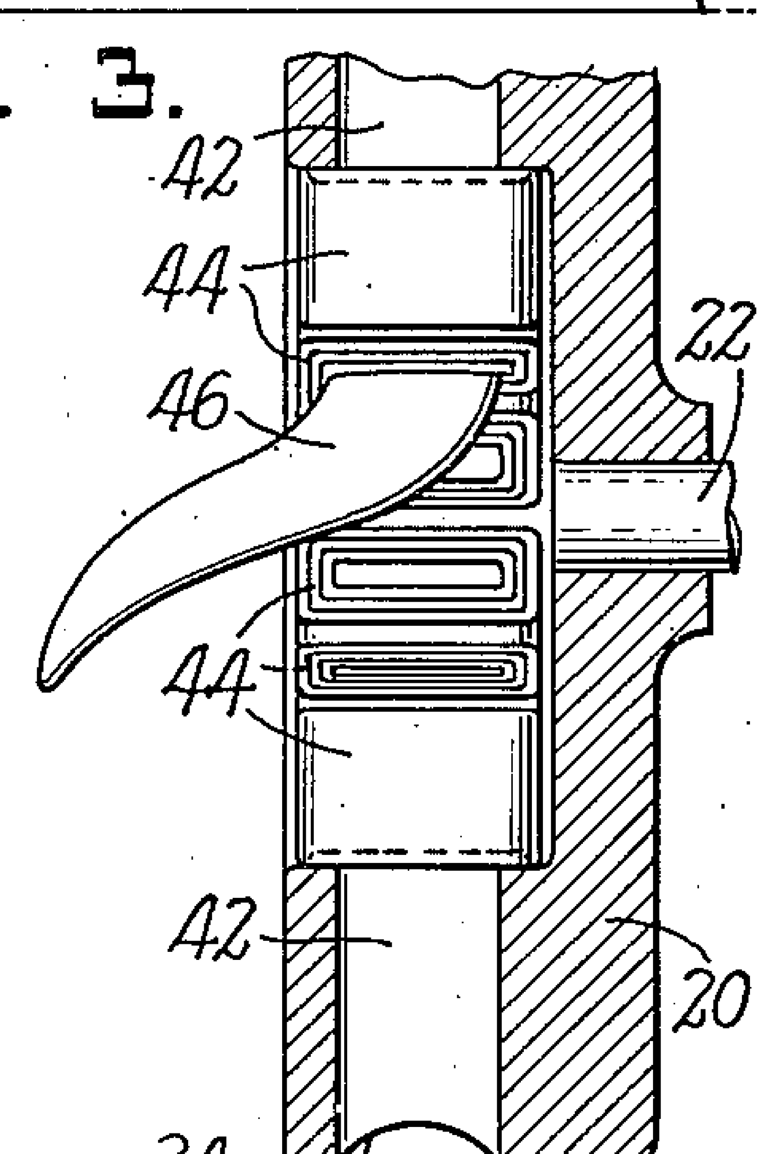

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FIG. 4.

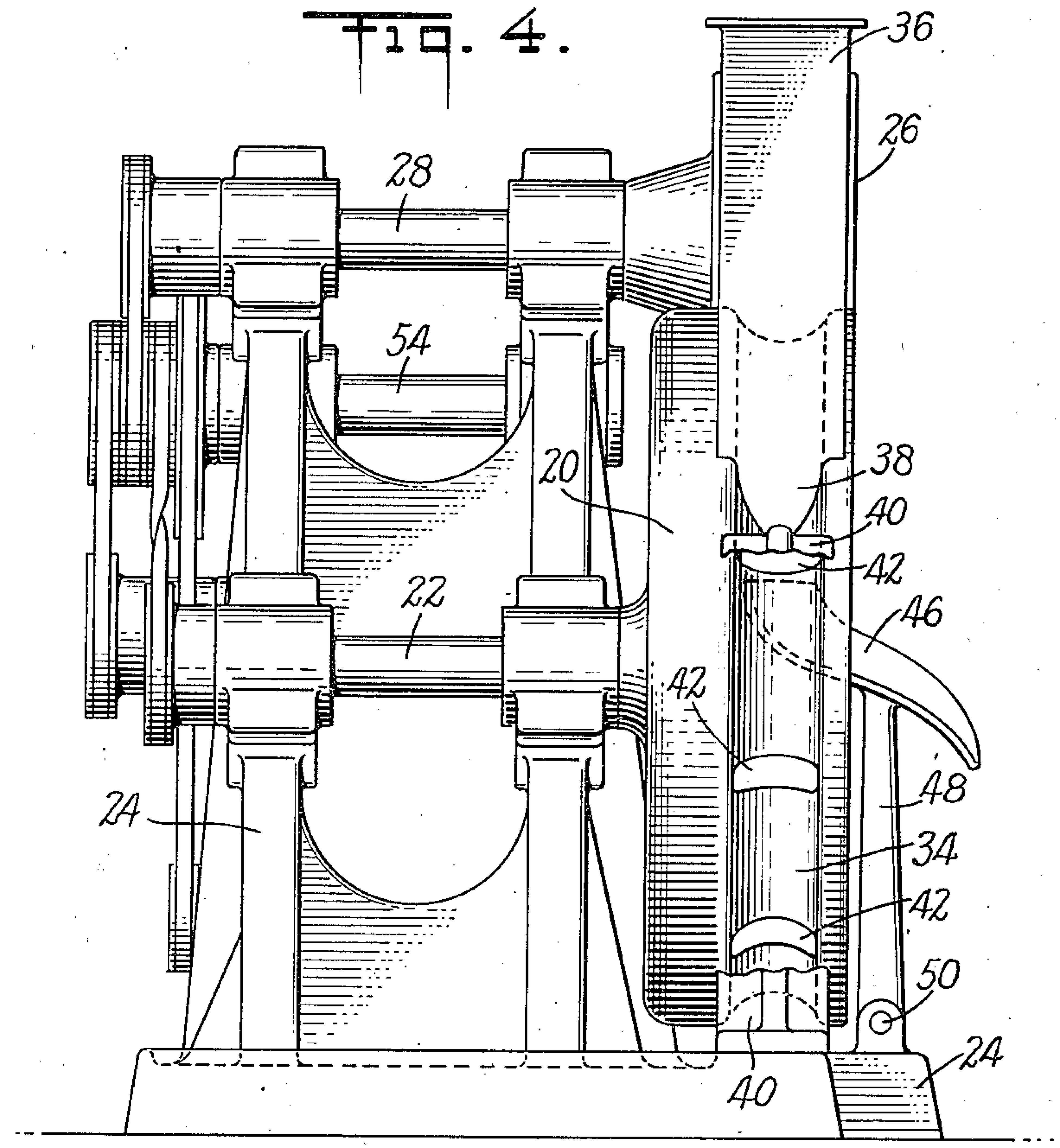


FIG. 5.

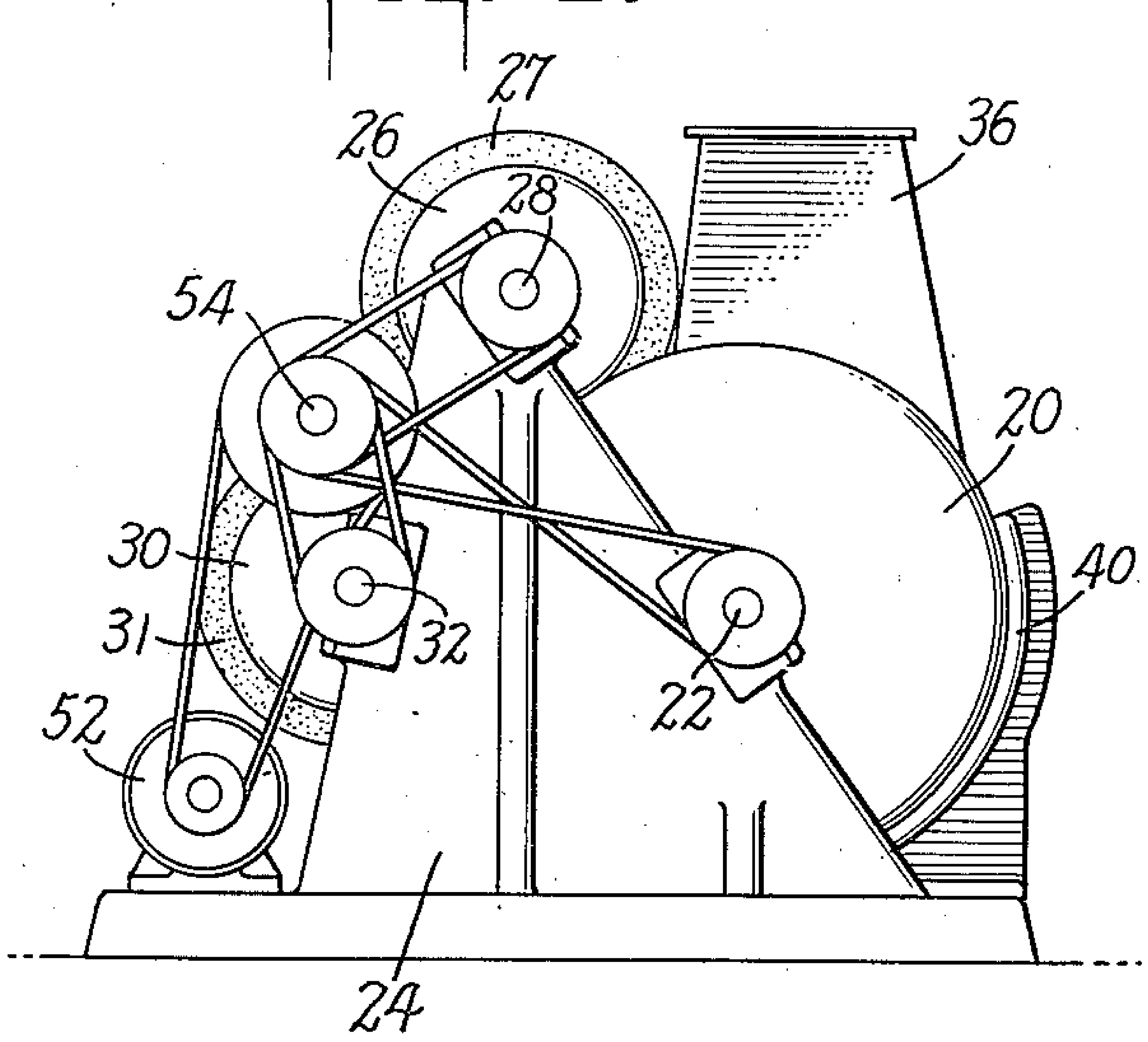
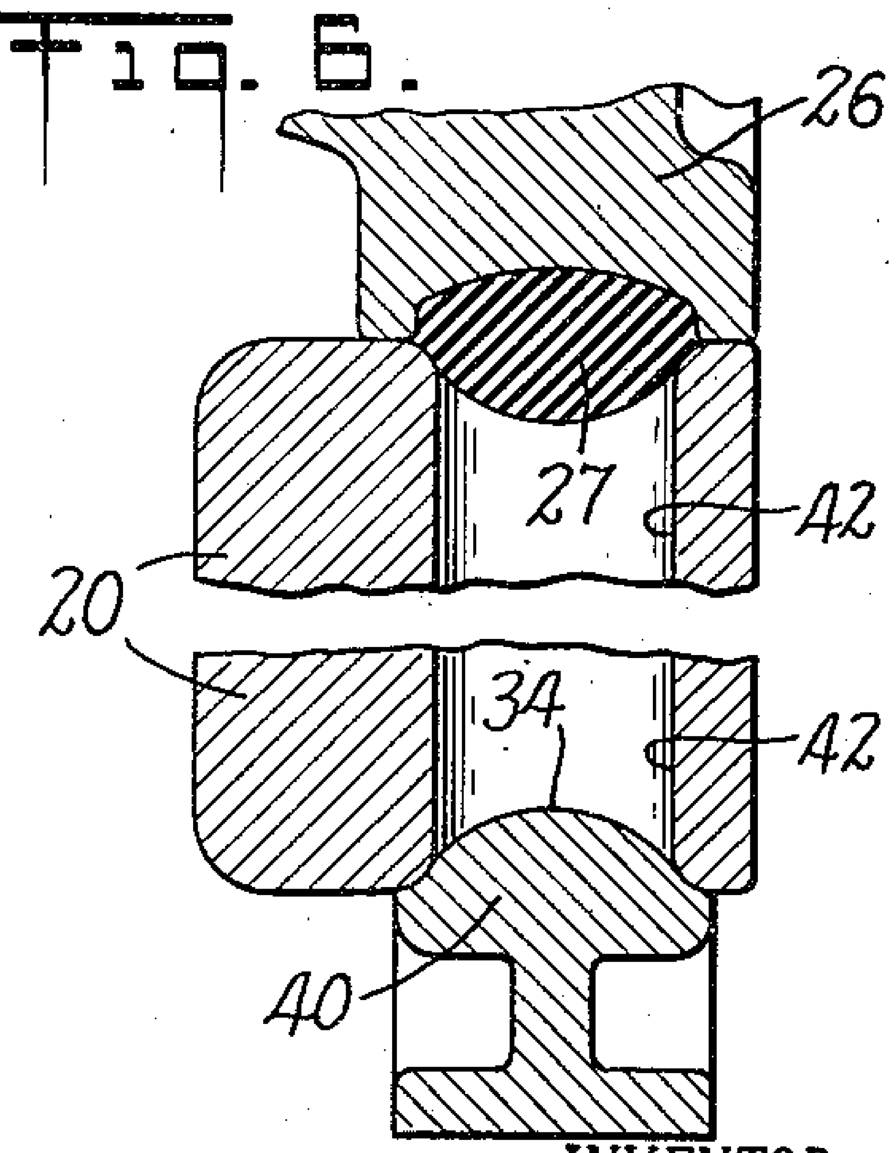


FIG. 6.



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UNITED STATES PATENT OFFICE

2,427,644

METHOD OF AND APPARATUS FOR ROTARY EXTRUDER

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Application January 20, 1944, Serial No. 519,033

13 Claims. (Cl. 18—12)

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This invention relates to a method of, and apparatus for, converting particles or fragments of frozen fluid, and the like, into a solid mass and more particularly to a method and apparatus for pressing such fragments into a solid, homogeneous rod or bar substantially free from undesirable internal stresses and having appreciable mechanical strength.

I have found that ice made in the form of a rod or cylinder of a length one or more times its diameter is particularly well adapted for packing certain perishable food stuffs and for refrigerating car bunkers and the like.

It is an object of the present invention to provide novel methods and apparatus for carrying out the manufacture of solid ice masses from ice particles or fragments utilizing the converging nozzle action.

Other objects will be in part pointed out as the description proceeds and will in part become apparent therefrom.

The invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and methods of operations as will be exemplified in the structure hereinafter described, and the scope of the application of which will be set forth in the appended claims.

In the drawings, in which one satisfactory embodiment for achieving the above objectives is set forth, and in which similar reference characters refer to similar parts throughout:

Figure 1 is an elevation, with parts broken away, of a machine embodying the invention;

Figure 2 is a fragmentary view on an enlarged scale of a portion of the machine illustrated in Figure 1, with parts in section;

Figure 3 is a fragmentary view, with parts removed, taken along the section line **3—3** of Figure 1;

Figure 4 is a side elevation of the machine of Figure 1 as viewed from the left;

Figure 5 is an elevation on a reduced scale and taken from behind as viewed in Figure 1; and

Figure 6 shows on an enlarged scale two fragmentary sections taken along the line **6—6** of Figure 1.

The machine herein described by way of explaining the invention is built around a large, cast metal rotor which includes chambers radially located within its body and each extending from an opening in the outer cylindrical surface of the rotor straight through to an opening in an inner cylindrical surface within the rotor. Each of these chambers has a cross-section which reduces somewhat in area in a direction toward

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the axis about which the rotor turns. Fragments to be compacted are fed to these chambers through the larger openings in the outer cylindrical surface of the rotor and are forced radially through the converging walls of the chambers and extruded through the smaller openings in the inner cylindrical surface of the rotor. Means are provided adjacent the chamber outlets for breaking off pieces of the extruded product and delivering them to a receptacle.

As herein disclosed, the fragments are forced radially toward the center of the rotor by means of compression rolls which are mounted on shafts parallel to the axis upon which the rotor turns and which are so constructed and arranged as to provide a rolling effect with respect to the outer periphery of the rotor. Thus, there is a rolling engagement between the compression rolls and the outer cylindrical surface of the rotor, and this rolling engagement is arranged so as to coincide with the path followed by the larger chamber openings during rotation. The surfaces of these compression rolls are relatively elastic. In the instant machine they are formed by rubber treads mounted upon metal wheels but they might in some applications of the invention advantageously be formed by the surfaces of pneumatic tires.

The arrangement is such that fragments to be compacted are supplied to the chambers as they rotate past a hopper-like feeding device; and thereafter, as they pass by the compression rolls, the resilient surface of each roll, because of the pressure of the roll upon the rotor, is expanded radially into each chamber to give a limited compacting component within the chamber. The amount of ice compacted by each compression is relatively small, but because of the nature of the machine the rotor may be turned at high speed. Hence rapid refilling and subsequent compacting of the outer portion of particles within each chamber is achieved with the result that the increments of compacted product effectively extrude the product radially inwardly and through the converging walls of each chamber to project a rod of the compacted product to a point where it may be broken off during rotation.

In Figure 1, the rotor of the machine is indicated at **20**, mounted upon a shaft **22**, carried within a frame **24** (see also Figure 4). A compression roll **26** carrying a rubber tread **27** and mounted upon a shaft **28**, and a second compression roll **30** carrying a rubber tread **31** and mounted upon a shaft **32**, are also illustrated. The rubber tread of the second compression roll is given the required difference in elastic characteristics to compensate for greater pressure at the second roll. Around the outer cylindrical surface of rotor **20** an annular groove **34** is provided (see also Figure 6) and compression rolls **26** and **30** are so positioned upon their respective shafts as to roll with their treads **27** and **31** forced into this groove. A hopper **36** is mounted above and fitted to rotor **20** and tabs **38** and **39** at the lower left-hand and right-hand corners of the hopper, as viewed in Figure 1, are provided to fit into groove **34** so as to prevent fragments from escaping between the hopper and the rotor.

A support **40** is shown extending semi-cylindrically around the lower portions of the rotor and fitted to groove **34** (see Figure 6). The fit is such that there is negligible friction between rotor **20** and support **40**, rotor **20** itself being supported by shaft **22** as previously described. Support **40** serves to maintain particles of the product in the extrusion chambers to be described when operation of the machine is initiated and eliminates any possibility of the contents of a chamber being thrown out by centrifugal force.

Figure 2 shows a section through rotor **20** and illustrates extrusion chambers **42** extending radially therethrough and running circumferentially around the rotor. The side walls of each chamber converge toward one another in a direction extending toward the center of the rotor and the larger, outer openings of each chamber are positioned in rotor **20** in alignment with and extending across groove **34** (see also Figure 3). Each chamber **42** includes, toward its smaller end, a nozzle **44**. These nozzles are of the type described and claimed in my co-pending application, Serial No. 476,384, filed February 19, 1943, and for a more detailed treatment of their construction and operation, reference may be made to said application. Thus, each extrusion chamber has converging side walls, a relatively large fragment receiving opening and a relatively small, extruded-product delivery opening. Groove **34** in effect forms a compression roll bed, and the receiving opening of the extrusion chambers are cut into the surface of, and extend radially inwardly from, the bed formed by groove **34**.

Figures 1 and 2 illustrate a part of a camming spout **46** mounted upon a standard **48** (see Figure 4) which extends upwardly from the base of frame **24**. Standard **48** is pivotally mounted upon frame **24** by means of a pin indicated at **50**. Thus, when sufficiently long pieces of product have been extruded, the spout may be moved counterclockwise, manually or otherwise, to the position shown in Figure 4. Thereupon rotation of the rotor acts to break off pieces of the extruded product against the spout. During intermediate periods the spout is moved clear of the rotor so as to permit the product to extrude to the desired length. The shape of the spout is such as to direct the pieces into a receptacle.

Figure 5 illustrates what might be termed the rear of the machine. A motor **52** is shown upon the base of frame **24**. Motor **52** drives a jackshaft **54** from which power is taken in a conventional manner to drive the shafts **22**, **28** and **32**. In the embodiment illustrated, compression rolls **26** and **30** are driven so as to have a slightly higher surface speed than that of rotor **20**. It has been found that the invention may in certain instances be best practiced by positively driving the rotor and by driving the compression rolls entirely through the tangential, frictional contact between them and the surface of the

rotor. In such an embodiment the compression rolls simply turn freely upon the rotor and within the annular groove. But by having a positive drive upon the compression rolls which provides a higher surface speed for the rolls than for the surface of the rotor, any tendency of the compacted particles to crowd into the rearward, trailing portions of each chamber with a greater pressure than in the forward leading portions of the chamber may be eliminated. In other words, by proper adjustment of the surface speeds of the compression rolls and rotor, the same net compacting pressure may be applied all the way across the surface of each chamber, and hence the same amount of particles may be compacted at the forward, leading portions of each chamber as at the rearward trailing portions. Thus, no internal stresses are allowed to build within the extrusion chambers.

A machine having a rotor or sixty inches outside diameter with chambers of approximately four inch inside minimum diameters and turning at 500 revolutions per minute would have an approximate output of ice, when fed with particles of ice such as are described in my patents mentioned above, of 300 tons a day. A machine having the same diameter rotor but with chambers of cross-sectional dimensions at the smallest point equal approximately to four inches by eight inches and turning at 500 revolutions per minute would have an output of somewhere around 585 tons per day.

From the above description it is apparent that the present invention comprehends simple and economical methods and apparatus for converting fragments of a product such as a frozen fluid into a solid bar or rod which may be broken into convenient lengths. The invention may be practiced upon either dry or wet ice, for example, and a dense, compact, homogeneous mass is readily produced in either case which is substantially free from undesirable internal stresses.

Since many embodiments may be made of the present invention and many changes might be made in the embodiment here described in adapting the invention to meet the requirements of different applications, it is to be understood that the above description is to be interpreted as illustrative only and not in a limited sense.

I claim:

1. In the art of compacting fragments of ice and extruding them in a relatively solid mass by forcing them through a nozzle-like, converging chamber, that improvement which includes the steps of successively filling the chamber from one end thereof substantially to the brim with ice fragments and then forcing said fragments toward and finally out of the other end thereof by successively moving a resiliently surfaced roll under compression across the brim of the opening at the filling end of the chamber and thus expanding the resilient surface of the roll into the chamber against the surface of ice fragments therein and within the brim of the opening.

2. In apparatus for compacting ice fragments or the like by forcing said fragments through a converging, nozzle-like chamber, in combination, a source of ice fragments supply, a converging, nozzle-like chamber having a receiving opening for receiving ice fragments and a relatively smaller delivery opening through which the compacted ice mass is extruded, means for successively delivering ice fragments from said supply to said receiving opening to fill said chamber to the brim, and a compression roll having a resilient rolling

surface adapted to roll successively across said receiving opening, whereupon the portion of said resilient surface of said roll which is unsupported by the brim of said chamber expands through said opening and into said chamber and thereby compresses fragments therein toward said delivery opening.

3. In apparatus for compacting ice fragments or the like by forcing said fragments through a converging, nozzle-like chamber, in combination, a source of ice fragments supply, a converging, nozzle-like chamber having a receiving opening for receiving ice fragments and a relatively smaller delivery opening through which the compacted ice mass is extruded, a compression roll having a resilient rolling surface adapted to roll successively across said receiving opening, and means for causing relative movement of both said source of ice fragments supply and said compression roll with respect to said chamber; whereby said chamber is first filled to the brim with ice fragments by said source, and then said roll is caused to roll across the receiving opening of said chamber so that the portion of said resilient surface of said roll which is upsupported by the brim of said chamber, expands somewhat through said opening and into said chamber and thereby compresses ice fragments therein toward said delivery opening.

4. In apparatus of the character described, the combination of a hopper for particles to be compressed, a compacting chamber, a resiliently surfaced compression roll, and driving means; said hopper and said compression roll being relatively moveable with respect to said chamber, whereby said chamber may be filled by said hopper with said particles and thereafter said compression roll may be moved across the surface of the particles within said chamber to compress them; and said compression roll being driven by said driving means with a speed such that its surface comes into contact with the surface of the particles in said chamber with slippage in the direction from which the compression roll approaches said chamber.

5. In apparatus for extruding a solid product from a supply of particles of the product by forcing said particles through a smoothly converging nozzle-like chamber, in combination, a hopper for holding the supply of particles; a rotor having inner and outer peripheries, an annularly positioned groove around one periphery, and a radially extending extrusion chamber having a product receiving opening in said groove and having smoothly converging side walls extending from said opening in said groove to a delivery opening at the other periphery; and a compression roll mounted to roll upon said groove as a bed and across the face of the product receiving opening in said extrusion chamber, said compression roll including a resilient tread, whereby, as said roll rolls upon said groove as a bed, the surface of said resilient tread expands inwardly into said extrusion chamber as said roll passes across said product receiving opening.

6. In apparatus of the character described, a compression bed, a compacting chamber in said bed for receiving and compacting particles of material, a resiliently surfaced compression roll mounted for relative movement with respect to said chamber and across the surface of said bed, and a groove in the surface of said bed and across the mouth of said chamber; said groove and said resilient compression roll having substantially complementary cross-sectional profiles, whereby said compression roll may roll in said groove across said bed surface with wall portions of said groove giving lateral support to exterior portions of the resiliently surfaced compression roll.

7. In apparatus of the character described, a compression bed means, a compacting chamber in said bed means for receiving and compacting particles of material, a compression roll means mounted for relative movement with respect to said chamber and across the surface of said bed means, and a groove in the surface of said bed means and across the mouth of said chamber; one of said means having a compression surface made of a relatively resilient material and said groove and compression roll means having substantially complementary cross-sectional profiles.

8. In apparatus for compacting a fragmentary material the combination including a compacting chamber, means for filling the chamber evenly across the brim thereof, and a resiliently surfaced compression roll movable across the brim of the evenly filled chamber, whereby the portions of the roll surface unsupported by the brim edges of the chamber may flex into the chamber to compact material therein.

9. In apparatus for compacting a fragmentary material the combination including a compacting chamber, means for filling the chamber evenly across the brim thereof, a resiliently surfaced compression roll, and means for causing the chamber to move in a path between the filling means and the compression roll, whereby the chamber may be evenly filled and therafter the material therein may be compacted by the compression roll.

10. In apparatus for extruding a solid product from a supply of particles of the product by forcing said particles through a converging nozzle-like chamber, in combination, a rotor having inner and outer peripheries and a radially extending extrusion chamber therein between said peripheries, means for filling said chamber from one end evenly and substantially flush across the brim thereof, and a resiliently surfaced compression roll mounted to roll upon the rotor periphery which is adjacent the filling end of said chamber, whereby the chamber may be evenly filled and thereafter portions of the roll surface unsupported by the brim edges of the chamber may flex into the chamber to compact particles therein.

11. In apparatus for extruding a solid product from a supply of particles of the product, in combination, a hopper for holding the supply of particles; a rotor having inner and outer concentric surfaces, an annular groove positioned in one of the surfaces, a radially extending extrusion chamber having a product-receiving opening in the groove and having smoothly converging side walls extending from the opening substantially to a delivery opening at the other surface; and a compression roller mounted to roll within the groove and across the face of the product-receiving opening to force particles thereinto, the compression roller having a radially resilient particle-pressing member to aid in forcing and compacting the particles within the extrusion chamber.

12. The apparatus covered by claim 11 but including in the combination a power drive for the compression roller whereby the roller is rotated at a rate such that its peripheral speed exceeds the peripheral speed of the rotor, thereby producing a forwardly-acting slippage between the roller and the rotor where the two are in contact.

13. In apparatus of the character described, a compression bed, extrusion chambers in the bed for receiving particles of material to be extruded, a supply means for supplying particles of material to be extruded by the chambers, and a compression member spaced from the supply means and cooperating with the bed and chambers to force particles into and through the latter, the bed and its chambers being relatively movable with respect to the supply means and compression member to permit successive operations, and said compression member having a yieldable portion positioned to make contact with the particles.

CROSBY FIELD.

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