G. K. DAVOL.
PROCESS OF MAKING ICE.
APPLICATION FILED APR. 28, 1905.

988,316. Patented Apr. 4, 1911.

4 SHEETS—SHEET 1.

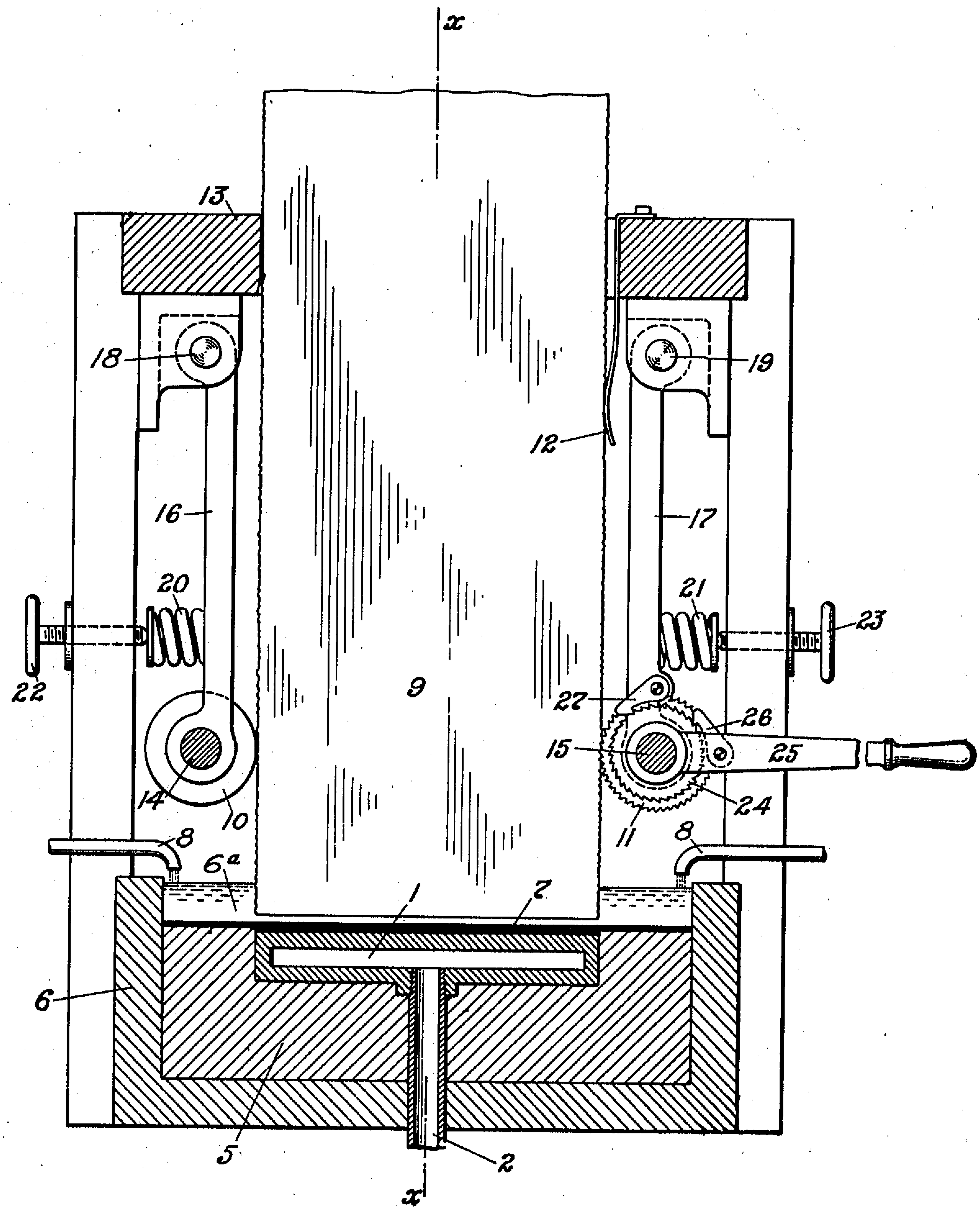

FIG. 1.

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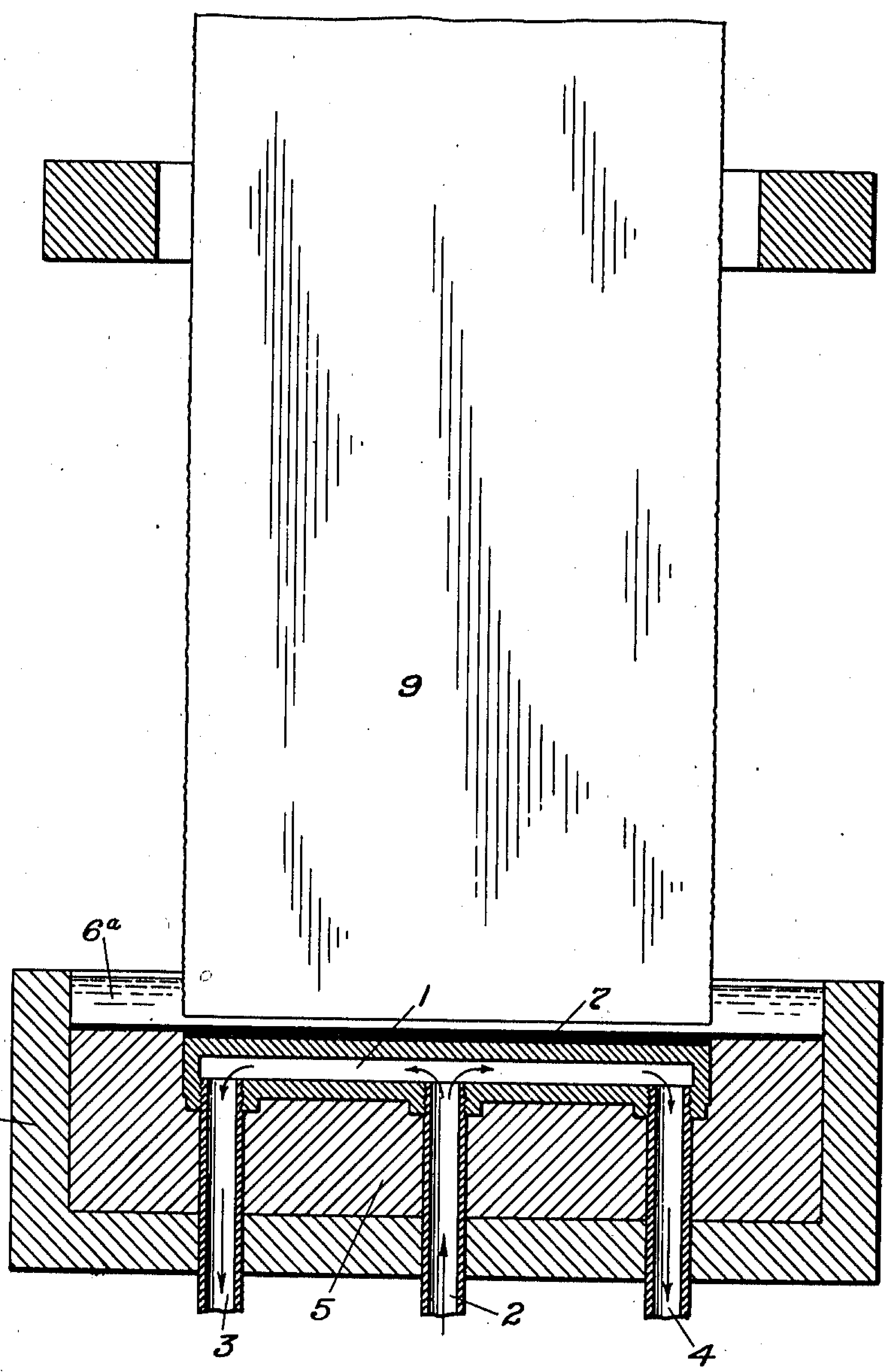

FIG. 2.

WITNESSES:

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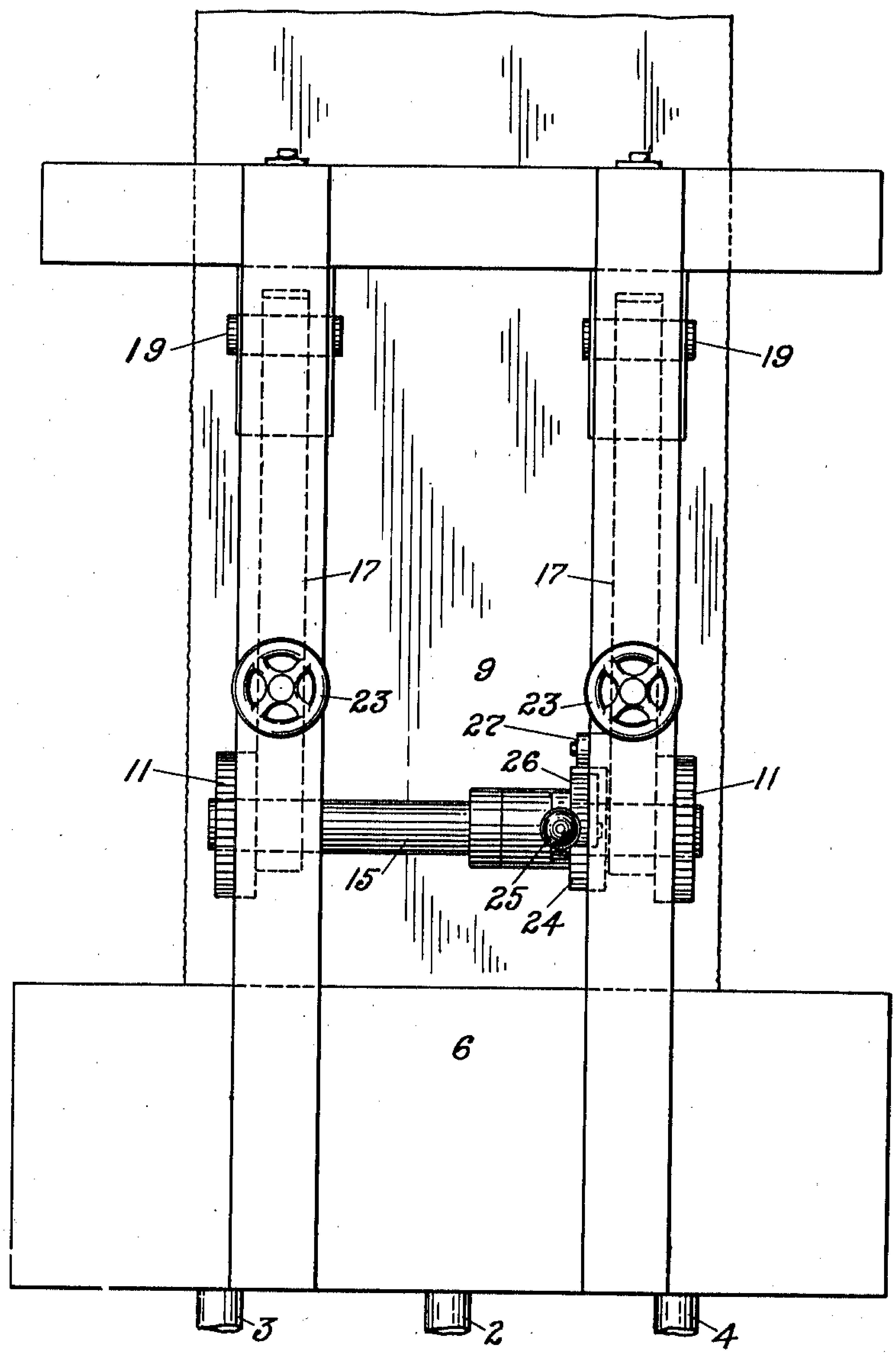

FIG. 3.

WITNESSES:

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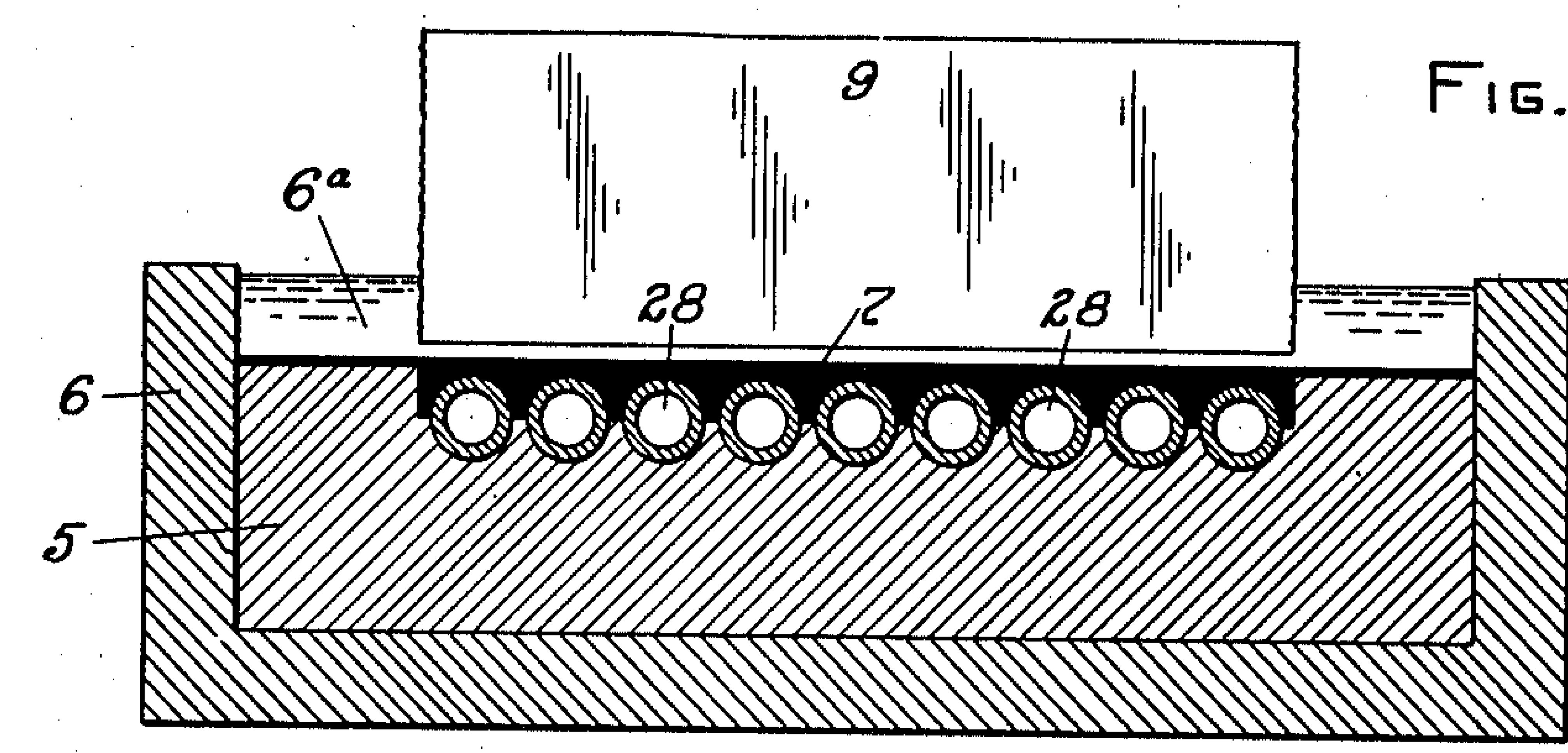

FIG. 4.

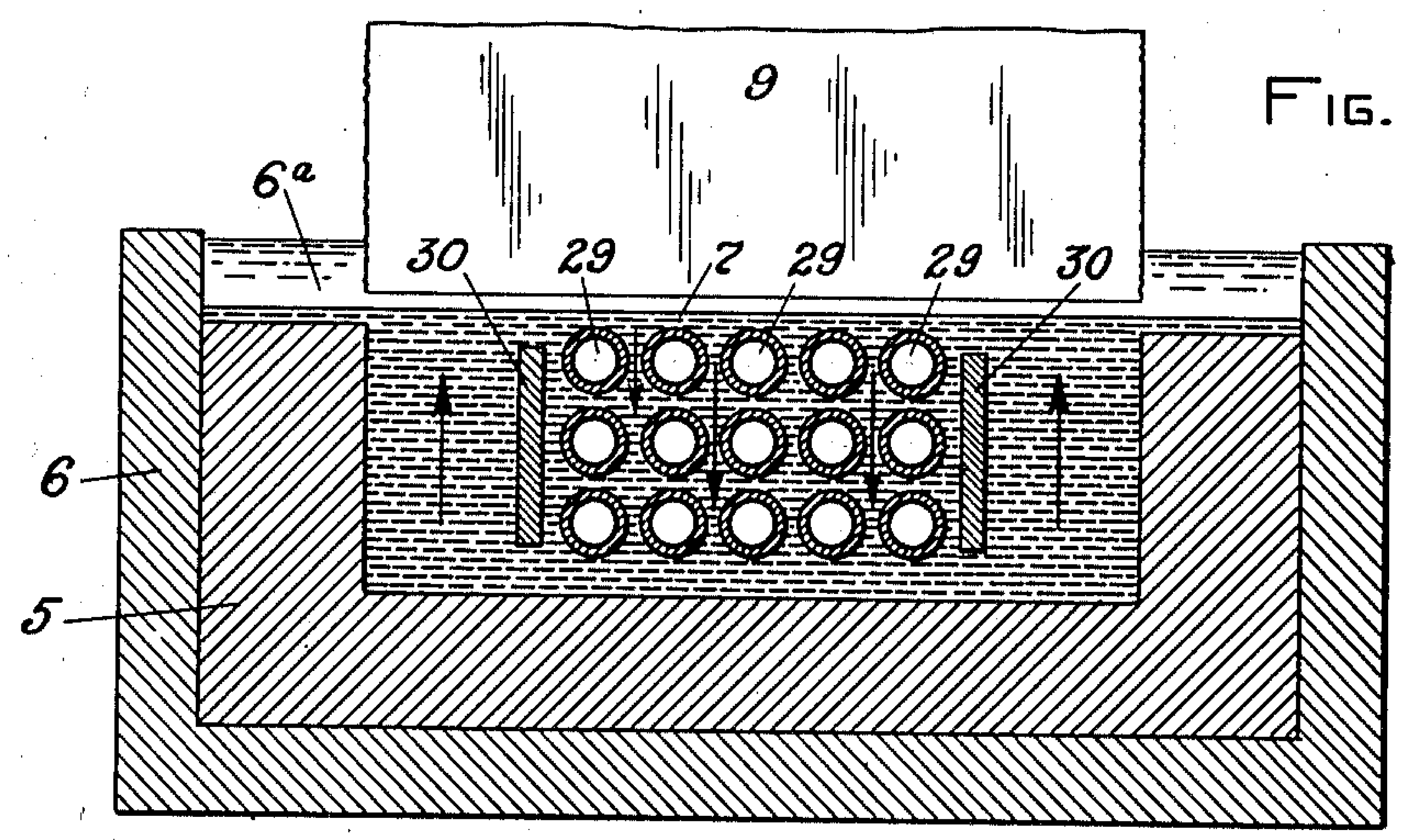

FIG. 5.

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UNITED STATES PATENT OFFICE.

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PROCESS OF MAKING ICE.

988,316. Specification of Letters Patent. **Patented Apr. 4, 1911.**

Application filed April 28, 1905. Serial No. 257,889.

To all whom it may concern:

Be it known that I, George K. Davol, citizen of the United States, residing at San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Processes of Making Ice, of which the following is a specification.

My invention relates to a method intended to be employed in conjunction with some suitable refrigerating agent. With the source of such refrigerating agent or medium, my invention is not directly concerned, but given a fluid capable of absorbing heat at a sufficiently low temperature, my invention supplies a method of employing such a fluid, to quickly and efficiently withdraw heat from water, to the end that the water may be frozen into cakes or blocks of ice.

My invention particularly offers a method of freezing water into thick cakes or blocks of ice at as rapid a rate as that at which very thin pieces of ice are commonly formed.

By the methods at present commonly employed for the formation of artificial ice, heat is withdrawn from water through a solid metallic surface or partition, by the refrigerating agent, and the ice is formed in contact with the said solid metallic surface, or partition, which surface is commonly formed either by the body of a can in which the water to be frozen is contained, or by the exterior of a hollow plate through which is circulated the refrigerating agent. By such methods the ice as it is formed, covers the cooling metallic surface, or partition, so that the heat withdrawn from the water to be frozen, has not only to pass through the said metal partition, but also through the thickness of ice which is formed on the said metal surface or partition, which ice is constantly increasing in thickness as the freezing progresses. The rate of formation of ice by such processes, therefore, continually decreases, as the action progresses, with the result that, for the formation of thick blocks or cakes of ice, long periods of time are required.

It has long been recognized that if the ice formed in contact with a freezing surface, (such as is formed by a hollow plate through which is circulated a refrigerating agent) could be withdrawn periodically, a short distance from the said freezing surface, allowing a thin layer of water to flow in between the ice so formed and the freezing surface, an ice block or cake could be quickly built up, by so freezing the water in successive layers. It is found however that ice formed in contact with a freezing surface, such as may be formed by a hollow metal plate, adheres with great tenacity to the surface, and cannot be withdrawn in any practical manner, except by heating the plate and so melting the surface of the ice in contact with it.

The principal object of my invention is to provide a freezing surface, in contact with which water may be frozen, but to which the ice when formed will not adhere, but can be readily withdrawn. I accomplish this object by using a liquid, to form the freezing or heat conducting surface, and in contact with which, the water is frozen. The liquid so used to form the freezing surface must have qualities which prevent it as far as possible from mixing or combining with the water to be frozen, and it should preferably be a good conductor of heat. Any liquid possessing these qualities to the requisite degree may be employed.

Any metal or mixture of metals which is in a liquid state at the low temperatures employed meets the required conditions very well. I prefer to employ for this purpose, metallic mercury, or quick silver which at the temperatures commonly employed for the artificial formation of ice, is a liquid. If a body of metallic mercury be maintained by any suitable means at a sufficiently low temperature, water may be frozen into ice by being brought into contact with it, and the ice so formed, will not adhere to the mercury but may be readily withdrawn from it, (either by lifting the ice or by lowering the mercury surface) and more water allowed to take its place.

I have hereinafter described practical apparatus for carrying out my invention and have illustrated the same in the accompanying drawings, in which:—

Figure 1 is a vertical section through the center of one form of ice making apparatus embodying my invention. Fig. 2 is a vertical section on the line x—x of Fig. 1 of the same apparatus. Fig. 3 is a side elevation of the same apparatus. Fig. 4 is a vertical section of part of a similar apparatus, showing a modified form of certain parts. Fig. 5 is a sectional view similar to Fig. 4, showing further modification of certain portions of such an apparatus.

The same parts have the same reference numerals in the views shown.

In all the said figures the ice block 9 is shown raised free from the mercury surface, the space between the ice block 9 and the mercury 7 being occupied by water 6^a.

In Figs. 1, 2 and 4 the liquid forming the freezing surface for which I preferably employ mercury is shown sectionally in black for the sake of rendering the drawings clear, as the body of mercury is comparatively thin. In Fig. 5 the same liquid is shown sectionally by heavy broken lines.

As seen in the drawings Fig. 1 and Fig. 2, a hollow plate 1 is provided with pipe connections 2, 3, and 4 by means of which connections, a suitable refrigerating agent is circulated through the plate. This refrigerating agent may be a salt solution cooled by any suitable external means, or it may be liquid or gaseous ammonia, or carbon dioxid or any other suitable refrigerating fluid. As shown in the drawings this refrigerating fluid is supplied to the plate through the center pipe connection 2 and withdrawn from the plate by the pipe connections 3 and 4. The plate 1 is embedded and held in a suitable insulating material, such as cork, as shown at 5, which prevents an undue passage of heat to the plate from underneath. The plate and insulation are held within the shallow tank 6. The insulating material surrounds the plate on all sides and bottom but does not cover the top. The top surface of the insulating material may be as shown, slightly higher than the top surface of the plate 1 and the top surface of both insulating material and plate are preferably level. On top of the plate 1 and the surrounding insulating material, is placed a quantity of the liquid employed to form the freezing surface, for which I prefer to use metallic mercury or quick silver, and in designating this liquid hereinafter I shall term it mercury although it must be understood that I do not limit myself to the use of mercury alone. This mercury 7 completely covers the top surface of both plate and insulation and preferably extends to the walls of the tank 6. It is desirable that the mercury covering the insulation 5 should be in as thin a layer as possible, only enough being used to completely cover the surface of the material 5.

It is now seen that the apparatus so far described for carrying out the method of my invention, provides a tank having its bottom covered with mercury, and a means of withdrawing heat from the mercury which occupies the center portion of the bottom of the tank. If now water be admitted to the tank, and the refrigerating agent circulated through the plate 1, the water lying in contact with the mercury, immediately above the plate 1 will be quickly frozen into ice, while the water around the sides of the tank will not be readily frozen, as heat can only pass from it to the plate 1 through the insulating material 5, which is a bad conductor of heat, or by means of the very thin layer of mercury covering the top of the insulating material 5. Therefore under the above conditions, after a lapse of a short period of time, a layer of ice will be formed on the surface of the center portion of the mercury. If now this layer of ice is by any suitable means lifted a short distance above the mercury, water will flow in between it and the mercury, which water will in turn be frozen, and form with the first layer, a thickened layer or plate of ice. This layer of ice may cover a portion of the mercury surface lying above the insulation 5, but the formation or growth of ice sidewise on the surface of the mercury lying above the insulating material 5, will be comparatively very slow, as the layer of mercury covering the insulating substance 5, is very thin and does not offer a good channel for the rapid transmission of much heat to the plate 1. Consequently the ice layer formed on the surface of the mercury does not have time to spread sidewise to any objectionable extent before it is lifted off the surface and the formation of a new layer begun. This extension of mercury in a very thin layer above the insulating material to the sides of the tank, is an important feature, as it prevents the ice coming in contact with any solid surface, even should it spread sidewise to a considerable extent. It can now be readily seen that this operation of withdrawing the ice from the mercury a short distance, may be repeated periodically, and each time water will flow in on the mercury and be in turn frozen and add to the thickness of the ice previously formed. All that is further required to carry out these repeated operations, is that the tank be supplied with water, and a suitable means be provided, whereby the ice may be periodically lifted from the mercury surface.

Water is supplied to the tank 6, preferably at a number of points around its sides, so that the colder water may not gather at any point around the sides of the tank and freeze. In other words it is desirable to maintain a flow of water from the sides of the tank toward the center all around the tank, and this may be accomplished to a sufficient extent, by supplying the water to the tank at a number of points located around its sides. In the drawings the pipes 8 are indicated as supplying water to the tank.

As shown in the drawings a block of ice 9 has been formed. This block of ice is held between the rollers 10 and 11 and guided at its upper end by the block 13, against which it is pressed by the springs 12. The apparatus shown is provided with four rollers, of which two are shown in Fig. 1. The shaft 14 has one roller mounted at each end, which bears against the ice block, and the shaft 15 has a roller mounted at each end. The shafts 14 and 15 are carried by links 16 and 17 which are hung from the pins 18 and 19. Springs 20 and 21 are caused to bear against the links 16 and 17, their degree of compression being regulated by the hand screws 22 and 23. It can now be seen that the rollers 10 and 11 are pressed against the ice block by the action of the springs 20 and 21 which press against the links 16 and 17; the links being hung freely on the pins 18 and 19. The rollers 11 are provided with sharp teeth which take hold of the ice block, and means are provided for turning the rollers 11 at intervals and so raising the ice block. The rollers 11 are keyed fast to the shaft 15 on which is also keyed a ratchet wheel 24. A lever 25 is mounted loosely on the shaft 15 and is provided with a pawl 26 which engages with the ratchet wheel 24. On the hanger 17 is also mounted a pawl 27 which engages with the ratchet wheel 24. When the lever 25 is moved down, the pawl 26 engages with the wheel 24 and causes the shaft and rollers 11 to make an angular movement, which raises the ice block 9. An angular movement of the rollers 11 and shaft 15 in the opposite direction, being prevented by the pawl 27 engaging with the wheel 24 and so holding the same from moving back. The lever 25 can be operated by hand or by any suitable or convenient mechanical means and by its operation the ice block can be intermittently raised.

As shown in Figs. 1, 2, 4 and 5 the ice block 9 has been raised free from the mercury surface and water has occupied the space between. When this water has been frozen solid to the block 9, the block is again raised a short distance, and the freezing operation repeated. As the ice block is raised it is cut off at the top by any suitable means into pieces of convenient size.

In order to start the operation of the apparatus as described and shown in the drawings, it is intended that a block of any suitable substance, such as wood, metal, or, if desired, ice, be inserted in the apparatus in the position normally occupied by the ice being formed; and as the freezing action is started the first layers of ice are formed on the bottom surface of the block so inserted. The lifting roller 11 will take hold of the block and lift the ice formed off the mercury surface, as the ice formed will adhere to the bottom surface of the said block. This block after sufficient ice has been formed may be detached.

Any suitable means other than the means described can be employed to raise the ice as it is formed, it being only necessary to furnish suitable mechanical devices capable of raising the ice block short distances at frequent intervals.

The upward movement of the ice block is described as intermittent or periodical, which movement is to be preferred, as a comparatively quick upward movement, repeated periodically, allows the water to run in quickly, between the ice formed and the mercury surface before it can be congealed, and when it occupies the space between the mercury and the ice block, time is allowed for it to congeal into ice. However if desired, suitable mechanical means may be provided whereby a continuous upward movement of varying speed may be given to the ice block, so that it may never absolutely come to rest, but may move very slowly upward for a period, allowing the water to freeze below it, and then move quickly upward for a short period, allowing water to run in between it and the mercury surface; but as stated above, I prefer to use an intermittent upward movement or a small upward movement repeated at intervals. The less the magnitude of the movement the more frequently it can be repeated.

The apparatus hereinbefore described and shown in the drawings, Figs. 1, 2, and 3 shows only one form of many by which my invention may be practiced. Any other suitable manner of cooling the mercury may be employed. For instance, as shown in Fig. 4, the mercury is cooled by a refrigerating agent which is passed through the pipes 28 which are placed beneath its surface and which are the substantial equivalent of the hollow plate 1 in Fig. 1.

The mercury or liquid forming the freezing surface may be employed in a thin layer, and no particular provision made for circulating it, as in the forms of apparatus hereinbefore described; or it may be purposely caused to circulate, and part with its heat by being passed in contact with cooling surfaces during its circulation. This is illustrated in the modification shown in Fig. 5, in which provision is made for causing the mercury to circulate. In this modified form of apparatus, a larger body of mercury is employed than in the construction shown in Fig. 1, which mercury is held in a recess, in which are placed a number of pipes 29 shown in section, in which the refrigerating medium is circulated. The pipes 29 are placed in the center of the recess, and preferably, suitable guiding partitions 30 are arranged on each side of the nest of pipes 29. The cooling of the mercury by the pipes 29, together with the action of what heat the mercury will take up from the sides of the recess, will tend to induce a circulation of the mercury in the direction of the arrows shown. Such circulation of the mercury may be increased by any suitable mechanical means if desired. It can further readily be conceived that the mercury may, if desired, be caused to flow through suitable pipes or conductors to an external refrigerator or cooler, where it may be cooled to any desired temperature and then returned to the freezing tank through suitable pipes. A continuous circulation of the mercury from freezing tank to refrigerator, and from refrigerator to freezing tank, may be maintained by any suitable mechanical means, if desired.

In the apparatus shown in the drawings and hereinbefore described the ice is withdrawn from the mercury or liquid forming a freezing surface, by lifting the ice block. It can be readily conceived that the same end can be attained by maintaining the ice block stationary and lowering the mercury freezing surface. Such manner of withdrawing the ice from the freezing surface I do not consider as practical as the manner hereinbefore described, but I wish it to be understood that my invention covers broadly any such modification.

As to the liquid forming the freezing surface, on which the water is congealed I prefer to use metallic mercury alone, but the mercury may be amalgamated to a certain extent, with other metals, and still possess the necessary characteristics which fit it for the purpose described.

In the accompanying claims, the term metallic mercury is intended to cover not only mercury in a pure state, but also any mixture of mercury with other metals which shall retain sufficient fluidity to effect the purpose intended.

Having thus fully described my invention what I claim as new and desire to secure by Letters Patent is:—

1. The process of forming ice which consists in bringing water into direct contact with a liquid of greater specific gravity than the water and reducing the temperature of the said liquid.

2. The process of forming ice which consists in reducing the temperature of a liquid of greater specific gravity than water and with which water will not mix and bringing water into direct contact therewith.

3. The process of forming ice which consists in bringing water into direct contact with a metallic liquid and reducing the temperature of the said metallic liquid.

4. The process of forming ice which consists in bringing water into direct contact with liquid mercury and reducing the temperature of the liquid mercury.

5. The process of forming ice which consists in maintaining a body of liquid mercury at a temperature below that at which water freezes, bringing water into direct contact with the said liquid mercury and withdrawing the ice so formed from the mercury.

6. The process of forming masses of ice in successive layers or accretions by bringing water into direct contact with a freezing liquid, reducing the temperature of the said freezing liquid and introducing water between the ice so formed and the said freezing liquid.

7. The process of forming ice which consists of freezing water on the surface of a body of liquid, separating the ice so formed from the said liquid surface, supplying water to the space between the said ice and the said liquid, and repeating the said operations.

8. The process of forming masses of ice which consists of reducing the temperature of a body of liquid mercury below that at which water freezes, bringing water into contact with the surface of the said body of liquid mercury, withdrawing the ice so formed from the surface of the said mercury and supplying water between the said ice and the said mercury, and repeating the operations of withdrawing the ice and supplying water, while maintaining the temperature of the said body of liquid mercury below the freezing point of water.

9. The process of forming ice which consists in bringing water into direct contact with a liquid of greater specific gravity than water with which it does not mix and which has a lower freezing point than water and reducing the temperature of the said liquid below that at which water freezes, substantially as described.

10. The process of freezing a liquid which consists in bringing it into direct contact with another liquid with which the liquid to be frozen will not mix or diffuse, and which has a lower freezing point than the liquid to be frozen, maintaining the said freezing liquid at a temperature below the freezing point of the liquid to be frozen, and of withdrawing from the freezing liquid the congealed portion of the liquid to be frozen.

In testimony whereof I have affixed my signature, in presence of two witnesses, this twentieth day of April 1905.

GEORGE K. DAVOL.

Witnesses:

L. W. SEELY,

CELESTE ANSELL.