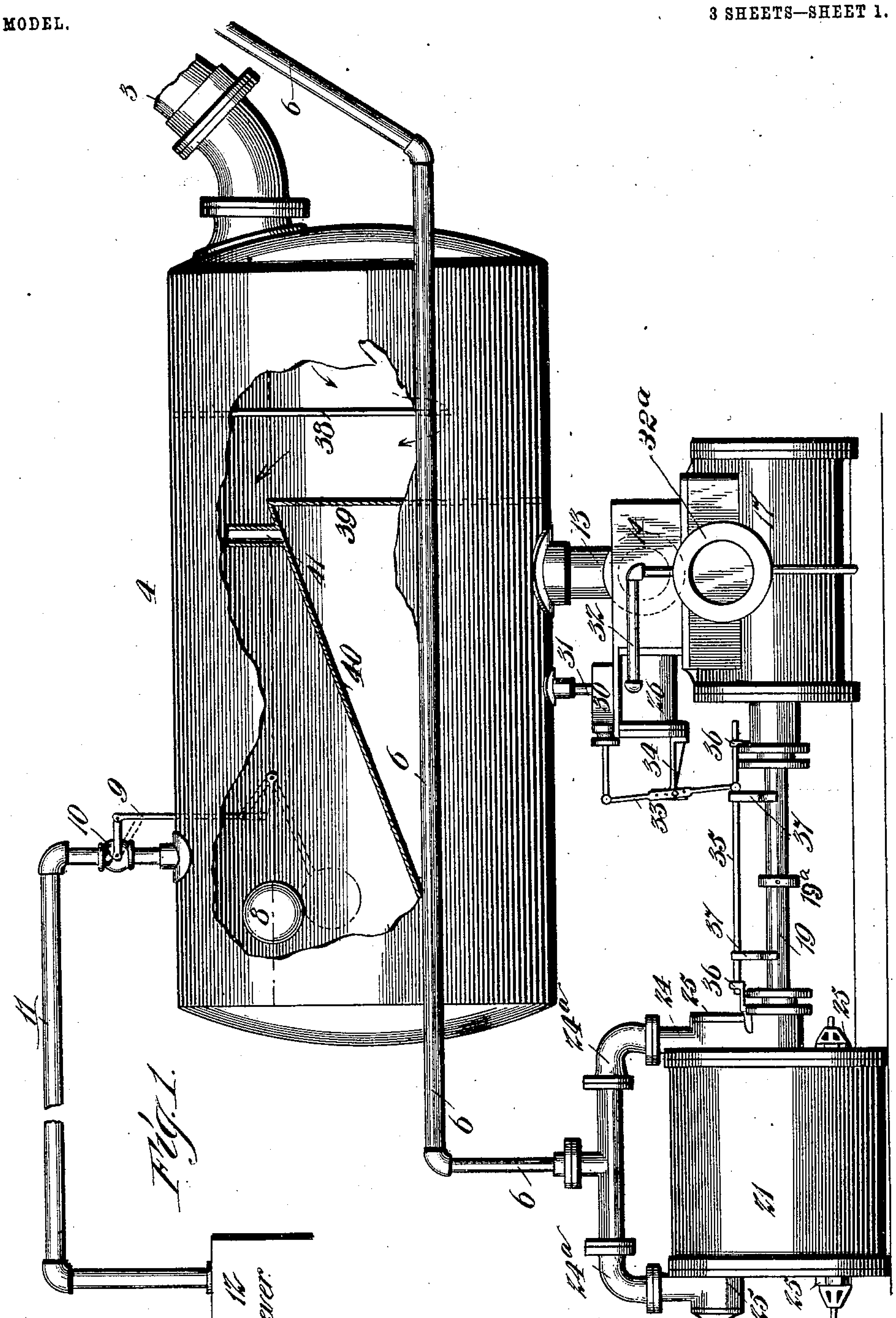
No. 763,239. PATENTED JUNE 21, 1904.

J. H. ALEXANDER.

HYDRAULIC AIR COMPRESSOR.

APPLICATION FILED MAR. 19, 1903.

NO MODEL. 3 SHEETS—SHEET 1.




WITNESSES:

Geo. P. Kingsbury

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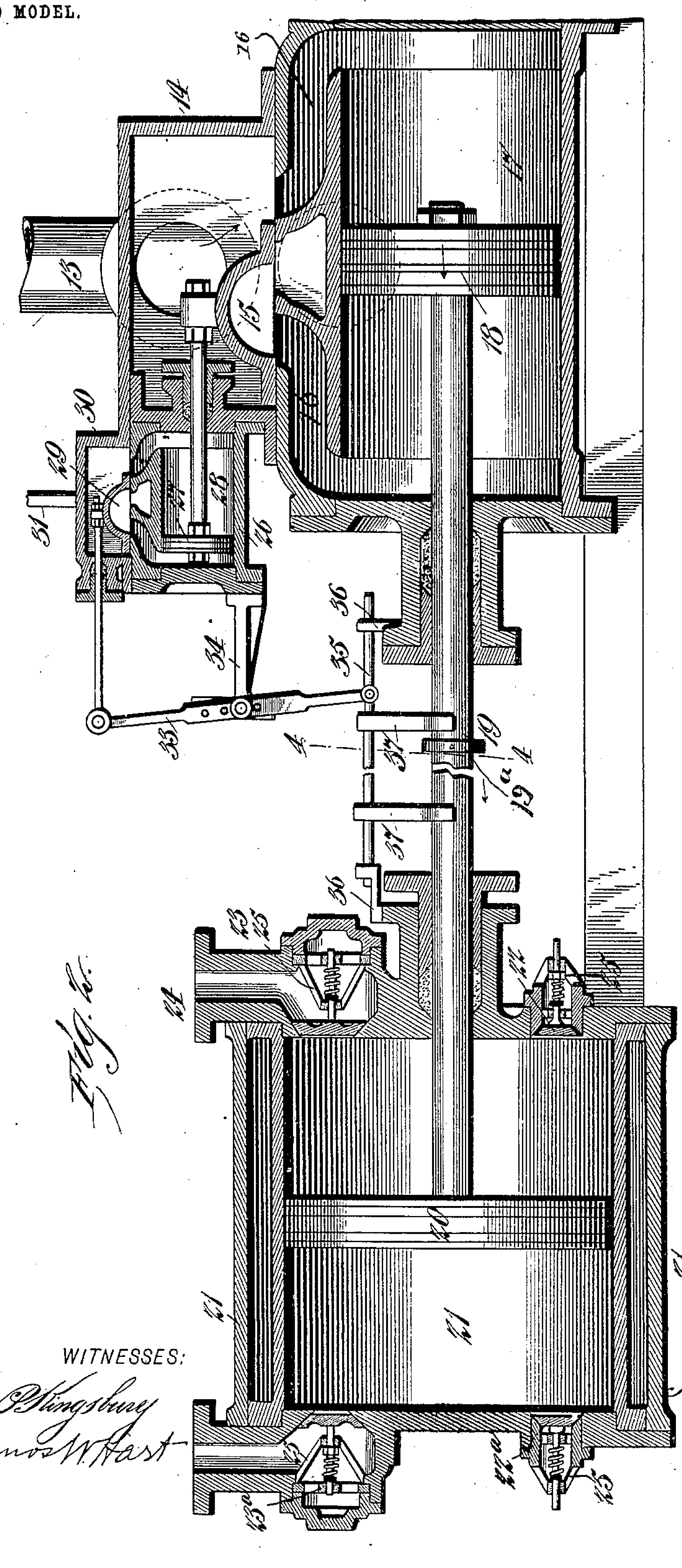

Fig. 2.

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NO MODEL. 3 SHEETS—SHEET 3.

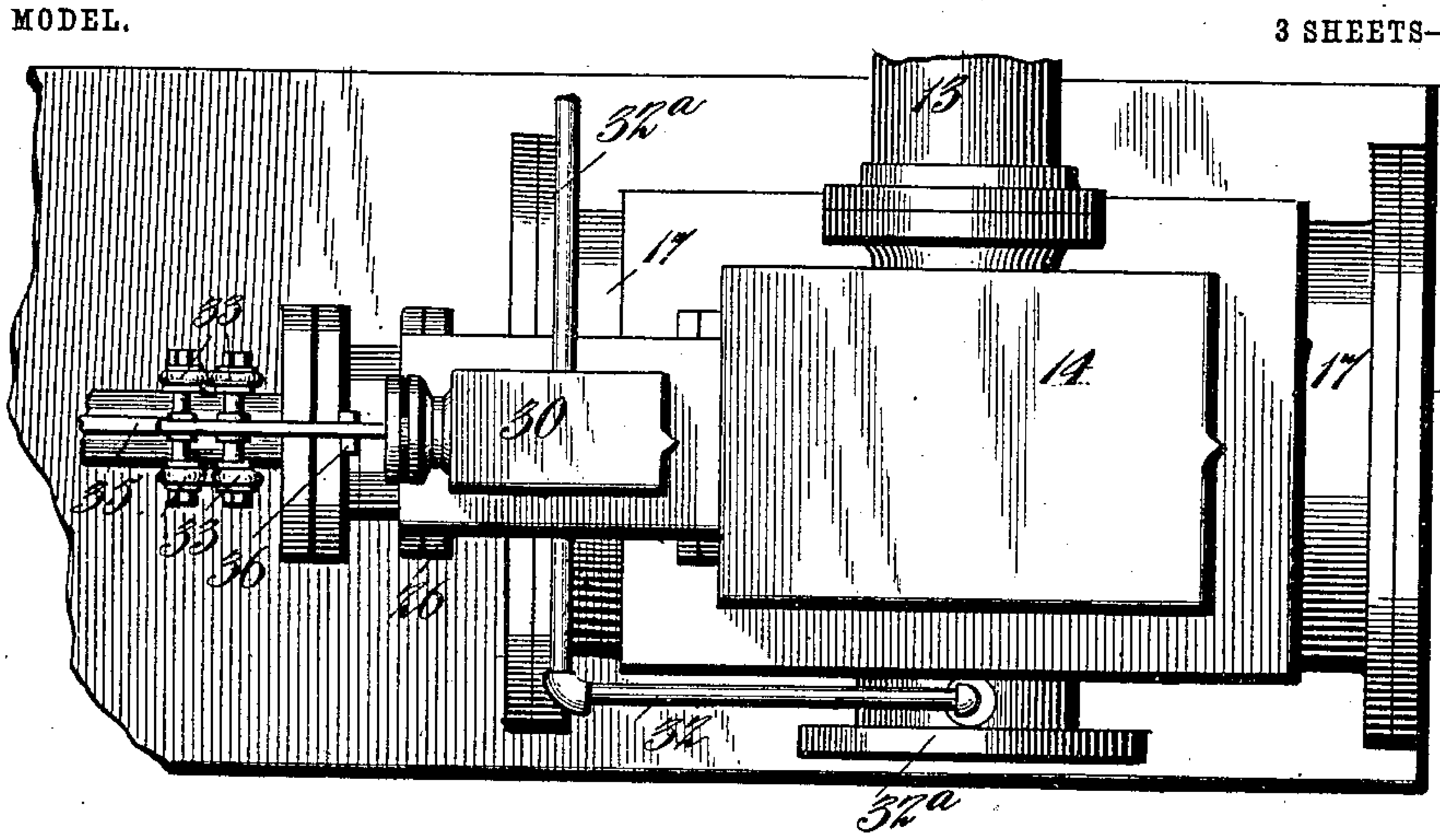

Fig. 3.

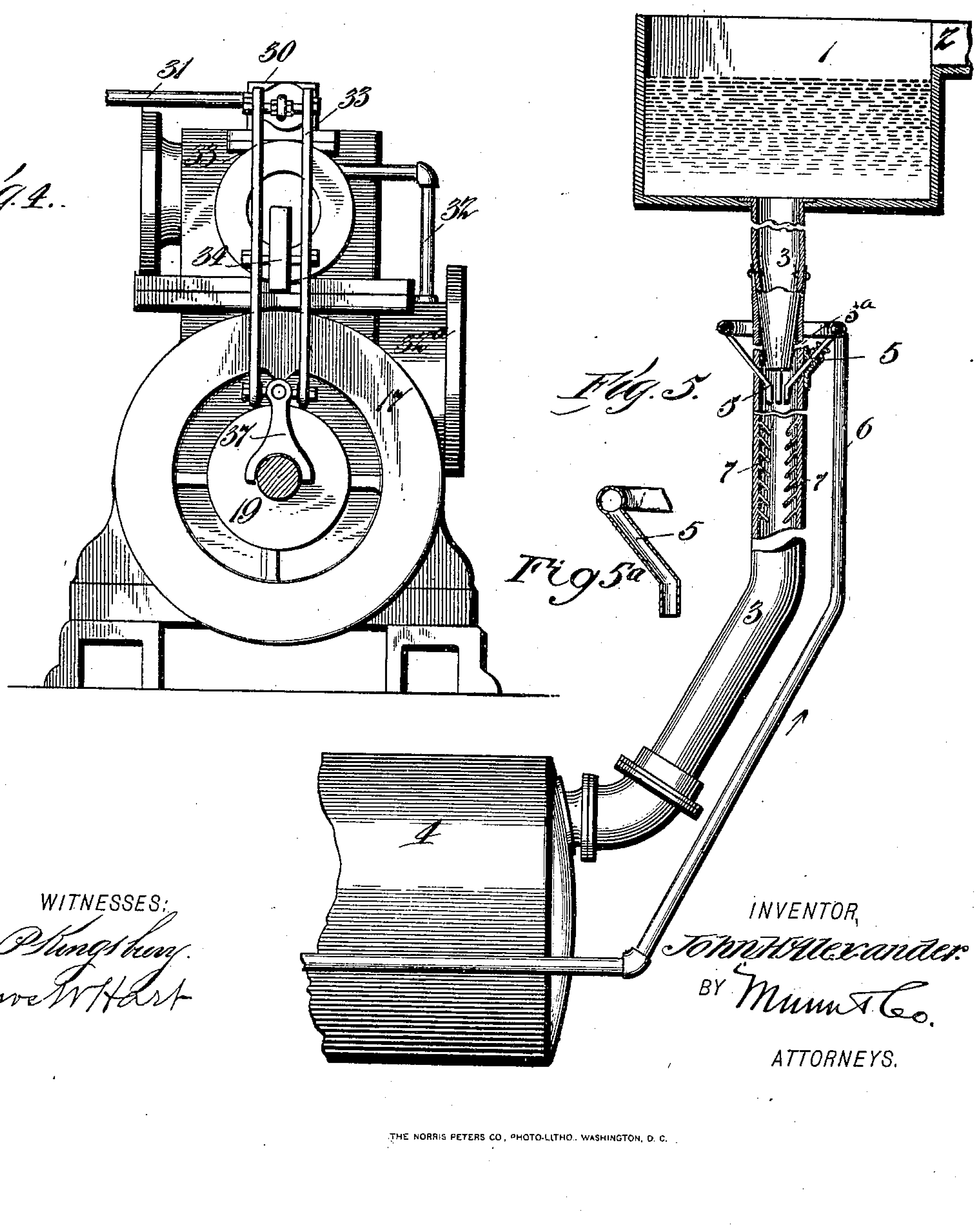

Fig. 4.

Fig. 5.

Fig. 5a

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# UNITED STATES PATENT OFFICE.

JOHN HOMER ALEXANDER, OF YMIR, CANADA, ASSIGNOR OF ONE-HALF TO KENNETH A. ROBERTS, OF VANCOUVER, CANADA, AND SAMUEL L. LONG, OF KELOWNA, CANADA.

## HYDRAULIC AIR-COMPRESSOR.

SPECIFICATION forming part of Letters Patent No. 763,239, dated June 21, 1904.

Application filed March 19, 1903. Serial No. 148,548. (No model.)

*To all whom it may concern:*

Be it known that I, JOHN HOMER ALEXANDER, a citizen of the United States, and a resident of Ymir, British Columbia, Dominion of Canada, have made certain new and useful Improvements in Hydraulic Air-Compressors, of which the following is a specification.

It is the object of my invention to provide an improved apparatus for compressing air wherein a falling column of water is received by an air and water separating tank, which is connected with a hydraulic air-compression apparatus proper whose operation is such that the air compressed by it may be delivered to the same pipe through which the column of water falls, and thus be conveyed into the said separating-tank, whence it is conducted into a storage-tank.

The construction, arrangement, and operation of the several parts comprising my apparatus are as hereinafter described, and illustrated in accompanying drawings, in which—

Figure 1 is a side elevation, part being broken away, of the main portion of the apparatus embodying my improvement. Fig. 2 is a central longitudinal and vertical section of the automatic hydraulic air-compressor connected with the separating-tank. Fig. 3 is a plan view of the portion of the apparatus shown in Fig. 2. Fig. 4 is a vertical section on the line 4 4 of Fig. 2. Fig. 5 is in part a side elevation and in part a section of the primary air-compressing apparatus. Fig. 5$^a$ is a detail section of an air-discharge pipe and nozzle therefor.

As shown in Fig. 5, water is received into a tank 1 by means of the flume 2 and passes thence downward into a pipe 3, by which it is conveyed into the separating-tank 4. (See also Fig. 1.) In this downward passage the water draws in air by induction through lateral openings 3$^a$ in pipe 3 and also through the nozzles 5, (see Fig. 5$^a$,) forming an attachment of an air-pipe 6, which is connected with the hydraulic and automatic air-compressing mechanism to be presently described. Downwardly-projecting flanges or plates 7 (see Fig. 5) are provided in the pipe 3, the same serving to keep air and water from separating in their downward flow. When the water flowing into the tank 4 has risen to a sufficient height therein, it raises a float 8, which through lever connections 9 closes a valve 10 in the air-pipe 11, leading to a storage-tank 12. The water is prevented rising above a certain level by the operation of the float 8—that is to say, when the water rises high enough in the separating-tank 4 the float also rises, and by its described connection with valve 10 the latter is closed, so that escape of air from tank is cut off. Thus air is confined in the tank until it gains sufficient volume to lower by its elastic pressure the level of the water in the tank, whereupon the float 8 being also lowered the valve 10 is again opened, so that air flows through pipe 11 in receiver 12. In brief, whenever the water rises to a certain height in the tank 4 and the pressure of the air confined therein is thereby made sufficient water is expelled or forced through pendent pipe 13 into the water-cylinder 17 and operates the piston 18 therein. It is apparent that the pressure of air and water within the tank 4 will depend upon the head and volume of water received from tank 1 through pipe 3. The automatic hydraulic air-compressing engine before referred to is connected with the tank 4 by means of a pipe 13. (See Figs. 1 and 2.) Said pipe 13 connects with a chest 14, in which a large D-valve 15 is adapted to slide, the same controlling side ports 16, as usual in steam-engines. Automatic mechanism is provided for shifting this valve 15, as will be presently described. Within the cylinder 17 is arranged a piston 18, which is connected by a rod 19 with a piston 20 in a larger cylinder 21. The latter is provided with air-inlet valves 22 22$^a$ in its lower portion and with air-outlet valves 23 23$^a$ in its upper portion. The valves 23 23$^a$ are seated in ports or passages 24, that communicate with pipes 24$^a$, (see Fig. 1,) connecting with the air-pipe 6, before referred to, and which is in communication with the compression-pipe 3. (See Fig. 5.) As shown in Fig. 2, water is being received through pipe 13 from tank 4 on the right-hand side of the hydraulic piston 18, and the latter and the air-piston 20 are consequently moved to the left, so that air between the piston 20 and the left-hand end of cylinder 21 is being forced out past the valve 23[a], and thus into the pipe 6, by which it is conducted to nozzles 5, arranged in the water-conducting pipe 3. It will be seen that the air thus compressed in the cylinder 21 and conducted into pipe 3 must be delivered at a point where the water-pressure in said pipe 3 is somewhat less than the air-pressure in cylinder 21. The air thus delivered by nozzles 5 is carried down by the falling column of water into the tank 4, and thus finally finds its way through pipe 11 to the storage-tank 12. For example, if we have a three-hundred-foot head of water the air taken in by the compressor-pipe 3 and carried down therein will be compressed to eighty pounds, and consequently the water discharged from the separating-tank 4 will be under similar pressure, which will be transferred to the piston 18 of the hydraulic cylinder 17. Say that the piston 18 is fourteen inches in diameter and the area of the air-piston 20 much greater. A pressure of thirty-five pounds may be secured in the air-cylinder 21, and the air forced out of it through the pipe 6 and delivered in the compressor-pipe 3 will be practically at this pressure. A pressure of eighty pounds to the square inch is found sufficient for practical mining purposes, such as running machine drills, hoists, pumps, and so on.

To further illustrate the invention, I will state that in practice the air-cylinder 21 has about two and one-fourth times the capacity of the water-cylinder 17, so that if there be eighty pounds pressure to the square inch on the piston 18 of the latter there will be about thirty-five pounds in the piston 20 of the air-cylinder. The air forced through pipe 6 into compressor-pipe 3 enters the latter at a point where water-pressure therein is somewhat less than the air-pressure from air-cylinder 21. The air thus delivered into pipe 3 and carried down by the falling body of water is compressed to eighty pounds in the tank 4. By this means a greater efficiency or power is secured than would be practicable by applying the full pressure of water to piston 18 and compressing air to eighty pounds by piston 20. For example, if one hundred cubic feet of water be used per minute under a three-hundred-foot head and air be compressed to eighty pounds by means of piston there would be about one hundred and sixty cubic feet of water compressed per minute, whereas by compressing air by direct flow of water, as in my system, I am able to compress about two hundred and twenty-five cubic feet of air to eighty pounds with a three-hundred-foot head of water. The several air inlet and outlet valves 22 22[a] and 23 23[a], before described, are represented as beveled and having corresponding seats, one set opening inward and the other outward. The stems of the several valves are guided in spiders 25 and encircled by spiral springs which hold the valves normally seated. It is apparent that when the piston 20 reciprocates an air-inlet valve—say 22—is opened on one side and an air-outlet valve 23[a] is opened on the other side, and vice versa. Thus air is alternately taken into and expelled from the space formed on each side of the piston 20 as it reciprocates.

The automatic means for shifting the slide-valve 15 of the hydraulic cylinder 17 are as follows: A small cylinder 26 is attached to and alined with one end of the chest 14, (see Figs. 1, 2, 3,) and a small piston 27 is arranged therein and connected by a rod 28 with the D-valve 15. A small D-valve 29 is arranged in the chest 30 of such cylinder 26, and water is received in such chest 30 by a pipe 31, that communicates with the tank 4. (See Fig. 1.) Exhaust of the small cylinder 26 is provided for by a pipe 32, (see Figs. 1, 3, 4,) which communicates with the exhaust 32[a] of the hydraulic cylinder 17. The small slide-valve 29 is operated by tappet mechanism, consisting of a rod, parallel levers 33, which are fulcrumed centrally on a bracket 34, forming a fixed attachment of the small cylinder 26, also a slidable rod 35, working in fixed guides 36, forming attachments of the two cylinders 17 and 21, the said rod 35 being reciprocated by tappets 37, (see Fig. 2,) attached to the piston-rod 19 and which alternately come in contact with a collar 19[a], secured on said rod midway between the two cylinders.

The hydraulic piston 18 is moving to the left, as shown in Fig. 2, and when it reaches the limit of its stroke in that direction the rod 35 will be moved also to the left, and thereby the small D-valve in chest 30 will be shifted to the right, which will open the left-hand port in the cylinder 26 and allow water to enter on the left-hand side of the piston 27, whose pressure being practically the same as that in the tank 4 will force the piston 27 to the right, and thereby cause the valve 15 of the hydraulic cylinder to shift in the same direction, thus opening the left-hand port of the hydraulic cylinder 17. The water thus admitted on the left-hand side of piston 18 will force the latter to the right, and consequently the piston 20 of air-cylinder 21 will move in the same direction, and air will be forced out of said cylinder past valve 23 and taken in on the other side of the piston 20 through the valve 22[a]. When the piston 18 reaches the limit of its stroke to the right, the tappet mechanism will reverse the small slide-valve 29, and the piston 27 will then move to the left, and the slide-valve 15 will be drawn to the same position, (shown in Fig. 2,) when the two pistons 18 and 20 will again move to the left, and so the operation goes on automatically so long as water is received in due volume and at due pressure in the tank 4.

While I have described the hydraulic air-compressing apparatus (shown in Fig. 2) as an attachment of the tank 4 and primary air-compressing pipe 3, it is apparent that it may be connected through pipe 13 directly with a pipe extending directly to the tank 1 or any other source of water-supply which is at due elevation.

Referring now especially to Fig. 1, 38 indicates a vertical pendent partition arranged in the tank 4 at a short distance from its water-receiving end. The same extends about two-thirds of the distance from the top to the bottom of the tank. Consequently the water received in the latter must pass under it, as indicated by arrows. Another vertical partition or baffle-plate 39 is arranged nearer the center of the tank and joined to the wall of the tank, so that no water can pass it save over its top, between which and the top of the tank there is a considerable space. A third partition or baffle-plate 40 is arranged at an angle of forty-five degrees and joined to the top of the partition 39. Its lower end is separated from the left-hand end of the tank. An air-vent or escape-pipe 41 is attached to the partition 40 at a point adjacent to its junction with the vertical partition 39. The water passing under the first-named baffle-plate 38 flows over the vertical partition 39 and thence under the lower end of the inclined partition 40 and passes back beneath the latter to the depending pipe 13. In further explanation of this portion of my invention I will state that the purpose or function of the inclined partition 40 is to cause the water to flow the length of the tank 4, by which the air held mechanically in such water has better opportunity to separate, while such quantity of air as may be carried under the partition 40 and separates in the angular space below it will escape through tube 41 into the air-space above.

What I claim is—

1. The combination in an air-compressing apparatus of a pipe for conducting a falling column of water under due pressure, and having an outlet to atmosphere, a separating-tank into which said pipe discharges, a storage-tank and a supplemental air-compressing mechanism, comprising a hydraulic cylinder having a piston arranged for operation by the water discharged under pressure from the separating-tank, an air cylinder and piston, the air-piston being connected with said piston of the hydraulic cylinder for operation thereby, and a pipe 6 connecting the supplemental air-compressing mechanism and the said vertical pipe leading to the separating-tank, whereby the air compressed by said supplemental mechanism is conveyed into said pipe 6 and thus into the separating-tank substantially as shown and described.

2. In an air-compressing apparatus, the combination with a separating-tank, of a water-inlet pipe, and air-storage tank connected with the respective ends of said separating-tank, the latter having a vertical partition pendent from the top and separated from the bottom thereof, and an angular partition whose vertical part is attached to the bottom of the tank and left free at the top for passage of water, the inclined portion of the partition extending downward but left free from both top and bottom of the tank and having an air-vent at its angle as shown and described.

3. In an air-compressing apparatus, the combination of a pipe for conducting a flowing column of water under pressure, a separating-tank into which said pipe discharges, an air-compressing mechanism connected with said separating-tank, and having movable parts arranged for operation by the water descending from the separating-tank, and an air-discharge pipe leading from said air-compressing mechanism to the pipe in which water flows to the separating-tank, as described.

4. The combination of a pipe for conducting a flowing column of water, a separating-tank into which said pipe discharges, a hydraulic apparatus having a piston arranged for operation by the water discharged from the separating-tank, whose air-compressing piston is connected with the first-named piston for operation thereby, a pipe connecting such air-compressor with the first-named pipe, and a storage-tank connected with said separating-tank, all arranged and operating substantially as described.

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