No. 741,270. PATENTED OCT. 13, 1903.

C. A. PARSONS.

CONDENSER.

APPLICATION FILED AUG. 5, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

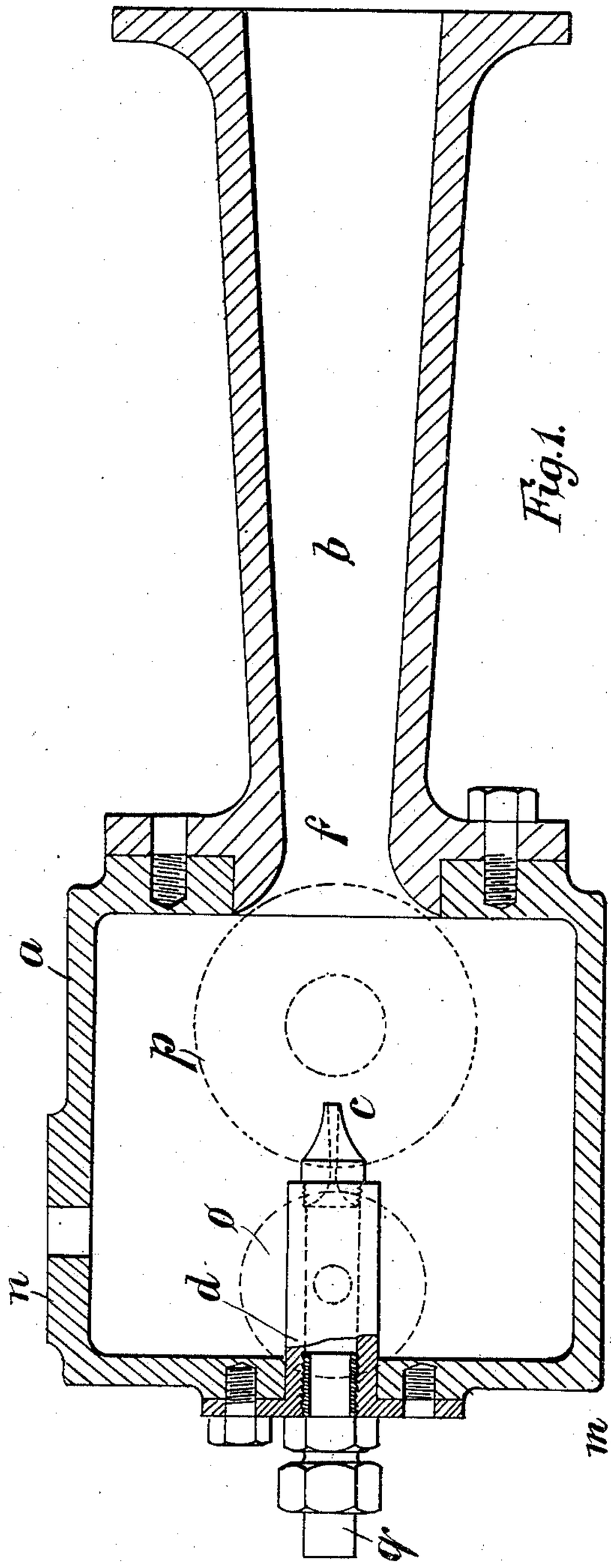

Fig. 1.

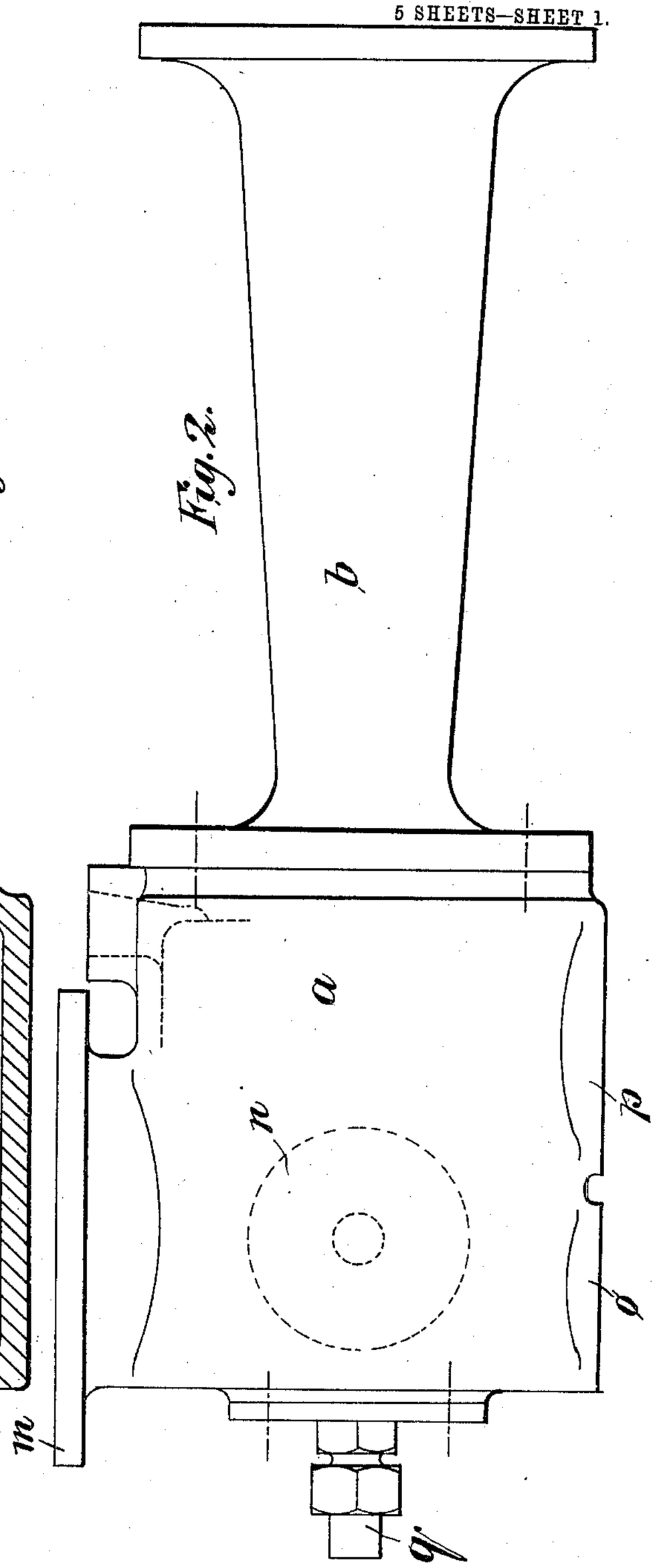

Fig. 2.

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NO MODEL. 5 SHEETS—SHEET 2.

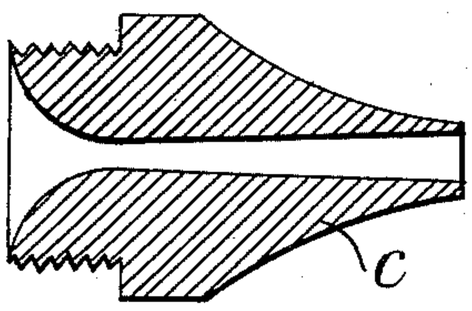

Fig. 3.

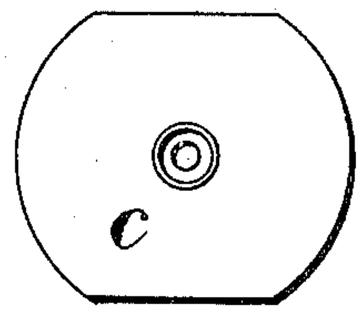

Fig. 4.

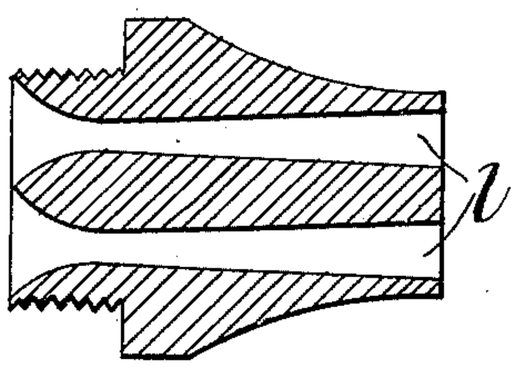

Fig. 9.

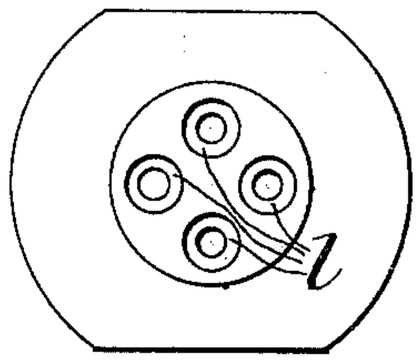

Fig. 10.

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NO MODEL. 5 SHEETS—SHEET 3.

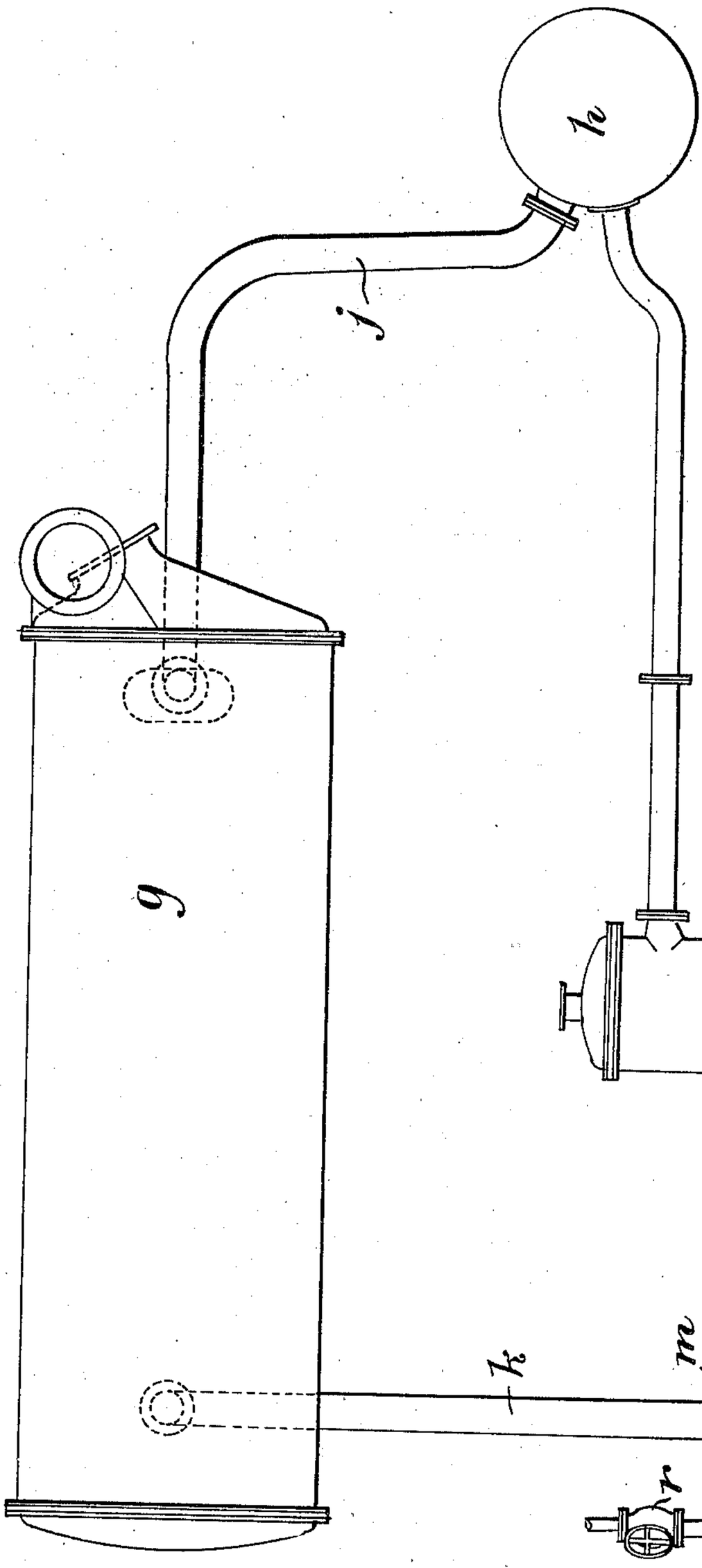

Fig. 5.

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No. 741,270. PATENTED OCT. 13, 1903.

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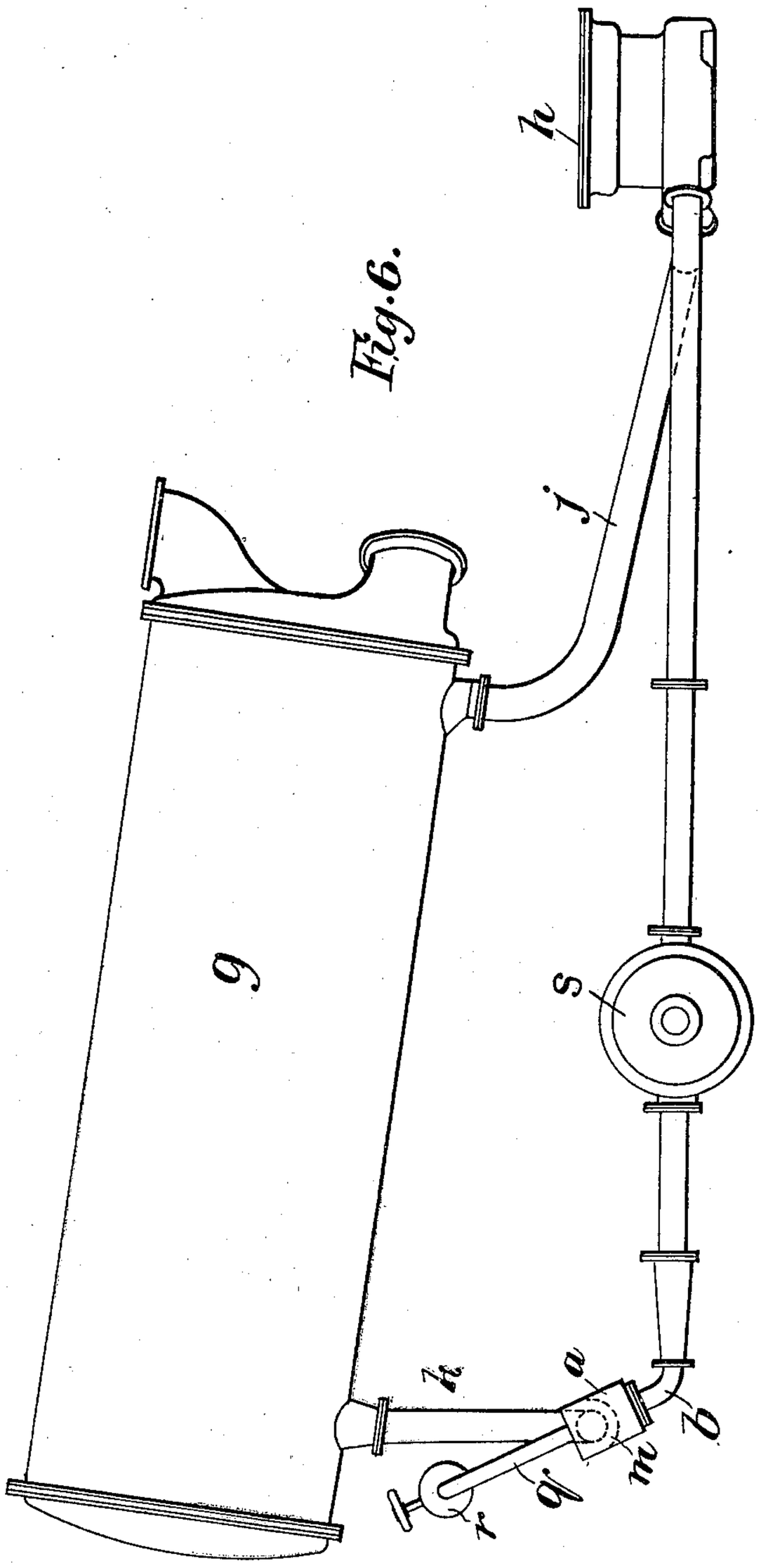
APPLICATION FILED AUG. 5, 1902.

NO MODEL. 5 SHEETS—SHEET 4.

Fig. 6.



Attest:
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CONDENSER.

APPLICATION FILED AUG. 5, 1902.

NO MODEL. 5 SHEETS—SHEET 5.

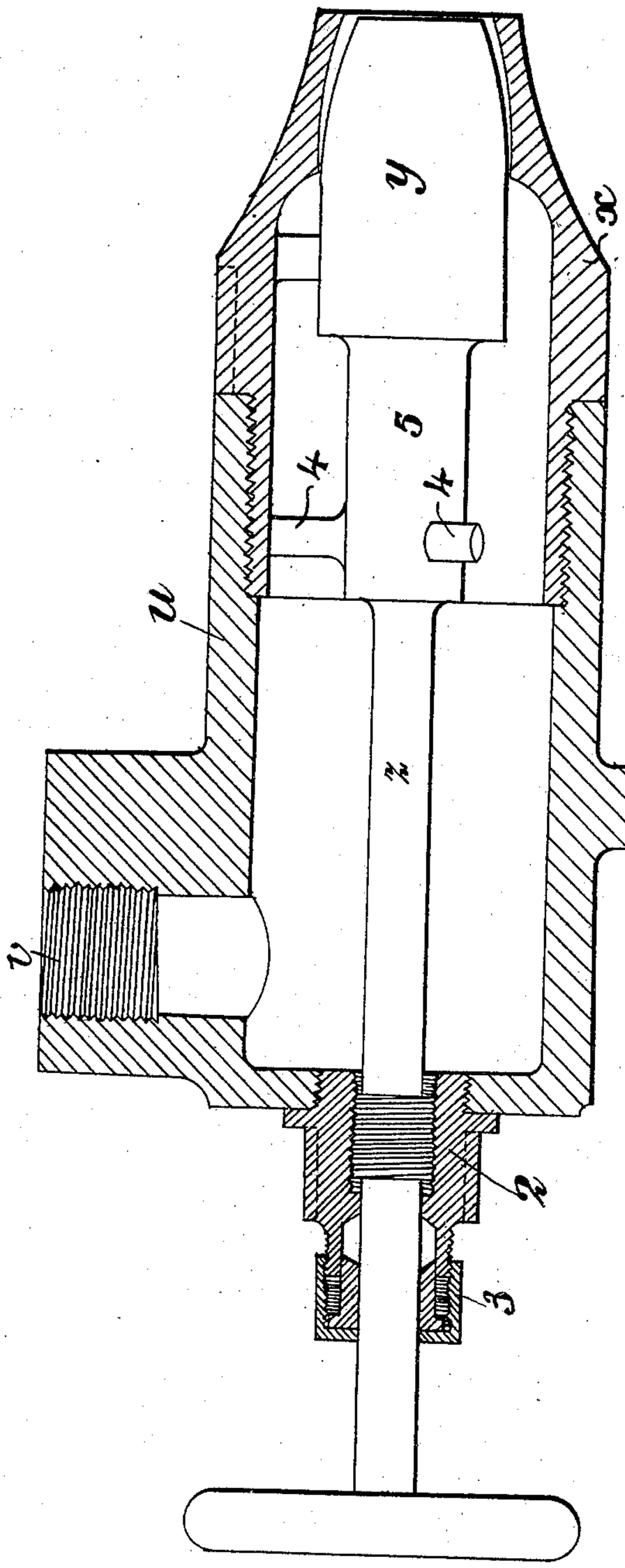

Fig. 7.

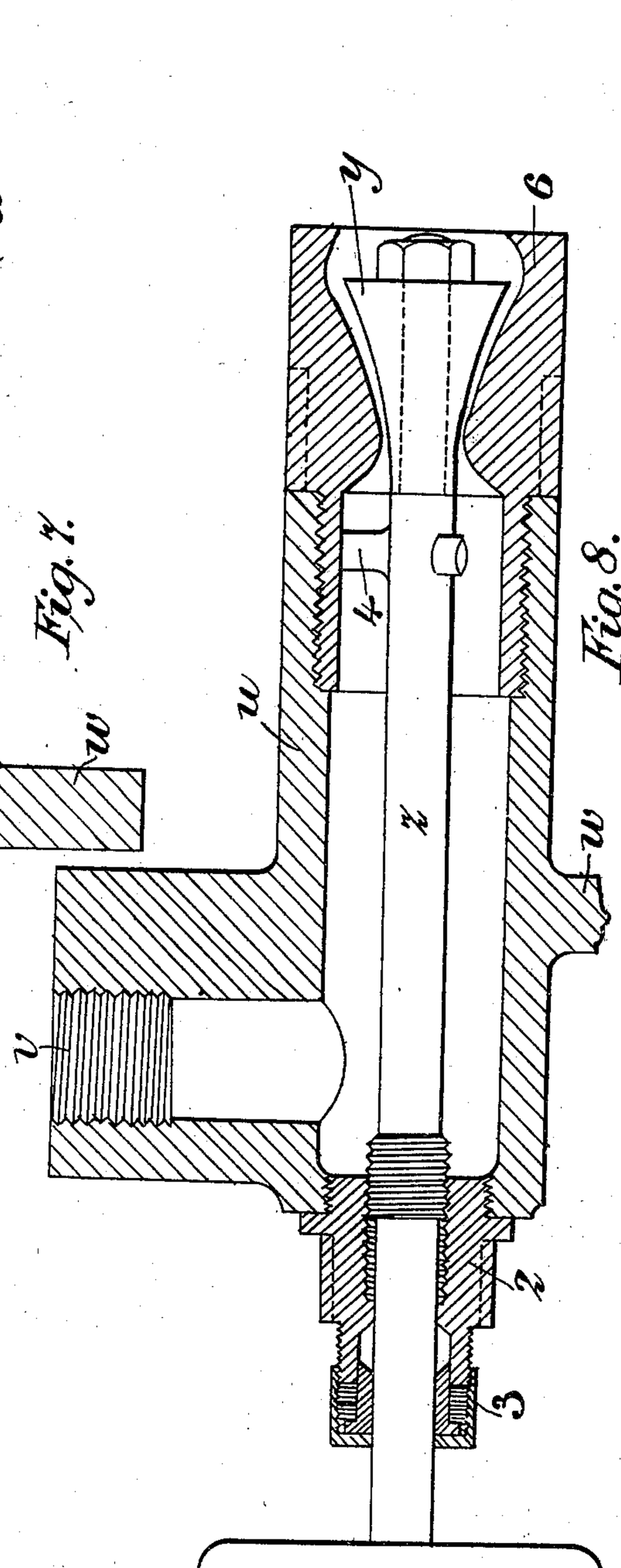

Fig. 8.

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No. 741,270. Patented October 13, 1903.

UNITED STATES PATENT OFFICE.

CHARLES ALGERNON PARSONS, OF NEWCASTLE-UPON-TYNE, ENGLAND.

CONDENSER.

SPECIFICATION forming part of Letters Patent No. 741,270, dated October 13, 1903.

Application filed August 5, 1902. Serial No. 118,550. (No model.)

To all whom it may concern:

Be it known that I, CHARLES ALGERNON PARSONS, a subject of the King of Great Britain and Ireland, residing at Heaton Works, Newcastle-upon-Tyne, in the county of Northumberland, England, have invented certain new and useful Improvements in Condensers Working in Conjunction with Air-Pumps, (for which I have made application for Letters Patent in Great Britain, No. 840, dated January 11, 1902,) of which the following is a specification.

My invention relates to improved means of increasing the vacuum obtained in condensers operated by air-pumps.

My invention consists in a combination of an air-pump with a propelling-jet operated by steam, whereby the gases and vapors proceeding to the air-pump are assisted in their progress to the pump-cylinder and the vacuum produced in the condenser thereby increased.

The object of this invention is to obtain improved vacua in surface and jet condensers and other similar work and general purposes.

I am aware that exhaust-ejectors worked with steam or compressed air have been used for obtaining moderate degrees of vacua; but the present invention is to use an ejector in conjunction with an air-pump constituting a vacuum-intensifier and by this means to propel the steam, air, mixture, or gases on their way to the air-pump from the condenser. The effect of this is that with a moderate vacuum at the suction-inlet of the air-pump a very much higher degree of vacuum is obtained in the condenser or receptacle which is being exhausted and this with a very small expenditure of steam in the jet-pump.

Referring now to the accompanying drawings, Figure 1 is a longitudinal section on the center of an intensifier suction-box, conical steam-jet, and discharge-neck drawn to one-third full size. Fig. 2 is an elevation of the same. Figs. 3 and 4 are sectional side and end views, respectively, of a steam-jet drawn full size. Figs. 5 and 6 are elevation and plan of a condenser and air-pump with my invention applied. Figs. 7 and 8 are sectional views of adjustable steam-jets. Figs. 9 and 10 on Sheet 2 are sectional elevation and plan of a steam-jet provided with four conical steam-openings.

In carrying my invention into effect I provide an ejector between the condenser and the air-pump. The ejector consists of a suction-box *a*, into which the exhaust from the condenser flows on its way to the air-pump. Opposite to the neck of the ejector or discharge pipe *b* I provide a steam-jet *c*. The steam-jet *c* may be screwed into a flanged pipe *d*, passing into the box *a*.

I have found by experiment that with an ejector-pipe having a discharge-neck of two inches in diameter at *f*, (see Figs. 1 to 4,) a steam-jet of one-eighth-inch diameter at the narrowed part, conically diverging to a diameter of one-fourth inch at the exit, supplied with steam at one hundred and ten pounds pressure and with a vacuum at the suction of the air-pump of twenty-five and one-half inches of mercury, I obtain a vacuum in the condenser of 26.9 inches, or a gain of 1.4 inches vacuum. With five-sixteenths-inch jet at the narrowest part, conically diverging to five-eighths inch at the exit, with seventy-two pounds of steam-pressure and the same vacuum as before at the air-pump suction—*i. e.*, twenty-five and one-half inches—I obtain a vacuum of twenty-nine inches in the condenser, this being a gain of 3.5 inches vacuum. I find it is also possible to allow a considerable amount of water or air to pass through the ejector without seriously interfering with its efficient working.

One among the many important uses of my invention may be mentioned—*i. e.*, in conjunction with steam-engines and surface condensers and air-pumps this ejector permits of a much smaller air-pump or, on the other hand, in spite of heavy air-leakage in the condenser or exhaust system, the maintenance of a much higher vacuum than is otherwise possible, as I find by experiment that this ejector is capable of dealing with a very large quantity of leakage without seriously affecting the vacuum when used in conjunction with the condenser. This application of my invention is illustrated in Figs. 5 and 6, where *g* is the condenser, preferably placed three or four feet above the level of the suction of the air-pump *h* and in such a position that the water of condensation shall flow by grav-

ity down the pipe *j* to the pump *h*, while the air and water vapors are sucked from another part of the condenser through pipe *k* by the vacuum intensifier or ejector *a*, so that little or no water shall pass into the ejector. Under these conditions the ejector deals solely with the air and water vapor and is, if necessary, capable of dealing with the water of condensation from the cylinder-drains and the like.

I find that the intensifier works best with a nearly vertical position of the jet and discharge-neck, so as to prevent accumulation of water in the suction-box.

I find by experiment that the action of the ejector is scarcely affected by bending the discharge-pipe through an angle of about forty-five degrees and not seriously affected by bending through an angle of even ninety degrees. In the apparatus shown in Figs. 5 and 6 the discharge-pipe *b* is bent through an angle of about seventy-five degrees. The pipe *k* couples to the flange *m* of the ejector suction-box. (See Fig. 2.) Provision may be made for connecting drain or other pipes to the suction-box, as shown at *n*, *o*, and *p*, the steam to the steam-jet being led in by the pipe *q*, connected to the flanged pipe *d*. I may control the supply of steam to the jet by an ordinary valve *r* in pipe *q* or by a special nozzle, as will be hereinafter described.

I find that it is desirable in some cases, in order to obtain the best results, to thoroughly mingle the discharge of air and vapor from the intensifier with the water of condensation on its passage to the air-pump, and in some cases I prefer to use a small auxiliary condenser *s*, Figs. 5 and 6, for condensing the vapor and cooling the water before they enter the air-pump.

The vacuum-intensifier may be used in conjunction with jet-condensers of the type with separate air and water pumps, the intensifier being placed between the condensing chamber or pipe and the air-pump.

In the case of war-ships, torpedo-boat destroyers, and the like, where space and weight are of great importance, this invention is very valuable and especially so in combination with steam turbine-engines, where a high vacuum is of great importance, but it may also be used for many other purposes, such as the evaporation of sugar and for use in chemical pans.

To obtain a graduation of the power of the intensifier, I usually vary the pressure of steam on the jet by a controlling-valve *i*, as described with reference to Figs. 5 and 6, but instead of the fixed bell-mouth jet hereinbefore described I sometimes use a jet rendered adjustable by means of concentric cones of diverging or converging conical surfaces, so that the bell-mouth character of the mouthpiece is maintained and a high velocity of jet with the different areas of discharge-opening is produced.

An adjustable jet with an opening converging toward its delivery end is shown in Fig. 7. It consists of a steam-chest *u*, provided with a high-pressure steam-inlet *v*. The chest is inserted in the ejector-box as far as the flange *w*, by means of which it is secured to the box. A nozzle *x* with a conical opening converging toward its steam-delivery end is screwed into the end of the chest *u*, and within the nozzle there is provided a plug *y*, which may be moved into the nozzle, so as to entirely close the jet or to adjust the space between the nozzle and the plug to admit any desired volume of steam. Adjustment of the plug is effected by means of the screwed spindle *z*, passing through the gland 2 and stuffing-box 3, and it may be guided by means of the arms 4, formed upon the extension 5 of the plug. In Fig. 8 a modification of this steam-jet is shown. The nozzle in this case diverges either continuously to the delivery end of the nozzle or to within a short distance from the end, where it gradually commences to converge to the end of the nozzle, as shown at 6. To close the steam-jet, the plug *y* is drawn up into the conical nozzle by means of the screwed spindle *z* and the area of discharge may be adjusted by varying the position of the plug. The jet is thus made adjustable in size by varying the space between the diverging or converging parts, and a high velocity of steam-jet is maintained with the different areas of discharge-opening.

Instead of using only one steam-jet I may employ several bell-mouthed jets, all pointing toward the center of the discharge-neck of the intensifier, and admit steam to one or more of these, or I may use any other similar device for graduating the power of the intensifier.

In Figs. 9 and 10 on Sheet 2 I have shown a nozzle with four bell-mouthed openings *l*, which may be employed instead of the nozzle. (Seen in Figs. 3 and 4.)

In some cases, and especially on board ship, it is desirable to keep the suction-box of the intensifier as low down as possible, so as to obtain a good fall for the cylinder drain-pipes.

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

1. In combination with a vessel to be evacuated and a vacuum-pump, a steam-jet operating in a passage which connects said vessel with the vacuum-pump, substantially as described.

2. In combination, a condenser, a vacuum-pump, a steam-jet operating in a passage which connects the condenser with the vacuum-pump, substantially as described.

3. In combination, a condenser, a vacuum-pump, a vacuum-intensifier operated by steam in a passage which connects the condenser with the vacuum-pump, substantially as described.

4. In combination, a condenser, a vacuum-pump, a passage between the condenser and vacuum-pump, a steam-jet vacuum-intensifier in said passage, and an auxiliary con-

denser between the steam-jet and the vacuum-pump.

5. In combination, a condenser having one end raised above the level of the other end, a vacuum-pump, piping connecting both ends of the condenser with the vacuum-pump, and a steam-jet vacuum-intensifier operating in the piping which connects the raised end of the condenser with the vacuum-pump, substantially as described.

6. In combination, a condenser having one end raised above the level of the other end, a vacuum-pump, piping connecting both ends of the condenser with the vacuum-pump, a steam-jet vacuum-intensifier operating in the piping which connects the upper end of the condenser with the vacuum-pump, and an auxiliary condenser between the vacuum-intensifier and the vacuum-pump, substantially as described.

7. In combination with a vacuum-pump, a vacuum-intensifier comprising a suction-box connected to the vessel to be exhausted, a steam-jet inserted in the box, a discharge-passage opposite the steam-jet, communicating with the air-pump, substantially as described.

8. In combination with a vacuum-pump, a vacuum-intensifier comprising a suction-box connected to the vessel to be exhausted, a steam-jet inserted in the box and having a conical opening, a conical discharge-passage opposite the steam-jet, the discharge-passage being connected to the vacuum-pump, substantially as described.

9. In combination with a vacuum-pump, a vacuum-intensifier comprising a suction-box connected to the vessel to be exhausted, a steam-jet inserted within the box, a curved discharge-passage opposite the steam-jet, whereby the vertical space occupied by the ejector is conserved, the curved passage discharging into the vacuum-pump, substantially as described.

10. In combination with a vacuum-pump, a vacuum-intensifier comprising a suction-box connected to the vessel to be exhausted, a steam-jet within the box, the jet being adjustable by means of a plug within a nozzle which converges toward the delivery edge, a discharge-passage situated opposite the jet and connected to the vacuum-pump, substantially as described.

11. In combination with a vacuum-pump, a vacuum-intensifier comprising a suction-box connected to the vessel to be exhausted, a steam-jet within the box, the jet being adjustable by means of a plug within a nozzle, and a discharge-passage situated opposite the jet and connected to the vacuum-pump, substantially as described.

12. In combination with a vacuum-pump, a vacuum-intensifier, comprising a suction-box connected to the vessel to be exhausted, a plurality of steam-jets within the box, all the jets being directed toward a discharge-pipe connected to the vacuum-pump, substantially as described.

In witness whereof I have hereunto set my hand in presence of two witnesses.

CHARLES ALGERNON PARSONS.

Witnesses:

WILLIAM DAGGETT,

HENRY GRAHAM DAKYNS, Jr.