No. 871,626. PATENTED NOV. 19, 1907.

E. C. POLLARD.

TURBINE AIR COMPRESSOR.

APPLICATION FILED JULY 20, 1906.

2 SHEETS—SHEET 1.

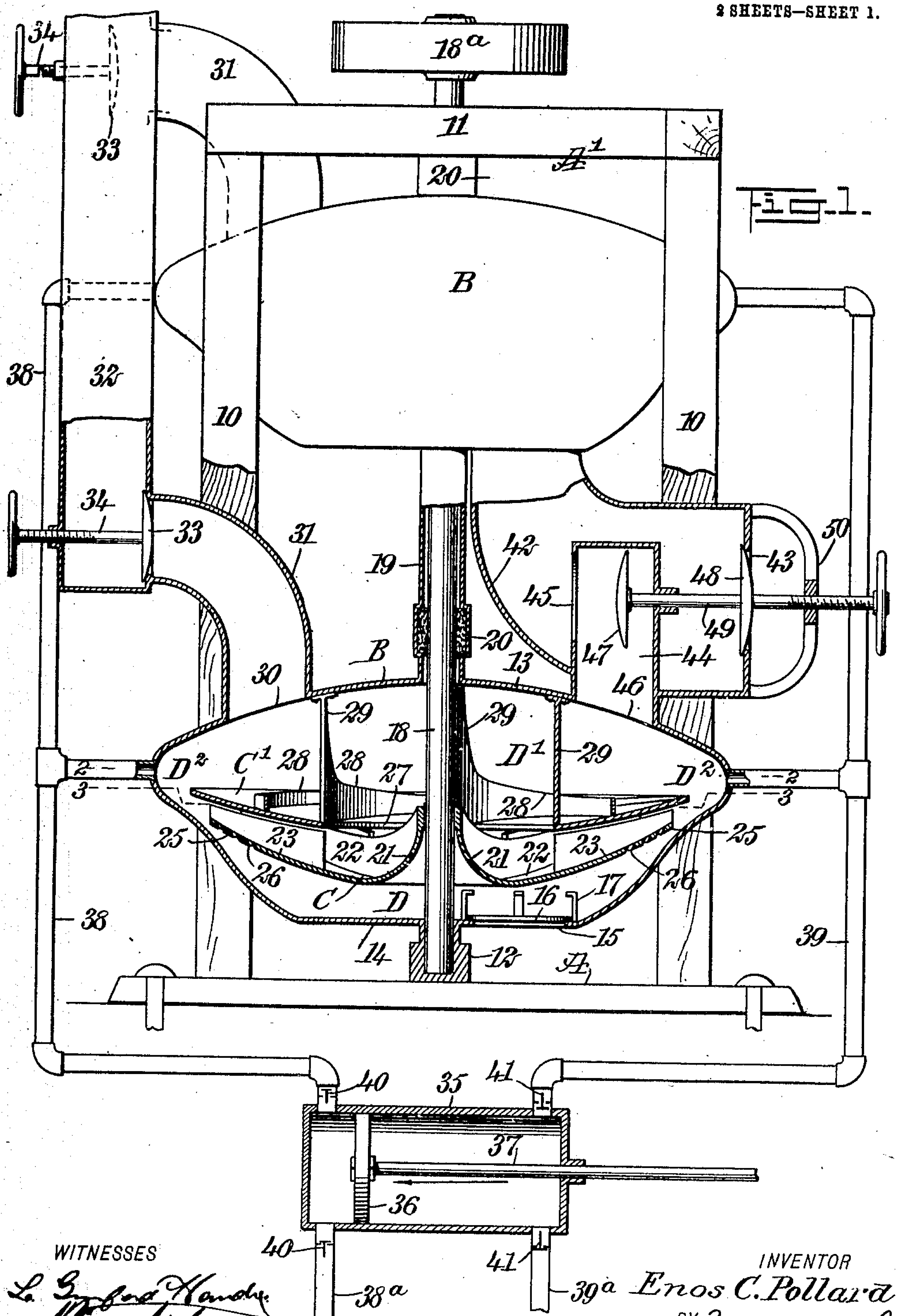

Fig. 1.

WITNESSES

40 41

38a 39a

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2 SHEETS—SHEET 2.

FIG. 2.

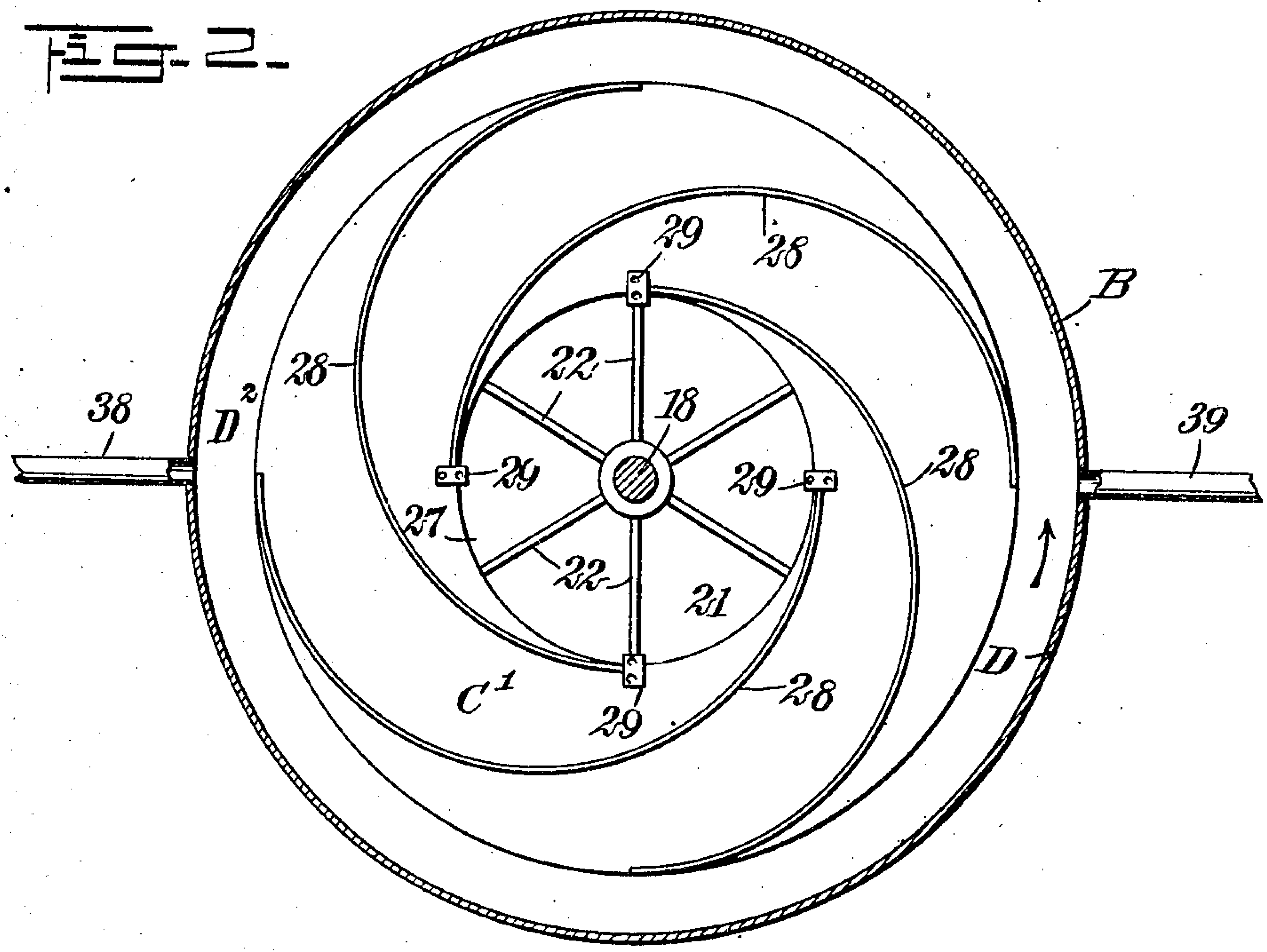
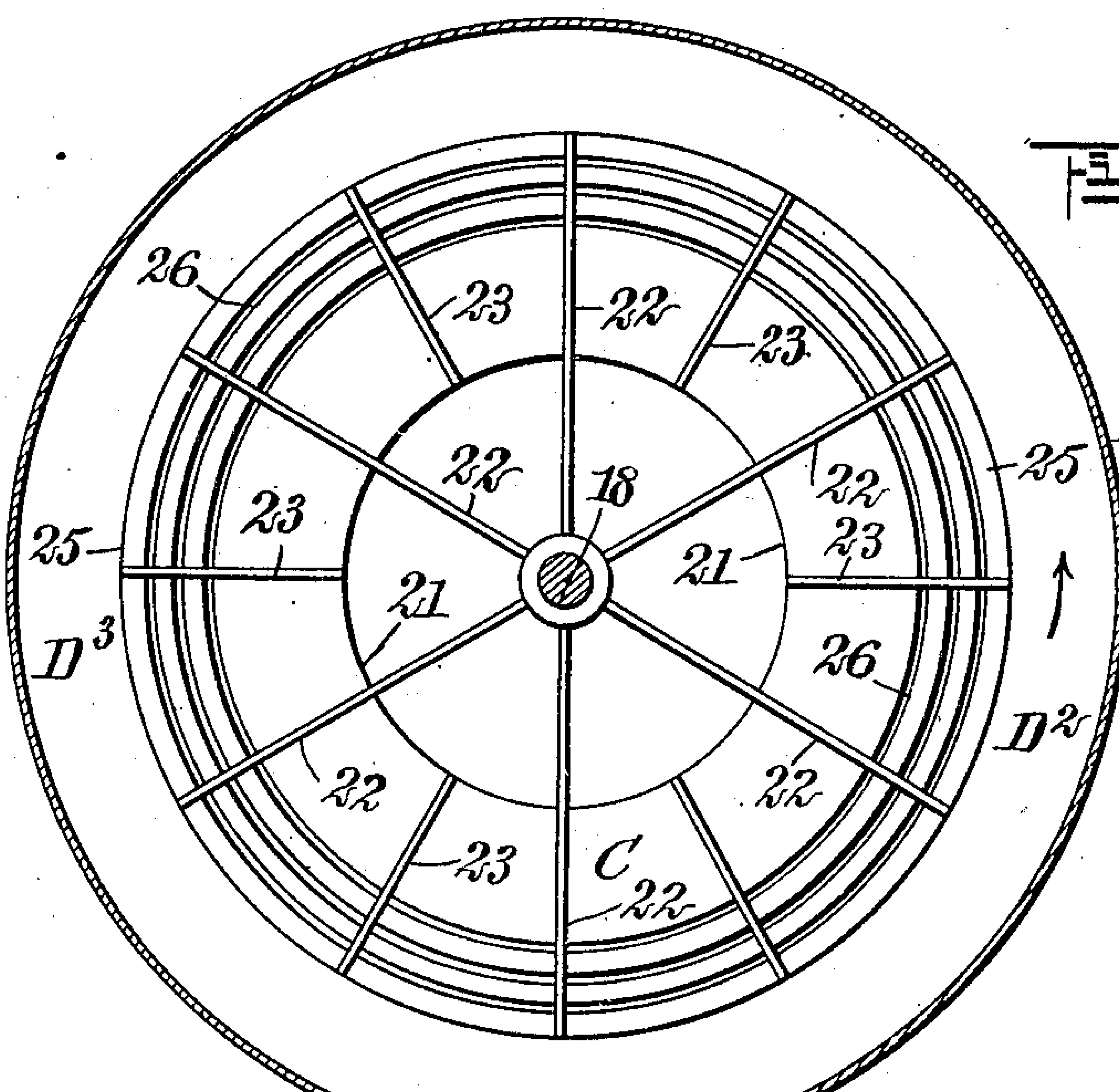


FIG. 3.



WITNESSES

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ENOS CAMPBELL POLLARD, OF SEATTLE, WASHINGTON.

TURBINE AIR-COMPRESSOR.

No. 871,626. Specification of Letters Patent. Patented Nov. 19, 1907.

Application filed July 20, 1906. Serial No. 327,022.

To all whom it may concern:

Be it known that I, ENOS CAMPBELL POLLARD, a citizen of the United States, and a resident of Seattle, in the county of King and State of Washington, have invented a new and Improved Turbine Air-Compressor, of which the following is a full, clear, and exact description.

The purpose of the invention is to provide a turbine or rotary air compressor which will develop moderately high pressure at practicable speeds and in so doing will draw air from the atmosphere by the use of the "trompe" principle, and compress it by the centrifugal force of a revolving mass of water, which being some eight-hundred times heavier than air will produce a proportionately greater degree of compression than a centrifugal blower wherein air alone is used.

The invention consists in the novel construction and combination of the several parts, as will be hereinafter fully set forth and pointed out in the claims.

Reference is to be had to the accompanying drawings forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the figures.

Figure 1 is a sectional side elevation of the improved turbine air compressor; Fig. 2 is a horizontal section taken practically on the line 2—2 of Fig. 1; and Fig. 3 is a horizontal section taken substantially on the line 3—3 of Fig. 1.

A represents a base or support of any character upon which a cage A′ is erected, or an equivalent thereof, said cage being made up of vertical timbers 10 and cross timbers 11. Within this cage one or more compressing vessels B are located, one above the other. Said vessels are connected and may be used collectively or individually as occasion may demand, being used collectively when multiple stages of compression are required.

The lowermost compressing vessel B is shown supported on the base A by a block 12 or its equivalent, located at its central portion, and the upper compressing vessels B may be entirely or partially supported by the timbers of the cage A′. Each compressing vessel B is of the same construction; each is circular in plan view and is provided with an arched or dome top 13 and with a dished bottom 14 as is shown in Fig. 1. In the dished bottom 14 of each of the compressing vessels B an opening 15 is produced for the admission of atmospheric air. The opening 15 in the lower compressing vessel B is closed by a disk valve 16 located within the vessel and operating between surrounding guides 17 as is shown in Fig. 1.

A shaft 18 is passed centrally through each of the compressing vessels B, being mounted to turn at its lower end in the block 12, for example, and in a suitable support at its upper end; and the said shaft 18 is provided with a pulley 18[a], adapted to be belted to any source of power. The various compressing vessels B are connected at their central portions by a casing 19 through which the shaft 18 passes, but communication is prevented through said casings 19 between the compressing vessels B by locating stuffing boxes 20 in the said casings around the shaft 18 and at a point slightly above the upper or dome portion 13 of the said vessels as is also shown in Fig. 1.

A rotor C is located within a compressing vessel B at its dished or bottom portion; and a suitable space intervenes between the bottom of the rotor and the bottom of the vessel. This rotor C consists of a circular plate having its under face more or less convexed and its upper face more or less concaved; and at the central portion of said rotor an upwardly-extending conical hub section is formed, whereby to attach the said rotor to the said shaft 18. The outer face of the said conical hub 21 is decidedly concaved, to form practically a deep annular central pocket, as is shown in Figs. 1 and 3.

Radial vanes are secured upon the upper face of the plate forming the said rotor C, and said vanes are in two lengths alternately arranged, the longer vanes 22 extending from the hub section 21 outward to the periphery of the rotor, while the other vanes 23 extend from the base of the hub section 21 to the periphery of the said rotor as is clearly shown in Fig. 3. The outer end portions of said vanes 22 and 23 serve to support a series of rings 25, which form the outer edge portion of said rotor, and the upper faces of the said rings are concaved more or less to constitute a continuation of the concaved upper face of the main or body portion of the rotor as clearly shown in Fig. 1. The spaces 26 between said rings 25 and the innermost ring and the body of the rotor serve as ducts for the passage of air from the lower chamber of the vessel to be hereinafter particularly referred to. A director plate C′ is located above the rotor C, and the bottom of said director plate is convexed and its upper face concaved, and the director plate is brought as near as convenient to the rotor without bringing the two parts in contact. The director plate is provided with a central opening 27 through which the hub portion of the rotor extends, and the upper face of the director plate C′ is provided with a series of spiral vanes 28, which vanes extend from the periphery of the said plate C′ to the central opening 27; and the vanes 28 increase more or less in depth as they approach the opening 27. At the inner end of each vane a vertical extension 29 is formed, and said extensions are carried upward and are secured in any suitable or approved manner to the under face of the top portion of the vessel B, as is also shown in Fig. 1. It will thus be observed that the rotor C turns with the shaft 18, while the vessel B in which it is located, and the director plate C′ are stationary. The director plate and rotor of a vessel B divides it into a lower chamber D, an upper chamber D′ and a vortex chamber D^2 at the wider portion of the vessel, or at a point just above the director plate. A space intervenes between the director plate and the rotor and the side portion of the vessel, and a space likewise intervenes between the bottom of the rotor throughout its entire diameter and the bottom portion of the vessel as is clearly shown in Fig. 1.

Each vessel B is provided with an opening 30 at its upper portion near one side, and a pipe 31 is led from said opening 30 to a communication with a service main 32, adapted to conduct the compressed air wherever needed; and each opening in the main 32 where the conducting pipe connects therewith can be closed by a valve 33. Each valve 33 is secured upon an independent stem 34, which extends out through the service main 32 and is exteriorly operated.

In the operation of the compressor, the vessels B are filled with water to about the bottom portion of the director plate, and as the shaft 18 is rapidly rotated turning the rotor C in the direction indicated by the arrows in Figs. 2 and 3, the centrifugal motion of the rotor draws up the water on to its upper face and in connection with its vanes, and the water in passing off over at the peripheral portion of the said rotor serves to create such suction at the spaces 26 as to open the valve 16 and draw in air from the atmosphere, which air is compressed by the action of the water and finds its way into the upper chamber D′, which is adapted to contain the compressed air, and the air passes from said chamber through the conducting pipe 31 to the service main 32, the valve 33 having been opened; and the water, as the rotor revolves, will whirl over upon the directing plate C′ and will be directed by the spiral vanes 28 to the opening 27 in the said director plate, through which the water will fall into the pockets at the central portion of the compressing vessel with comparatively no shock.

In connection with the compressing vessel B a pump is employed, shown in Fig. 1, the cylinder 35 whereof is equal at either end of its stroke. This cylinder is provided with a suitable piston 36 and attached rod 37, operated in any suitable or approved manner, and a pipe 38 is connected with the vortex chamber D^2 of the vessel at one side, and is connected with the upper portion of the pump cylinder at one end; and at the same end a pipe 38^a is connected with the cylinder, which pipe extends from its bottom to any source of water supply. Another pipe 39 is connected with the vortex chamber D^2 of the vessel at the side opposite to that at which the pipe 38 enters, and said pipe 39 is connected with the upper portion of the cylinder 35 at its opposite end, while another pipe 39^a extends downward from the same end of the cylinder 35, which latter pipe is a discharge or waste pipe. The pipes 38 and 38^a, which are supply pipes, are each provided with a valve 40 opening in an upward direction; and the two discharge pipes 39 and 39^a are provided with valves 41 opening in a downward direction. In the operation of this portion of the mechanism, when the piston is operating in the direction of the arrow shown in Fig. 1, the warm water will be drawn out from the vessel through the pipe 39 and will be delivered into the cylinder at the back of the piston, and the piston when traveling in such direction will force up the cold water through the pipe 38 into the vessel B, thus giving it a fresh supply; and at the rearward stroke of the piston 36 fresh water will be drawn up through the pipe 38^a to be forced into the pipe 38 at the next forward stroke of the piston, and said piston also at its rearward stroke will force the warm water back of it in the cylinder out therefrom through the waste pipe 39^a. Thus at intervals the warm water is withdrawn from a vessel B and fresh water is simultaneously supplied, so that the supply of water is always adequate.

Each upper compressing vessel B has its air inlet surrounded by a trunk 42, which extends out preferably beyond the cage A′, and is provided with an opening 43 at its outer end for the admission of air. Within this trunk a casing 44 extends from the opening 46 in the top of the next lower vessel, which casing 44 is provided with an opening 45 in that side which faces the outlet of the trunk, as shown in Fig. 1. Two valves 47 and 48 operate relatively to the openings 43 and 45. These valves have their working surfaces faced in opposite directions and are mounted on the same stem 49, which stem has guided movement in the casing 44 and in a bracket

50 secured to the outer end of the said trunk. When the valve 48 closes the opening 43 the valve 47 uncovers the opening 45, as shown in Fig. 1, and the reverse is also true. When the latter-named parts are in the position shown in Fig. 1, the compressed air from the lower vessel B will pass up through the trunk into the upper vessel, the valve 33 being closed, and the air compressed in the lower vessel will be further compressed in the upper vessel.

It will be observed that the same volume of air in the above named operation is preserved throughout the entire system, the air as finally compressed being delivered to the service main 32. If, however, it is desired to increase the volume of air and preserve the same pressure, the valves 47 are closed, thus shutting off communication between one vessel and the other and establishing communication between each individual vessel and the outside atmosphere, and the valves 33 are opened, so that each vessel acts independently, and each vessel delivers its supply of compressed air to the service main.

Where the number of units or compressing vessels B are coupled to the same shaft 18 they may be coupled to the same service pipe or main 32 in multiple or in any desired series. Thus with three units they may be coupled to use one, two or three volumes with three, one-and-a-half or one pressures respectively. This range of action adds much to the adaptability of the device to general purposes, and renders it unnecessary to design and manufacture an especial machine for each special purpose.

This device may be used to produce pressures which are negative with reference to that of the atmosphere as well as for those which are positive, it being only necessary to connect the chamber D with a receiver instead of with the atmosphere when a venturi vacuum will be produced and maintained with an economy of power and smoothness of action difficult to approximate with any other form of air pump. Applied to the condenser of a steam engine the device becomes especially effective, rapidly exhausting the air together with any excess of vapor left by the condensing jets, which excess is immediately condensed in the working water of the machine.

A more detail explanation of the application of the device may be set forth as follows: In practice, as has been stated, the vessel B in use is filled with water to about the bottom of the director plate C′, and the rotor C is rapidly revolved in direction of the arrows. The water is rapidly drawn from the chamber D and air takes its place through the valve 15. The vanes 22 and 23 force the water in a radial direction across the upper face of the annular air ducts 26 and draw in air from the chamber D on the principle of the "trompe". After the water has been expelled by centrifugal force from the rotor C the water is allowed to rotate freely in the vortex chamber D^2 until the same is filled, whereupon the water must slip over the edge of the director plate C′, where continuing its circular motion it presses against the concaved sides of the vanes 28 and is directed into the circular opening 27 in said plate C′, where it meets the uprights 29 without shock, which uprights also serve as vanes. The sudden change of direction in the flow of water in the vortex chamber D^2 produces a compression strain in the volume of the water, which being rigid transfers the strain to the confined air, which is thereby compressed; and as the water passes over the director plate C′ the air is freed into the chamber D′, in which chamber the pressure increases until it reaches that of the head of water due to its centrifugal velocity. It is evident that this pressure will exceed that which would be due to air alone when used as a working fluid in the same device and at the same speed in the ratio of the weight of water to the weight of air, which is 813 to 1. Thus, if a given speed produces a pressure of one ounce above the atmosphere when run by air alone, by using water as a working fluid a pressure of fifty pounds and thirteen ounces would be obtained, less the loss by the difference in friction of the two fluids, while the power consumed in maintaining the velocity would be eight-hundred and thirteen times as great. By the use of a heavier liquid, for example, mercury, as a working fluid, the pressure may be still further increased in proportion to the specific gravity of the liquid and corresponding increase of power. This power is expended in compressing the air and develops a heat which is absorbed in the water or other liquid as soon as developed. In order to render the compression entirely isothermal it is therefore necessary to change the water continuously. This is most readily effected by pumping the heated water out from the vessel and pumping in an equal quantity of cold water, and this is accomplished by the use of the pump shown in Fig. 1, the details of which have been described.

Among the advantages claimed for this machine over other air compressors of which I have knowledge, may be mentioned the following: Compared with centrifugal fans, or other forms of frictionless rotary blowers, the improved device produces approximately greater pressure at the same rotary speed, and is therefore capable of performing a much wider range of duties. Compared with reciprocal compressors, the improved machine is lighter, more economic in construction, and it can be coupled directly to the shaft of a rotary motor, or for example a steam turbine, or an electric or water motor. Again, there is less friction and vibration, hence less loss of power, less wear and tear and less lubrication is needed. Furthermore, perfect isothermal compression is obtained, while reciprocating compressors require frequent steps with inter-cooling to even approximate the results obtained by the improvement. Another advantage consists in the hygienic effect of the air when released in mines or in closed buildings. The compressed air from reciprocating machines is charged with odors and vapors from the oil used in lubricating the pistons sometimes to such an extent as to cause explosions in the pipes. My improved device is free from these objections because no oil is used in direct contact with the air, and none at all except in the stuffing boxes and trunnions. Furthermore, the air is washed during compression, so as to be freed from dust, etc., and leaves the compressor purer than when it entered. This construction suggests the use of the device for which there is no counterpart in other compressors, and that is for ventilating sanitariums or other buildings which may be densely inhabited.

It will be noticed that when the device is working against atmospheric pressure only in the chamber D′, the device consumes no more power than a centrifugal fan. Air can thus economically be drawn from the outside atmosphere, washed of its dust and poisonous gases and perhaps of many disease germs, and delivered to the building in an absolutely pure state.

In winter the working water may be heated by exhaust gases or other means, and in summer it may be cooled by ice or refrigeration to such a degree in either case as to give to the air of the rooms the desired temperature without the use of other means for heating or cooling. Chemicals may be dissolved in the working water, which will completely sterilize the air admitted to the building, while essential oils and other ozone-producing germicidal drugs may be added, which will destroy any infection resident in the building or emanating from a patient within the building. Another unique advantage of this machine is its great range of efficient pressures from the same machine which range extends from a venturi vacuum on the negative side to upwards of one-hundred pounds above atmospheric pressure without compounding the effect, and with any desired intermediate pressure available from the same power and with economy in the absorption of that power. This great range is due to the fact that the volume of air drawn from the atmosphere is inversely proportional to the pressure of the air discharged. The speed remaining constant the volume reaches zero when the pressure in the receiver is at the maximum that can be obtained from the centrifugal velocity of the working water.

Having thus described my invention, I claim as new, and desire to secure by Letters Patent,—

1. A turbine air compressor, comprising a vessel, a rotor provided with vanes within the vessel, a shaft for rotating the rotor and to which said rotor is secured, and independent means for passing a current of water through the vessel during the operation of the rotor.

2. A turbine air compressor, comprising a vessel, means for supplying water to the vessel, a vaned rotor within the vessel, means for operating said rotor, which rotor is provided with ducts, valved inlets and outlets for the vessel, and a fixed director plate located within the vessel above the rotor and adapted to receive water from the rotor and direct the water back thereto and independent means for passing water through the vessel.

3. In a turbine air compressor, the combination with the vessel of a means for supplying water to the lower portion thereof, said vessel being provided with a valved inlet in its lower portion and a valved outlet in its upper portion, a shaft mounted to revolve in said vessel, a rotor secured to said shaft, provided with marginal annular ports and with vanes upon its upper surface, and a director plate secured to the vessel and located above the rotor, which director plate is provided with a central opening and with spiral vanes extending from its outer marginal portion to the said opening.

4. A turbine air compressor, comprising a vessel, means for supplying water to the vessel and for extracting water therefrom, the vessel being provided with a valved inlet in its bottom and a valved outlet at its upper portion, a shaft mounted to revolve in the said vessel, a rotor secured to the said shaft, having a conical upwardly extending central portion, a series of vanes upon its upper surface, said vanes being alternately long and short, all the vanes extending to the outer peripheral portion of the rotor, the inner vanes stopping at the conical central section thereof, and a director plate secured to the said vessel and located close to and above the rotor, said director plate being provided with a central opening and with spiral vanes extending from the outer peripheral portion of the plate to the said opening.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

ENOS CAMPBELL POLLARD.

Witnesses:

W. B. Dickinson,

N. C. McLeod.