No. 700,223. Patented May 20, 1902.

J. D. McRAE.

STEAM CONDENSING SYSTEM.

(Application filed Nov. 21, 1900. Renewed Oct. 22, 1901.)

(No Model.) 5 Sheets—Sheet 1.

Fig. 6.

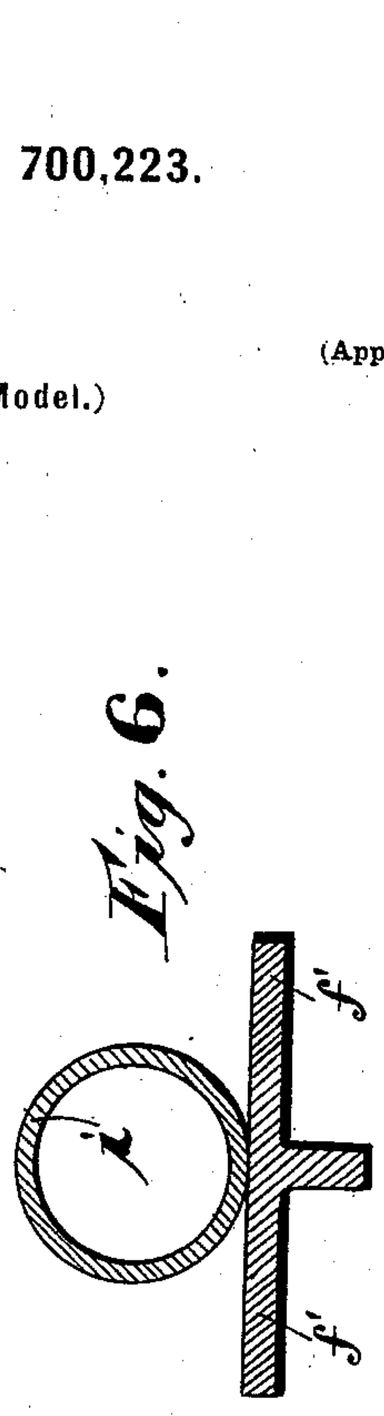

Fig. 1.

Witnesses
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(No Model.) 5 Sheets—Sheet 2.

Fig. 11.

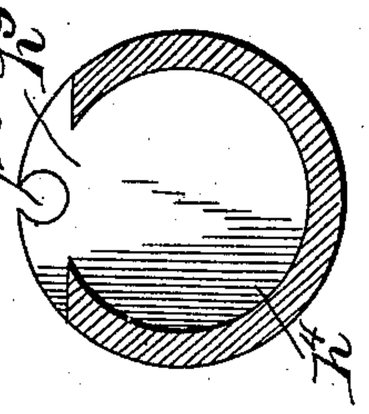

Fig. 10.

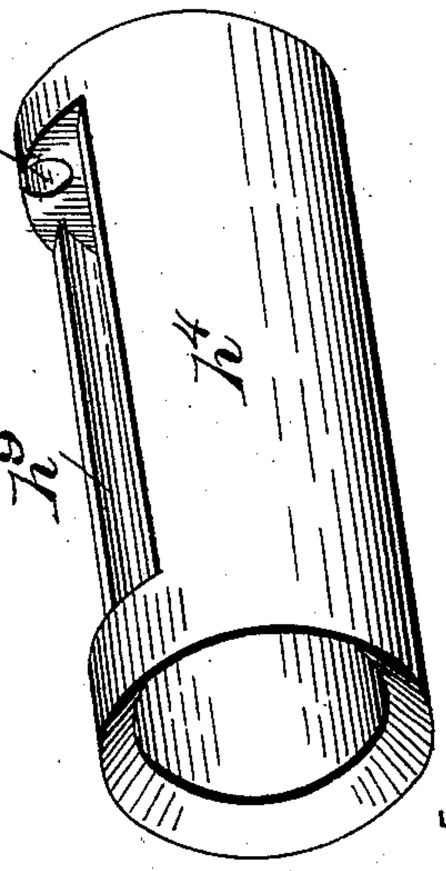

Fig. 2.

Witnesses

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(No Model.) 5 Sheets—Sheet 3.

Fig. 3

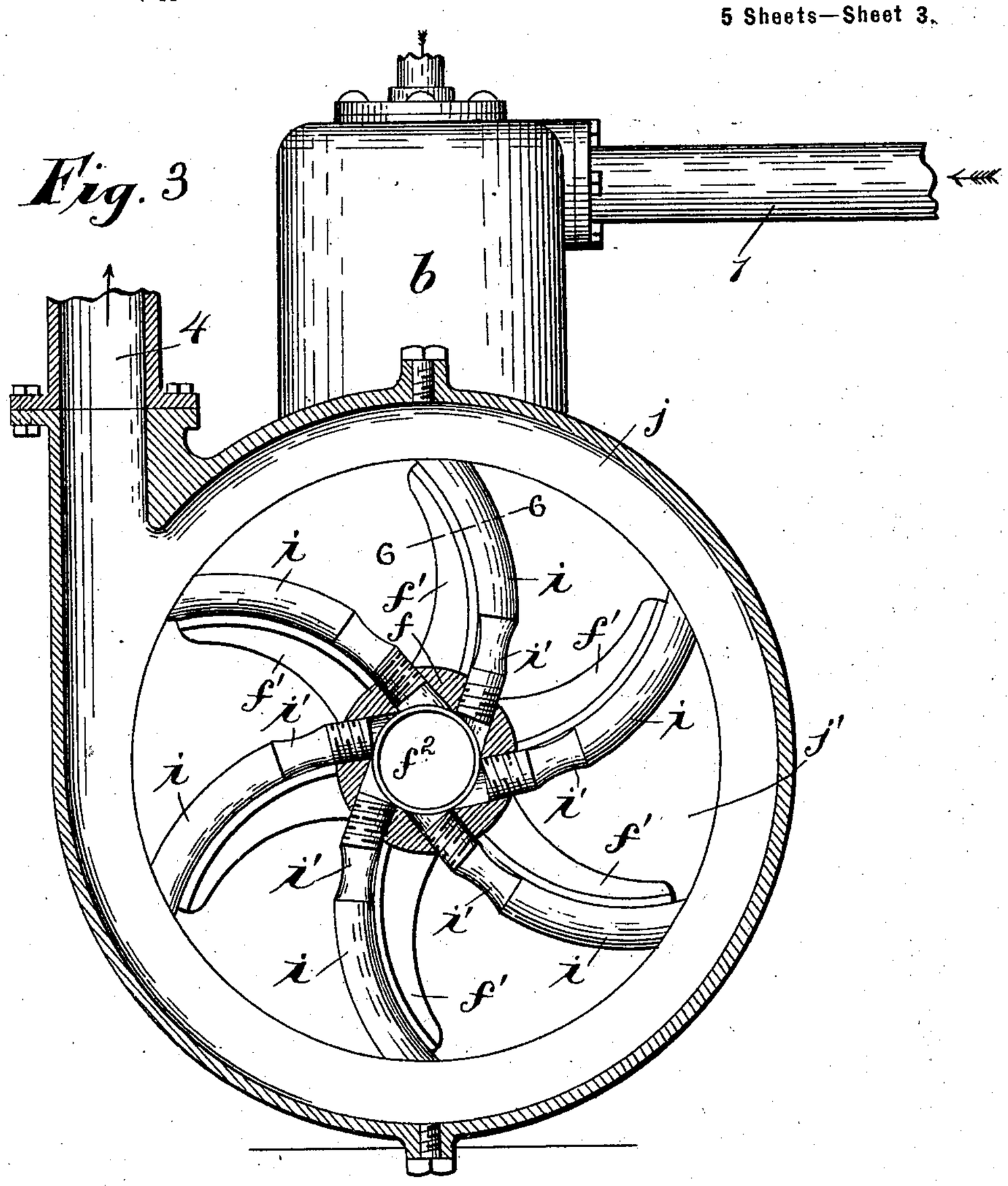
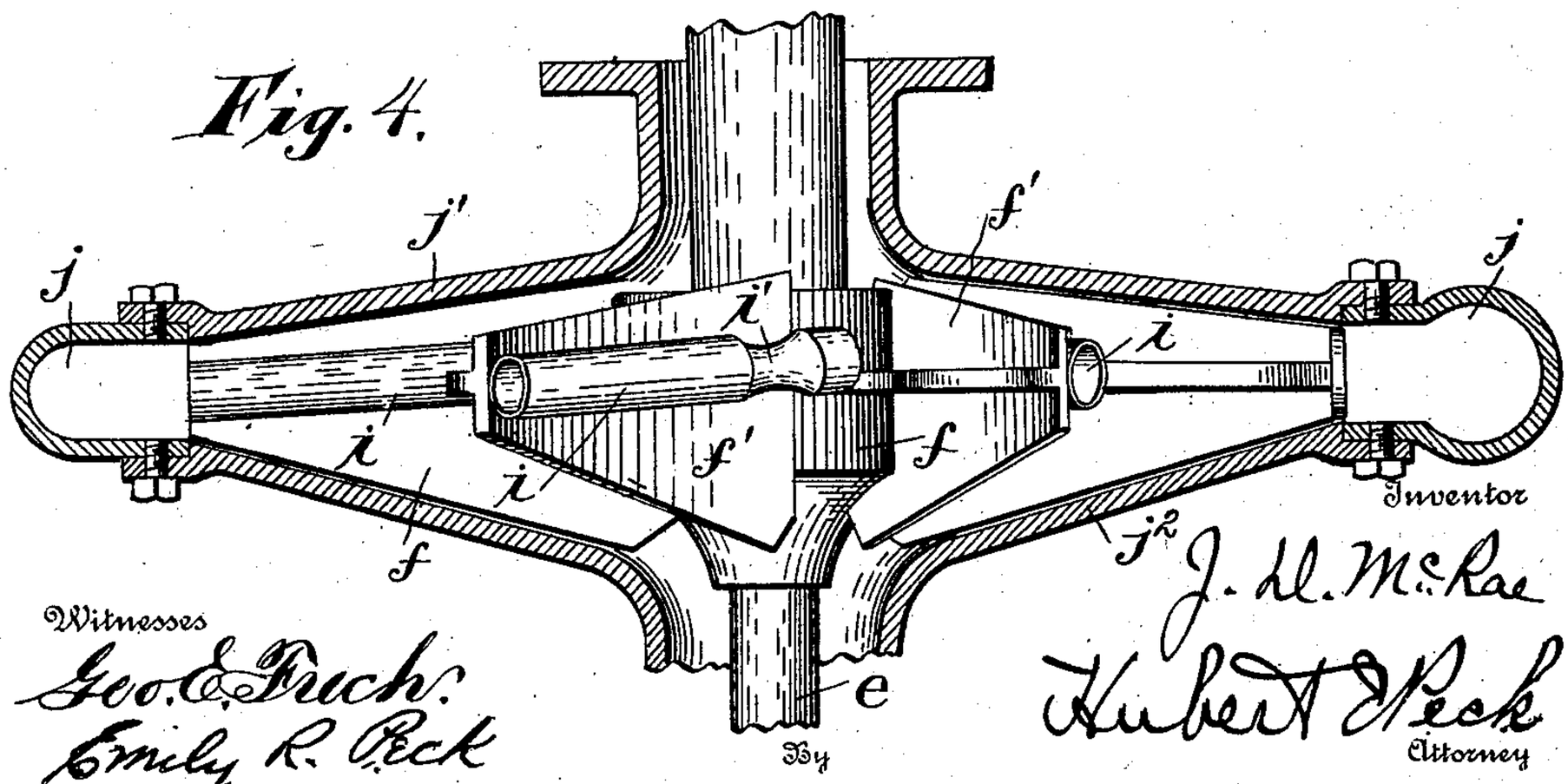


Fig. 4.



Witnesses
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(No Model.) 5 Sheets—Sheet 4.

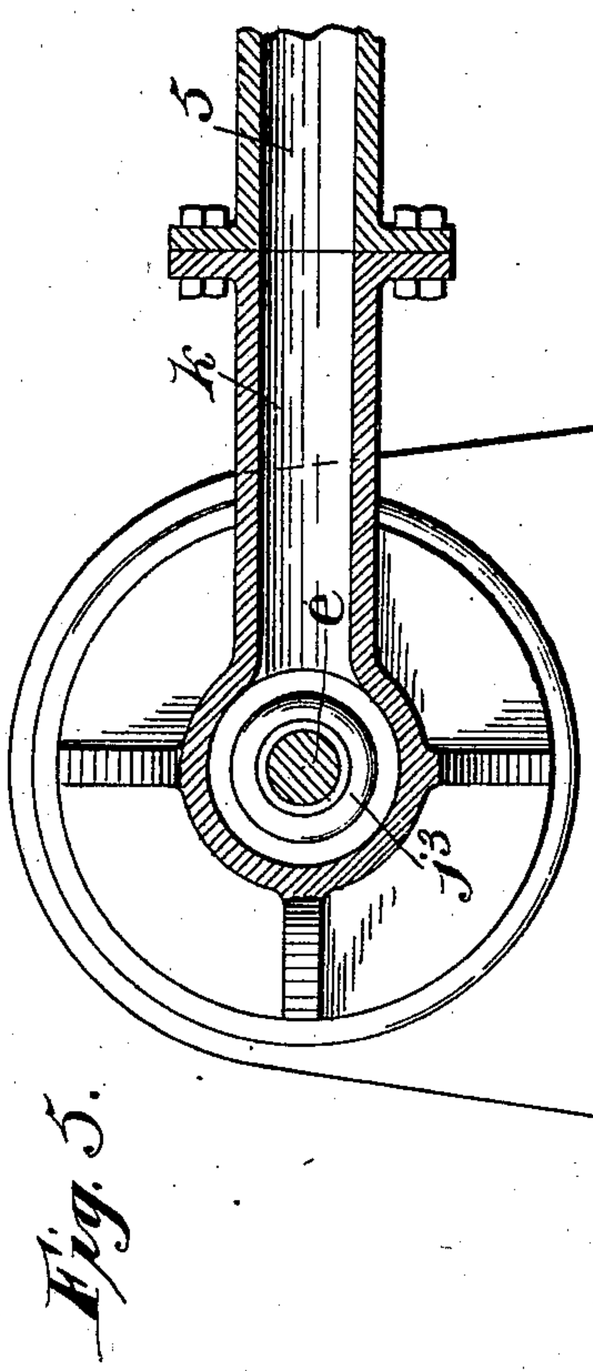

Fig. 5.

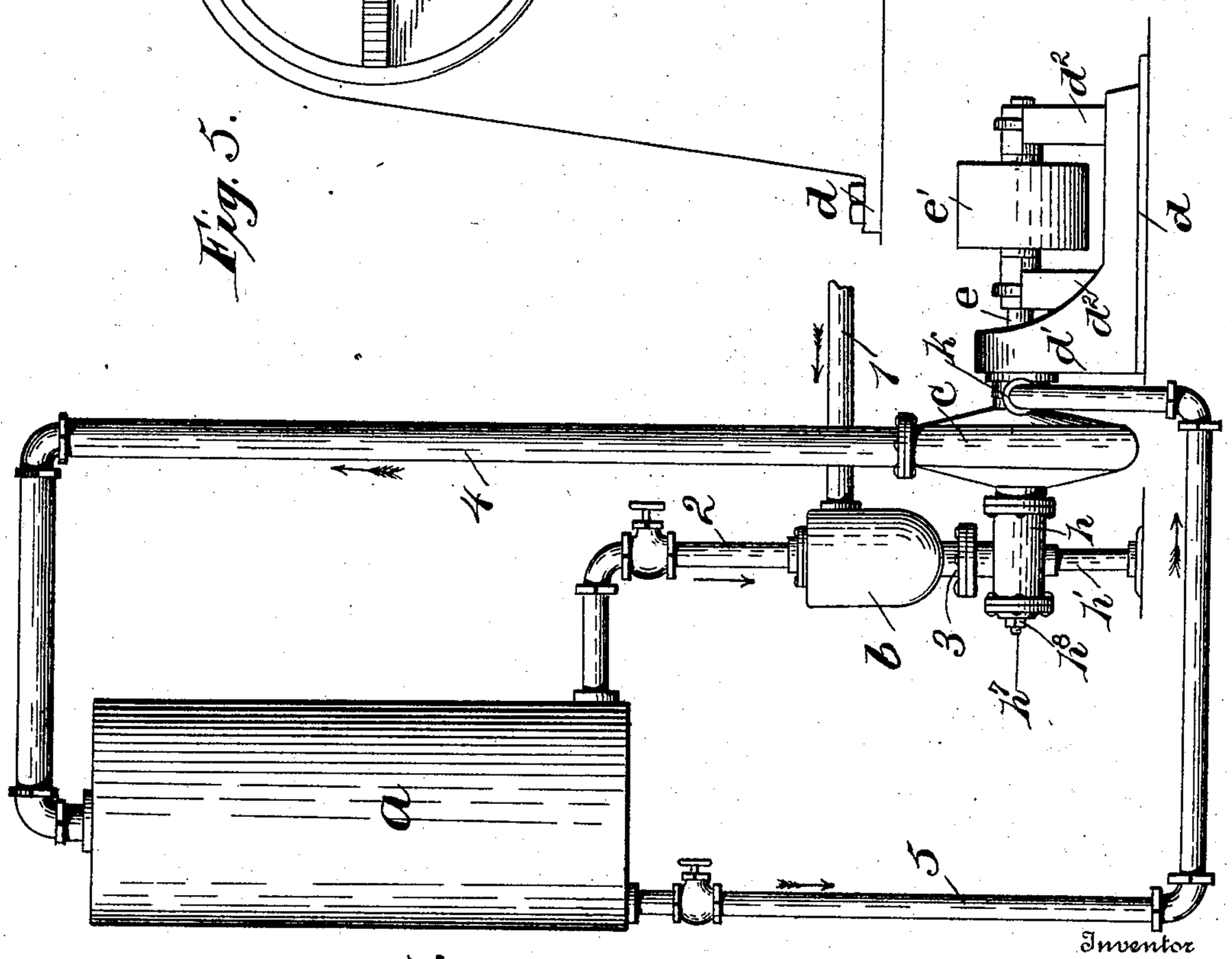

Fig. 7.

Witnesses
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STEAM CONDENSING SYSTEM.

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(No Model.) 5 Sheets—Sheet 5.

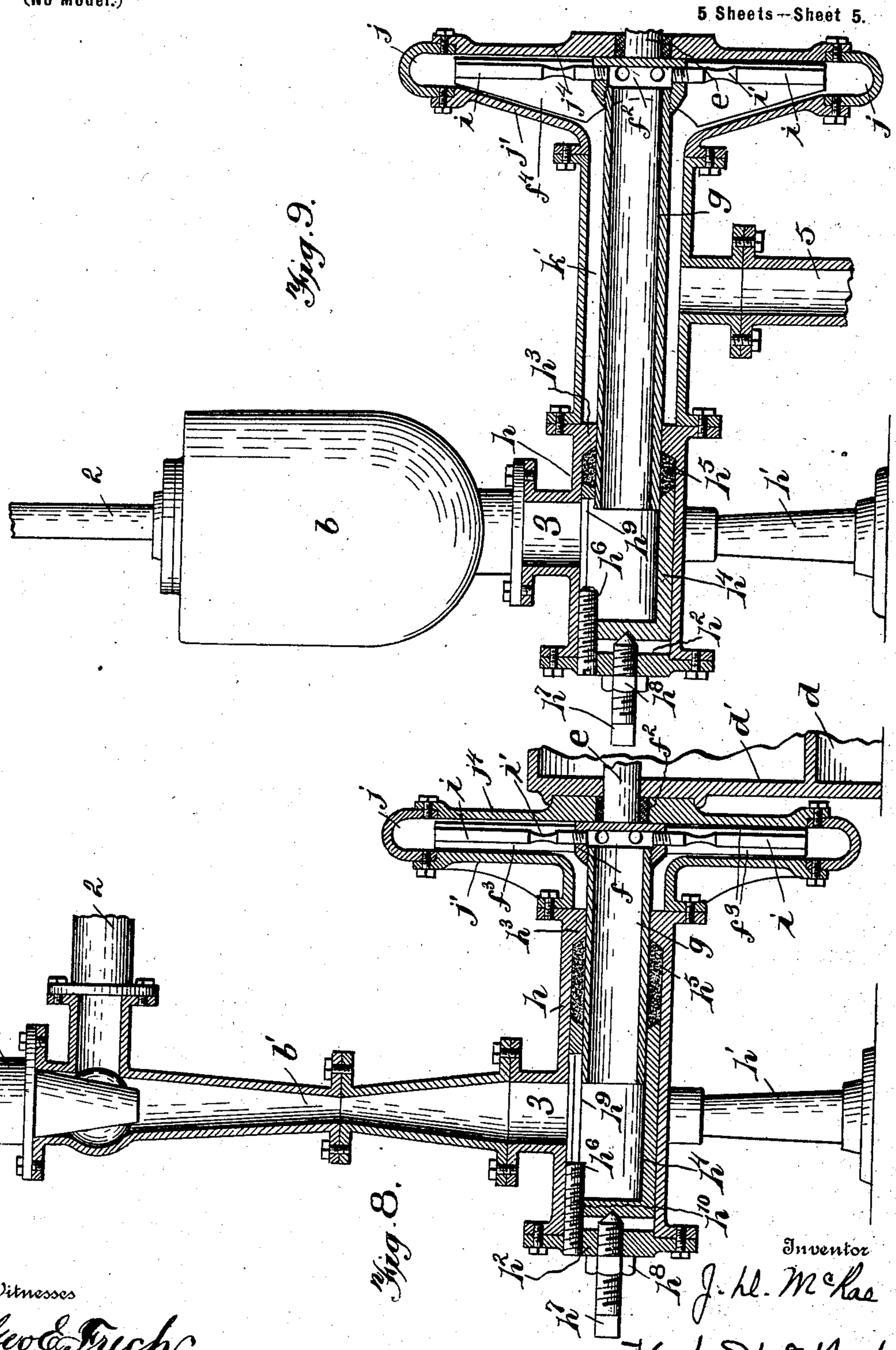

Fig. 9.

Fig. 8.

Witnesses

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UNITED STATES PATENT OFFICE.

JOHN D. McRAE, OF OSWEGO, NEW YORK.

STEAM-CONDENSING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 700,223, dated May 20, 1902.

Application filed November 21, 1900. Renewed October 22, 1901. Serial No. 79,541. (No model.)

To all whom it may concern:

Be it known that I, JOHN D. McRAE, a citizen of the United States, residing at Oswego, Oswego county, New York State, have invented certain new and useful Improvements in Steam-Condensing Systems; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to certain improvements in steam-condensing systems; and the objects and nature of my invention will be readily understood by those skilled in the art from the following explanations in the light of the constructions shown in the accompanying drawings as examples, among other constructions, within the spirit and scope of my invention.

My invention consists in certain novel features in construction and in combinations and in arrangements of parts, as more fully and particularly pointed out and specified hereinafter.

Referring to the accompanying drawings, illustrating for purposes of explanation constructions within the spirit and scope of my invention, Figure 1 is a vertical central section through part of a condensing system embodying my invention, said section being taken in the complete device in the plane of the dotted line 1 1 of the sectional view Fig. 2. Fig. 2 is a top plan, partially in section, of the apparatus shown in Fig. 1, the section being taken in the complete device in the plane of the line 2 2, Fig. 1. Fig. 3 is a cross-section through the complete centrifugal pump on the line 3 3, Fig. 2, looking in the direction of the arrow in Fig. 2 and showing the pump-runner in end elevation, with its hub broken away to show the central water-space into which the suction-tubes open. Fig. 4 is a detail top plan, enlarged, of the centrifugal-pump runner, the shell and end heads thereof being shown in section. Fig. 5 is a cross-section taken in the plane of the line 5 5, Fig. 2, looking in the direction of the arrow, Fig. 2. Fig. 6 is a detail cross-section, enlarged, taken on the line 6 6 through one of the runner arms and tubes. Fig. 7 is in the nature of a diagrammatical view illustrating the several circuits maintained by the single pump. Fig. 8 is a detail vertical section through my centrifugal pump, showing a siphon-condenser on and opening into the coupling or T instead of the jet-condenser of the previous views. The pump in this view creates its suction by the suction-tubes only, and the hollow journal is the only suction-duct of the pump. Fig. 9 is a detail vertical section through my centrifugal pump, showing the jet-condenser of Fig. 1 in elevation, but showing the two suction-ducts to the pump entering through the same head thereof and arranged concentrically one within the other. Fig. 10 is a detail perspective view, enlarged, of the adjusting gland or sleeve within the pump-coupling for taking up wear in the packing-joint around the hollow journal of the pump-runner. Fig. 11 is an enlarged detail cross-section of the gland of Fig. 10.

The condensing system generally illustrated and referred to herein is peculiarly adapted for employment in localities and under conditions where economy in the use of water is necessary, rendering it desirable to employ a cooling-tower or other means for cooling or keeping down the temperature of the water used for condensing the exhaust-steam, whereby the cooling-water and the condensing or injection water can be used over and over again or continuously practically without replenishing from an outside source or from a supply. In such systems as generally arranged heretofore it has been necessary to employ several pumps for maintaining the circulation of the various bodies of water and to raise the water to the top of the cooling-tower and in some to maintain the necessary vacuum in the condenser.

Among others, it is an important object of my invention to provide a condensing system wherein a single pump maintains the vacuum in the condenser and draws the cooling-water and water of condensation therefrom and elevates the same to the top of the cooling-tower and also elevates the cooling-water from the bottom of the cooling-tower to the top thereof to maintain the cooling circulation therein, and also maintains the circulation of the injection or condensing water, although other features of my invention are not limited to such a system.

Referring to the general or diagrammatical view, Fig. 7, *a* is a cooling-tower or other water-cooling device of any suitable or desirable construction.

I have not shown the specific internal construction of a cooling-tower, as such forms no part of my invention, and I do not limit myself to any particular mechanism for cooling the water.

b is the condenser. I have shown what might be termed a "jet-condenser" and have also shown a siphon-condenser in another view, but do not limit myself to any particular form or construction of condenser or device for condensing the exhaust or other steam.

As a mere example for the purposes of explanation I show a condenser composed of the closed chamber or vessel *b*, having the injection-pipe 2 passing down through the top thereof and the proper distance longitudinally within the chamber, if such be desirable.

2′ is a suitable spray or rose-head within the chamber, into which the injection-pipe discharges and which is arranged to throw a thin annular sheet or film of water radially and transversely of the chamber to the surrounding wall thereof. The steam-pipe 1, as shown, discharges into the chamber above said rose-head and above the film of water discharged therefrom. The suction pipe or duct 3 to the pump opens into the bottom or lower end of the condenser-chamber below the rose-head and exhaust-steam inlet. The steam is condensed in the ordinary way by contact and intermingling with the film of cool water, and the combined water of condensation and injection or condensing water is drawn into the pump, as hereinafter specified.

Referring again to Fig. 7, 1 is the exhaust-steam pipe or duct discharging into the condenser from the engine or conducting steam or vapor to be condensed from any other source.

2 is the pipe for injection or condensing water. This pipe extends from the lower end of the cooling-tower downwardly to and opens and discharges into the condenser to cause the condensation therein of the steam by any suitable or usual means.

3 is the suction or discharge duct or pipe from the condenser to the circulating and lift pump *c* and through which the condensing-water and the water of condensation are drawn from, and the partial vacuum is maintained in the condenser by the pump.

4 is the discharge-pipe or uptake from the pump *c* to the top of the cooling-tower and through which all the water drawn into the pump through the ducts or channels from the cooling-tower and condenser is lifted and discharged into the top of the cooling-tower.

5 is the suction or discharge pipe from the bottom of the cooling-tower to the pump *c* and through which the cooling-water from the bottom of the tank passes to the pump and by which it is lifted through pipe 4 to the top of the tower to maintain the downward cooling-passage of the water therethrough, so that the injection-water for condensing passing through pipe 2 will be maintained approximately at the desired temperature for the purpose of properly condensing the exhaust-steam in the condenser.

From the foregoing general description it will be observed that the single pump maintains the circulation of the cooling-water in the cooling-tower, also maintains the circulation of the injection or condensing water, and also maintains the partial vacuum in the condenser. As an example of a pump which might be employed for this purpose, I show a centrifugal pump of such novel and advantageous construction as to be peculiarly adapted for the foregoing purpose in a condensing system.

Various arrangements and constructions of centrifugal pumps within the spirit and scope of my invention can be employed in the condensing system generally described; but as I am at present advised the form and arrangement shown in the drawings possesses many advantages in operation and economy in construction and action.

Referring to the pump illustrated, *d* is a bed-plate, base, or frame, which can be of any suitable or desirable construction and in the present instance is arranged horizontally, with a suitably-braced upwardly-extending end web or wall *d′*, to which a pump-casing head is bolted or otherwise secured, as hereinafter set forth.

d^2 d^2 are pillow-blocks or supports rigid with and extending up from the base and at their upper ends provided with suitable alined journal-boxes. *e* is the horizontal rotary-pump-runner shaft mounted in said journal-boxes. *e′* is the driving-pulley secured to the shaft between the journal-boxes and adapted to be coupled with the source of power for rotating the shaft at the rate of speed desired. The shaft and pump-runner carried thereby can be driven by belt or otherwise from a steam-engine, electric motor, or any other suitable power. The shaft extends through and outwardly beyond an opening in the vertical end wall *d′* of the frame, and at its outer end is rigidly secured in the hub of the rotary pump-runner.

The pump-runner or rotary head comprises the central hub *f*, rigid with the radiating arms or blades *f′*, equally spaced and all of the same length. If desired, the hub and its arms can be formed of one casting. In the example shown the arms longitudinally curve outwardly and rearwardly from the hub, and each arm has a broad flat front face and is braced or strengthened along its rear face by a central longitudinal rib or flange; also, in the instance shown each arm tapers or decreases in width from the hub to its outer end. The hub is formed with an interior concentric water-chamber f^2, with a concentric

opening through the end of the hub opposite the shaft *e*. A hollow journal *g* is rigidly secured in said end opening of the hub and extends outwardly therefrom concentrically with the axis on which the runner rotates. This hollow journal is formed of a straight cylindrical section of pipe with open ends, the inner open end opening into the water-chamber f^2 of said hub. Suitable mechanism is provided to form a water-tight joint around said pipe, rotating with the runner, and yet permit open liquid communication between said journal-pipe and a duct or passage thereto. As an example of what might be employed for this purpose I provide a T pipe section, coupling, or casting *h*, arranged at the outer side of and secured to the pump-casing or a head thereof, as hereinafter described, with the horizontal portion of the T in continuation of and concentric with the axis of said tubular journal or pipe *g*, which extends thereinto and turns therein. The outer end of the T *h* is tightly closed in any suitable manner, as by a plate or head h^2 bolted thereto. The bottom discharge of the condenser-chamber is shown bolted on the top branch or opening of said T, which forms a downward continuation thereof. In the arrangement shown the condenser-chamber is mounted on and carried by said T-coupling *h*, and hence to aid in supporting and maintaining the parts rigid I provide the rigid leg or any suitable support *h'*, extending down from said T to the floor of a suitable base—about, for instance, as shown in Fig. 1. The journal-pipe *g*, rigid with the pump-runner, has an exterior diameter less than the internal diameter of the horizontal portion of the tubular coupling *h*, into which it concentrically projects the necessary distance. The said journal-pipe is surrounded within said tubular coupling by any suitable packing, in which the pipe turns and which is designed to form a tight joint around the same to prevent leakage between the coupling and said journal-pipe. As an example of what might be employed for this purpose I show the inner end of the coupling formed with an internal annular flange or shoulder h^3, surrounding the pipe-journal.

h^4 is a cylinder sleeve or gland arranged longitudinally within the coupling concentric with said journal-pipe and of such internal diameter that the end of the journal-pipe projects a short distance thereinto and turns therein. The inner end of said cylinder around the journal-pipe opposes and is arranged opposite the flange or shoulder h^3, before described, and suitable packing material h^5 surrounds an intermediate portion of the journal-pipe and is interposed and compressed between said shoulder h^3 and said end of said cylinder h^4. Said end of the cylinder and inner edge or face of the shoulder h^3 can be beveled, as usual, to force the packing to the journal-pipe and maintain the tight joint. It will be observed that the inner end of said cylinder h^4 is open to receive the end of the pipe-journal, while the outer end thereof is closed and arranged opposite or adjacent to the end head h^2 of the coupling *h*. The said cylinder is held against rotation, but is longitudinally adjustable, so that the packing or joint can be adjusted to take up wear, as is ordinarily necessary in a packing-joint. Various mechanisms can be provided to thus hold the cylinder against rotation and yet permit longitudinal adjustment of the same. I show a notch or recess h^{10} cut or otherwise formed in the end portion of the cylinder to receive the pin h^6, arranged longitudinally of the cylinder and secured in the end head h^2 of the coupling. This rigid pin fitting in the recess or notch in the cylinder holds the same against rotation and yet permits the cylinder to slide longitudinally on the pin and within the coupling.

The means shown for adjusting the gland consists of the screw-bolt h^7, screwing through a hole tapped through the head h^2 and having a conical end fitting and turning in a conical socket in the closed end of the cylinder h^4, so that the cylinder can be forced inwardly by screwing in the bolt. The bolt is shown provided with a jam-nut h^8 at the outer face of the end head h^2 for locking the bolt. The cylinder is formed with the longitudinal slot or opening h^9, registering with the suction or induction passage from the condenser-chamber to permit free passage of the contents thereof through the passage 3, cylinder h^4, and journal-pipe *g* into the central water-space or hollow hub of the pump.

Suitable mechanism is provided to maintain and create the suction through the hollow journal of the runner, and hence create the partial vacuum in the condenser and draw the water therefrom and discharge the same centrifugally or otherwise from the water-chamber f^2 and from the pump under the desired pressure. As an example of means which might be employed for this purpose I show a series of water ducts or passages radiating from and opening into the water space or chamber f^2, having open outer ends discharging into the shell of the pump-casing. I have devised a peculiarly advantageous construction and arrangement of radiating liquid-passages in connection with the centrifugal-pump runner. For instance, the radiating liquid-passages might be formed by tubes, although the broad features of my invention are not so limited. In this connection, *i* shows suction-tubes approximately radiating from the runner-hub. The hub is formed with openings into the central water space or chamber, and the inner ends of said tubes are rigidly secured in any suitable manner in said openings of the hub, so that their inner ends open into said water-chamber. If desired, the ends of said suction-tubes can open and extend into the hub tangentially of the axis of the hub and runner approximately as shown in the drawings, and the

tubes from thence curve longitudinally rearwardly and outwardly, approximately as shown. I prefer that the tubes opening into the one central water-chamber be all of equal capacity and length and that they be equally spaced around the runner.

As I am at present advised it is preferable to have the suction-tubes equal in number with the runner arms or blades and to arrange each suction-pipe longitudinally along the front face of a runner and conforming generally to the rearward and outward longitudinal curve of the runner-arm, with the open outer ends of the tubes slightly projecting beyond the ends of the runner-arms and cut off at an angle or on a curve or arc about concentric with the axis of the runner. However, I do not desire to limit myself to these specific constructions and arrangements, although as at present advised advantages and new results are attained thereby. If the tubes are made of sufficiently strong and heavy material, it will not be necessary to secure or fasten them to the runner-arms, as the tubes will be rigidly held in place by their inner ends screwed or otherwise fastened into the runner-hub.

To increase the suction and efficiency of the tubes during the rotation of the runner, I can form the liquid passage or duct of each tube with a contracted portion i' in the form of a double cone or taper, preferably on gradual curved lines. It is preferable that this contracted portion be located at an intermediate portion in the length of the tubes, usually nearer the inlet than the outlet end of the tube. The tubes are longitudinally internally open and unobstructed throughout, except for said contracted portion of each tube, which, however, I may not find necessary to use in all instances, although I consider it an important improvement for certain conditions.

The pump-casing can be of any suitable and desirable construction—such, for instance, as employed in the ordinary centrifugal pump. The closed casing shown in the drawings consists of two end heads and the annular trough-like shell j, forming a water space and passage around the runner and from which the tangential discharge opens, as shown in Fig. 3, to which the discharge or lift pipe 4 is bolted or otherwise secured. This shell j is secured to and between the outer surrounding edges of the two end heads j' and j^2. The head j' has the central opening through which the hollow journal g of the runner centrally passes, which opening is surrounded by the flanged neck of said head bolted or otherwise rigidly secured to the inner end of the coupling h, as clearly shown in Figs. 1 and 2. The opposite head j^2 is bolted or otherwise rigidly secured to the vertical web or wall d' of the bed plate or frame and has an opening for the passage of the runner-shaft and a water-tight joint or bearing j^3 for said shaft.

Where the condensing system is such as generally shown in Fig. 7, the single centrifugal pump is provided with another suction or inlet duct and independent of the axial duct to the suction-tubes and opening into the central portion of the casing, so that the suction is created therein by the action of the runner itself practically independently of the suction-tubes. In the condensing system shown this additional suction-duct connects with the pipe or connection 5 from the bottom or discharge of the cooling-tower, and said suction duct or inlet of the pump can be arranged in any suitable manner to enter the same at any suitable point.

In the specific example illustrated the end head j^2 is formed with a suction or inlet duct k, extending laterally thereinto and then turning inwardly and opening into the central portion of the casing and around and concentric with the inner portion of the runner-shaft, as more clearly illustrated in Figs. 1, 2, and 5. As shown in Fig. 2, said head j^2 is provided with an annular flange around the outer end of said suction-duct k, to which the suction-pipe 5 from the cooling-tower is bolted or otherwise secured. It will thus be observed that the suction created by the rotation of the runner-arms acts through the duct k and pipe 5 on the cooling-tower, and the water therefrom is drawn directly into the casing at the central portion of the runner and around the hub thereof and is directly acted on by the runner-arms, as in the ordinary centrifugal pump, to cause the discharge of the water under sufficient head or pressure through the discharge-pipe or uptake 4.

From the foregoing description it will be observed that the rotation of the runner at the necessary rate of speed will through the medium of the suction-tubes create suction through the hollow journal and intermediate duct and in the condenser, which will not only rapidly draw the water from the condenser, but will also create the desirable partial vacuum therein. The water will be discharged from the tube ends into the shell of the casing. From experience I am of the opinion that the revolving radiating tubes will create an exceedingly strong suction through the hollow journal and enable the water and air or gases to be withdrawn very rapidly and under considerable head or pressure from the condenser and that the suction will be most materially enhanced or increased by the double-cone contractions intermediate the lengths of the tubes.

The rotation of the same runner not only creates suction through the medium of the tubes, but through the medium of the runner-arms acting centrifugally on the fluid in the casing suction is created in the casing and through the end duct thereinto, and hence water is drawn from another source than the condenser and through a pipe to said end duct and directly into the interior of the casing. The rotation of the runner-

head and its arms through centrifugal action on the water in the casing creates sufficient pressure to force the water out through the discharge or uptake under a pressure and head which depends on the capacity and efficiency of the pump, which efficiency to a certain degree depends on the closeness of the fit of the runner-arms within the casing-heads, other conditions being equal.

It should be noted that water is discharged into the casing-shell through and by the action of the suction-tubes and also that water is drawn into the casing through the independent end duct and discharged into the casing-shell by the action of the runner-arms and that these various bodies of water are combined in the casing-shell and therein acted on by the centrifugal action of the rotating runner whatever its exterior form and forced through the single or common pump-discharge under pressure.

From experience I am of the opinion that the runner-arms coöperate with the suction-tubes in creating or maintaining a comparatively high degree of suction through said tubes, which among other features renders a condensing system within the spirit and scope of my invention of peculiar advantage and utility.

In Fig. 8 I show the centrifugal pump having the suction-passages of its runner or rotary head acting through the hollow journal on a siphon-condenser b', mounted directly on and opening into the coupling pipe or duct h, as in the construction previously described. This siphon-condenser can be of any desirable construction, with the condensing or injection water entering through pipe 2, and the steam or vapor to be condensed enters through pipe 1. By coupling up the siphon-condenser with my pump I can dispense with the long leg of the siphon, as my pump creates the necessary vacuum, which has been heretofore attained in such a condenser by a long pipe-leg, over thirty feet in length. In the construction shown in said Fig. 8 the pump is formed to draw from only one source and has only one suction inlet or duct, the suction being attained through the medium of the radiating tubes. Hence the runner-head only coöperates with the tubes and forces the water drawn through the tubes centrifugally under the necessary pressure from the pump-casing through the tangential discharge shown in other views of the drawings. I hence show in said Fig. 8 a narrow runner-head having comparatively narrow runner-arms f^3. The casing is correspondingly modified to receive the narrow runner and the end head j^4 has no suction-duct therethrough and is secured direct to the frame or base-plate.

I do not limit my invention to the condensing system employing the siphon-condenser with the specific form of pump shown in Fig. 8, as the condensing system of my invention can employ a siphon-condenser in connection with various forms of centrifugal pumps or with any of the forms of pump shown or in the system shown in Fig. 7.

In Fig. 9 I show a modified arrangement of pump adapted for the system shown in Fig. 7, but having the casing-head j^4 secured to the bed-plate and through which the runner-shaft passes without the suction-duct opening therethrough. The opposite end head j' of the casing is shown with the central opening through which the hollow journal passes, but said opening is considerably larger in internal diameter than the external diameter of said journal, forming a suction-duct around the same and opening into the pump-casing. A pipe connection k' is interposed between and secured to the said casing-head j' around said opening and the coupling h. The hollow journal passes through this pipe k' and is packed in the coupling h, as before described, although said journal is shown in this view somewhat exaggerated in length for purposes of illustration. A suction-duct is thus formed around, yet having no liquid communication with, said hollow journal. The cooling-water pipe 5 is shown bolted to and discharging into said pipe k'. Hence both suction-ducts of the pump open through one head of the casing, and consequently it is usually desirable in this connection to form the runner-arms f^4 about as shown in said Fig. 9, although the invention is not so limited.

I do not wish to limit the broad features of my invention to the specific means shown for establishing suction communication in my condensing system between the rotating hollow journal and a condenser, as other devices for establishing such connection and providing a packed joint for the rotating journal might be arranged within the spirit and scope of my invention.

I have specifically described and clearly illustrated various features of construction for the sake of clearness in explaining various examples of condensing systems within the spirit and scope of my invention; but I do not thereby wish to limit my invention to the features and details so set up, as it is evident various changes and modifications might be resorted to in adapting my condensing system to various conditions, and hence I do not wish to limit myself to the constructions set up, but consider myself entitled to all such changes as fall within the spirit and scope of my invention.

Having thus fully described my invention, what I claim as new, and desire to secure by Letters Patent of the United States, is—

1. A steam-condensing system having the single centrifugal pump provided with suction-pipes to the condenser and cooling-tower and a single discharge through which the water drawn from said tower and said condenser is elevated to the top of the cooling-tower, substantially as described.

2. A condensing system comprising a steam-condenser, a cooling device for the injection-

water, and a single centrifugal pump maintaining the circulation of the cooling-water and the injector-water, and maintaining the partial vacuum in the condenser, substantially as described.

3. A steam-condensing system comprising a cooling-tower for the injection-water, a cooling-water circuit therefor, a steam-condenser, an injection-water circuit including the condenser, and a centrifugal pump included in both the cooling-water and injection-water circuits and maintaining the circulation thereof and maintaining suction on and the partial vacuum in the condenser, substantially as described.

4. A steam-condensing system comprising a condensing-water-cooling device, a condenser, a condensing-water pipe thereto from said cooling device, a centrifugal pump having a suction-duct opening into the condenser, and another suction-duct for the cooling-water from said cooling device, and a discharge communicating with the cooling device through which all the water drawn from said condenser and said cooling device is forced to maintain the circulation back through the cooling device and condenser, substantially as described.

5. In a steam-condensing system, a cooling-tower for the condensing-water, a condenser into which the exhaust-steam and injector-water are discharged, and a centrifugal pump having a high suction-power duct communicating with the interior of said condenser and another suction-power duct to the cooling-tower and for the cooling-water, and a common discharge-duct through which the water from said suction-ducts is elevated back to the cooling-tower, substantially as described.

6. In a condensing system, a centrifugal pump having a case and a rotating runner therein provided with a series of radiating suction-passages at their outer ends discharging into the casing by centrifugal action, an axial suction-duct to the inner ends of said passages, a steam-condenser having its interior in direct suction communication with said duct and through the same with said passages, another suction-duct into the casing and through which suction is maintained by the centrifugal action of the runner itself, a water connection to said duct, and a common discharge from the pump-casing, substantially as described.

7. In a condensing system, the combination of a condenser, a centrifugal pump comprising a casing having a discharge duct or opening, a rotary runner in said casing arranged to act centrifugally on the water therein and force the same from said discharge under pressure, said runner provided with a central water-chamber and radiating suction-passages therefrom at their outer ends discharging into the casing, an axial suction journal-pipe discharging into said chamber, a suction-duct from said pipe opening directly into said condenser, and a fluid-tight packing or joint for said journal-pipe, substantially as described.

8. In a condensing system, the combination of a condenser, a cooling-tower, a centrifugal pump having a casing provided with a discharge, a rotary runner in the casing arranged to act centrifugally on the water therein to force the same under pressure through said discharge, a suction-duct opening into the interior of the casing and connected by a liquid-passage to said cooling-tower, said runner having a central water-chamber, radiating suction-tubes at their inner ends opening into said chamber and at their outer ends discharging under centrifugal action into said casing, a hollow journal opening into said chamber and a suction-duct from said journal to said condenser, whereby the suction-tubes have direct suction communication with said condenser, substantially as described.

9. In a condensing system, the combination of a steam-chamber, a centrifugal pump comprising a casing and a rotary runner therein, said runner having a hollow journal rotating therewith, and a series of radiating suction-tubes rigid with the runner and at their outer ends discharging into said casing and at their inner ends having liquid and suction communication with said hollow journal, a suction-duct from said chamber to said hollow journal, and a coupling between said duct and said journal and in which said journal rotates comprising a packing-joint within the coupling and around the journal, substantially as described.

10. In an exhaust-steam-condensing system comprising a cooling-tower and condenser, a centrifugal pump included in the cooling-water circuit and in the condensing-water circuit, in combination with suction and discharge ducts, whereby the single pump maintains the circulation of the cooling-water and the condensing-water and creates the partial vacuum in the condenser, and whereby said cooling-water and condensing-water are both drawn into and commingled in and discharged from the single pump, substantially as described.

11. The combination, in a condensing system, of a closed or vacuum chamber, a centrifugal pump having a casing with a discharge and a rotary centrifugally-acting runner in said casing having radiating suction-passages at their outer ends discharging into the pump-casing, an axial suction-pipe rotating with the runner and with which the inner ends of said passages have suction and liquid communication, a rigid coupling into which said pipe projects and in which it rotates, a suction-duct from said coupling to said chamber, and a packing-joint in the coupling forming a liquid-tight joint between the same and said rotating axial suction-pipe, substantially as described.

12. In combination, in a condensing system, a bed-plate, a centrifugal-pump casing secured thereto, a head of said casing having

a central opening, a horizontal coupling closed at its outer end and having its open inner end rigidly secured to said casing-head around said opening therein, a support for said coupling, a condenser-chamber rigidly secured on said coupling and having the suction opening or passage thereinto, and a rotary runner-head in said casing and creating suction through said coupling and condenser to draw the liquid therefrom into the pump-casing and discharge the same therefrom under pressure, substantially as described.

13. In combination, in a condensing system, a condenser, a centrifugal pump, having a casing with a discharge, and a rotary runner having outwardly-extending suction-passages discharging into the casing, a hollow journal rigid with the runner and in direct liquid and suction communication with the inner ends of said passages, a tube or casing in direct liquid and suction communication with said condenser and said hollow journal and into which said journal extends, and a packing-joint in said casing and around said journal, substantially as described.

14. A condensing system comprising in combination, a centrifugal-pump shell having a fixed casing rigid with and extending laterally therefrom, a condenser mounted on and discharging into said casing, a rotary runner in the shell having a hollow journal projecting and opening into said casing, said runner provided with suction-passages discharging into the shell and in direct suction and liquid communication with said journal, substantially as described.

15. A condensing system comprising in combination, a centrifugal-pump shell having a fixed casing rigid therewith, a siphon-condenser opening into said casing, a rotary runner in said shell having driving means and a hollow journal extending into said casing and in direct liquid and suction communication with said condenser, said runner having suction-passages discharging into said shell and having direct liquid and suction communication with said hollow journal, whereby said runner creates the necessary vacuum in said siphon-condenser, substantially as described.

16. A steam-condensing system having a single pump provided with suction-ducts acting on the condenser and cooling device and a single discharge through which the water drawn from said cooling device and from said condenser is discharged and whereby the circulation is maintained in the cooling and condenser circuits, substantially as described.

17. A condensing system comprising a condenser having a steam-inlet, a water-inlet and a discharge, in combination with a centrifugal pump having a discharge, and having a suction-duct in direct suction communication with said discharge of said condenser whereby the single pump draws the water and vapors from said condenser and maintains a partial vacuum therein, substantially as described.

18. A condensing system comprising a centrifugal pump having a discharge-duct, in combination with a condenser mounted on the pump-casing, said casing having a suction-duct from the pump in direct suction communication with said condenser, whereby the single pump draws the water and vapors from the condenser and maintains a partial vacuum therein, substantially as described.

19. A condensing system comprising a cooling device, a steam-condenser, and a single pump included in the cooling-water and condenser-water circuits and maintaining the circulation of the water in said circuits and the partial vacuum in the condenser, substantially as described.

20. A condensing system comprising a centrifugal pump having independent suction-ducts and a runner creating different degrees of suction through said ducts, said pump having a single discharge, in combination with a condenser in direct suction communication with one of said ducts, and a cooling device communicating with the other duct, substantially as described.

21. In a condensing system, a condenser, in combination with a centrifugal pump having a runner with suction-ducts in direct suction communication with said condenser, whereby the single pump draws the water and vapors from the condenser and maintains the partial vacuum therein, substantially as described.

22. A condensing system comprising a centrifugal pump having a runner with suction-ducts discharging into the pump-casing, a steam-chamber in direct suction communication with said chamber, whereby the partial vacuum is maintained therein, said pump having another suction-duct opening through its casing independently of said runner, a water-circuit maintained through said suction-duct, said pump having a single discharge, substantially as described.

23. In a condensing system, the combination with a condenser of a centrifugal pump in direct suction communication with said condenser, whereby the single pump maintains the partial vacuum therein and draws the water and vapors therefrom, substantially as described.

In testimony whereof I affix my signature in presence of two witnesses.

JOHN D. McRAE.

Witnesses:
W. V. BURR,
T. J. CURRIE.