(No Model.) 6 Sheets—Sheet 1.

C. T. PORTER.

STEAM ENGINE.

No. 517,982. Patented Apr. 10, 1894.

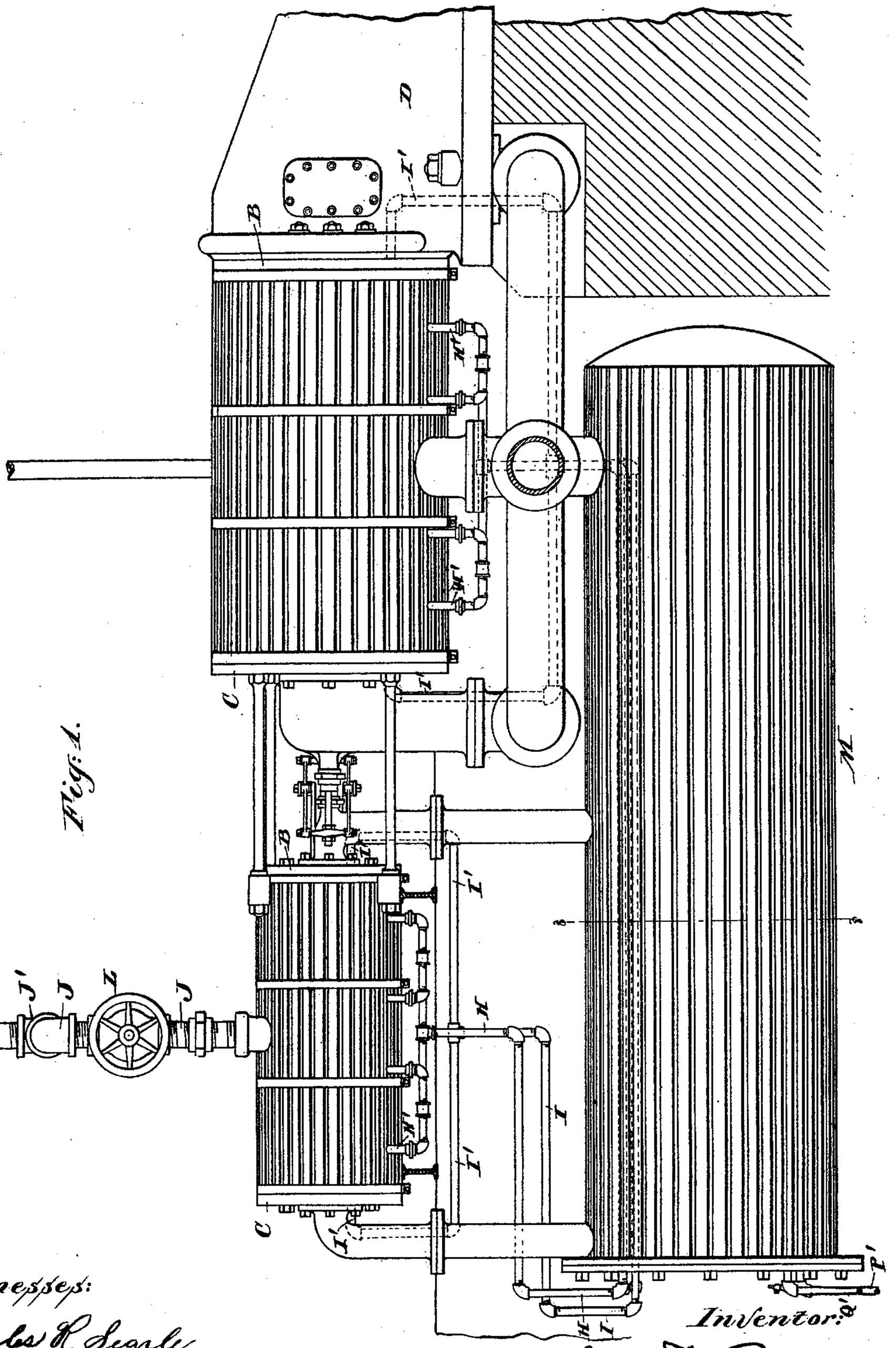

Fig: 1.

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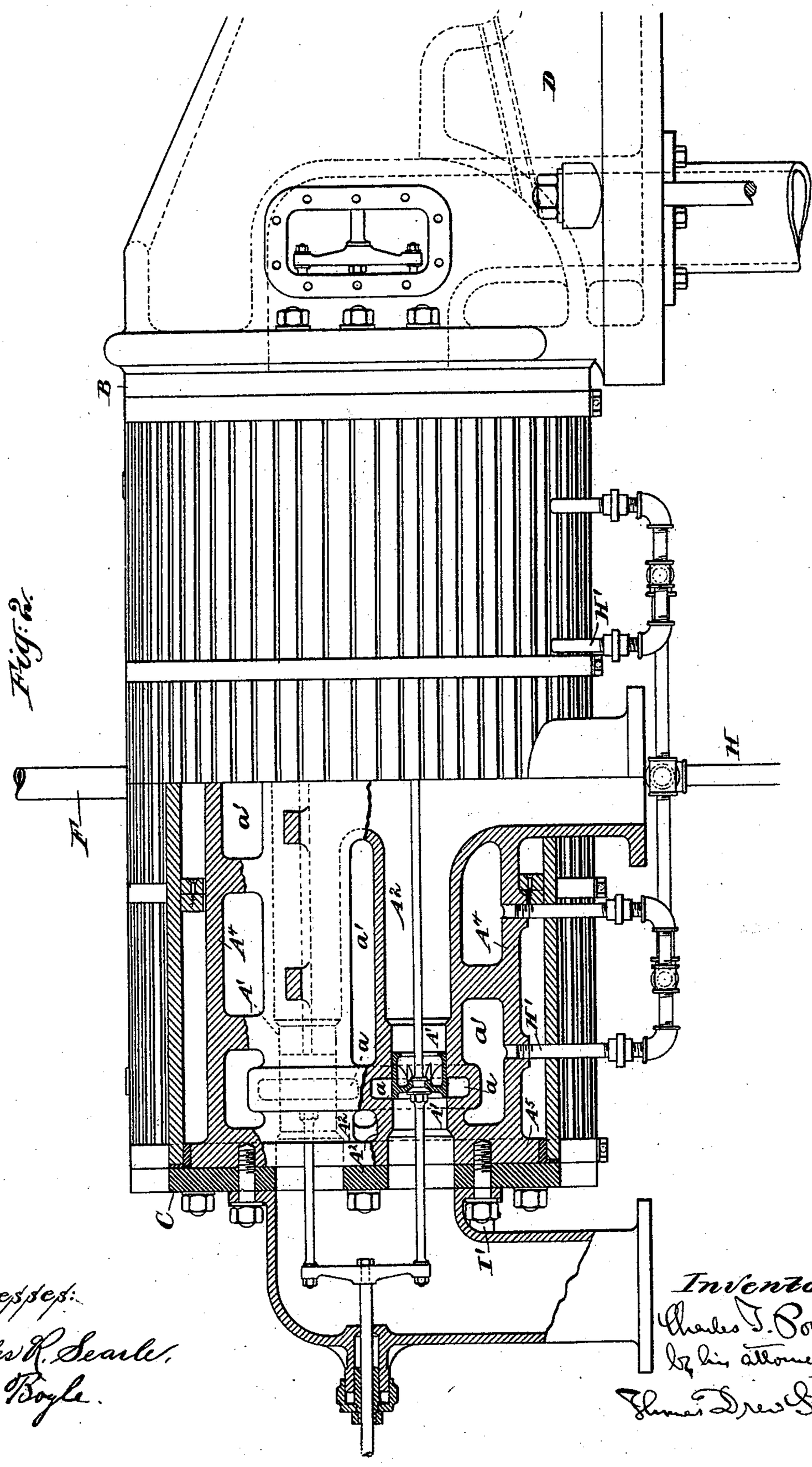

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STEAM ENGINE.

No. 517,982. Patented Apr. 10, 1894.

Fig: 3.

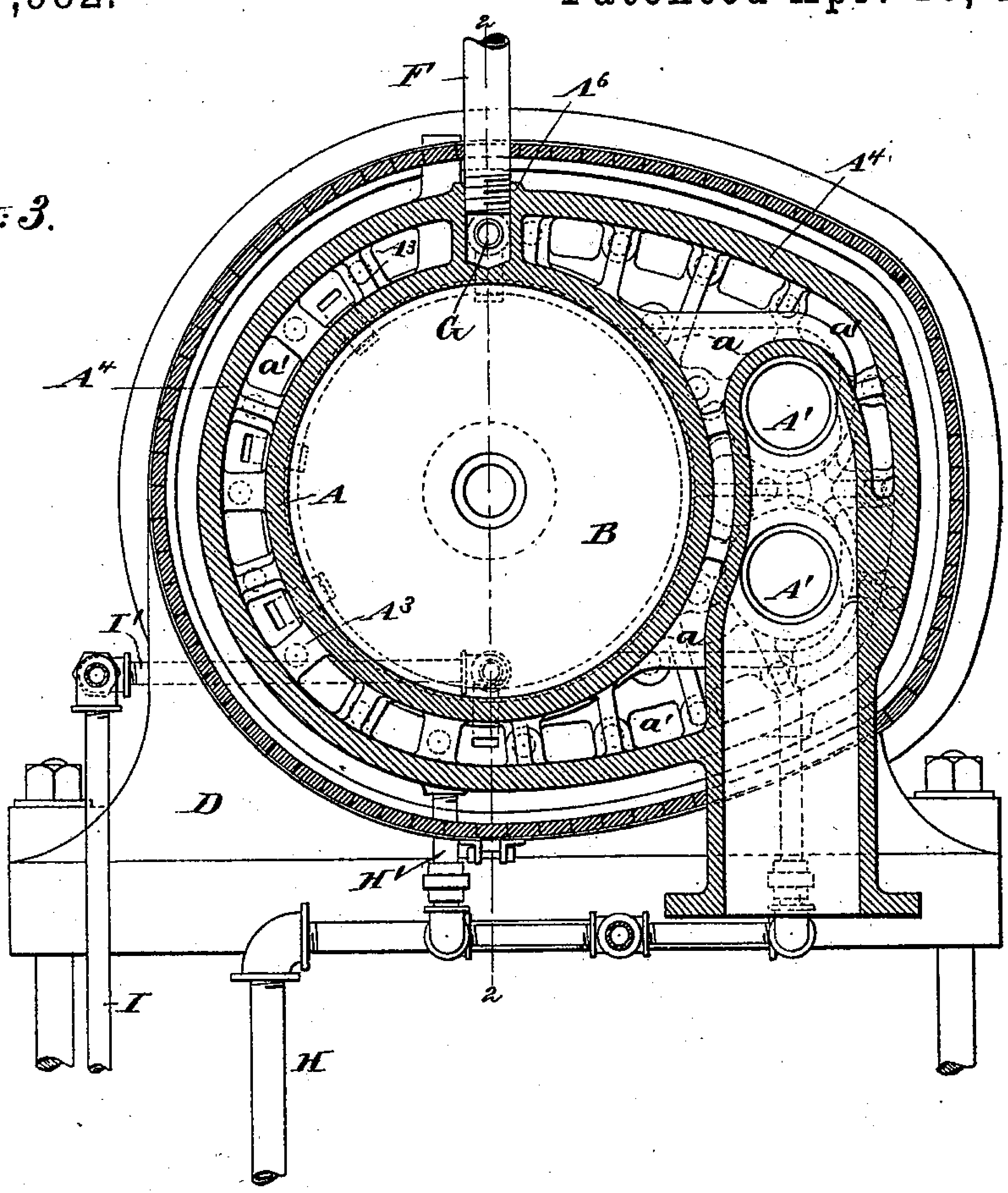
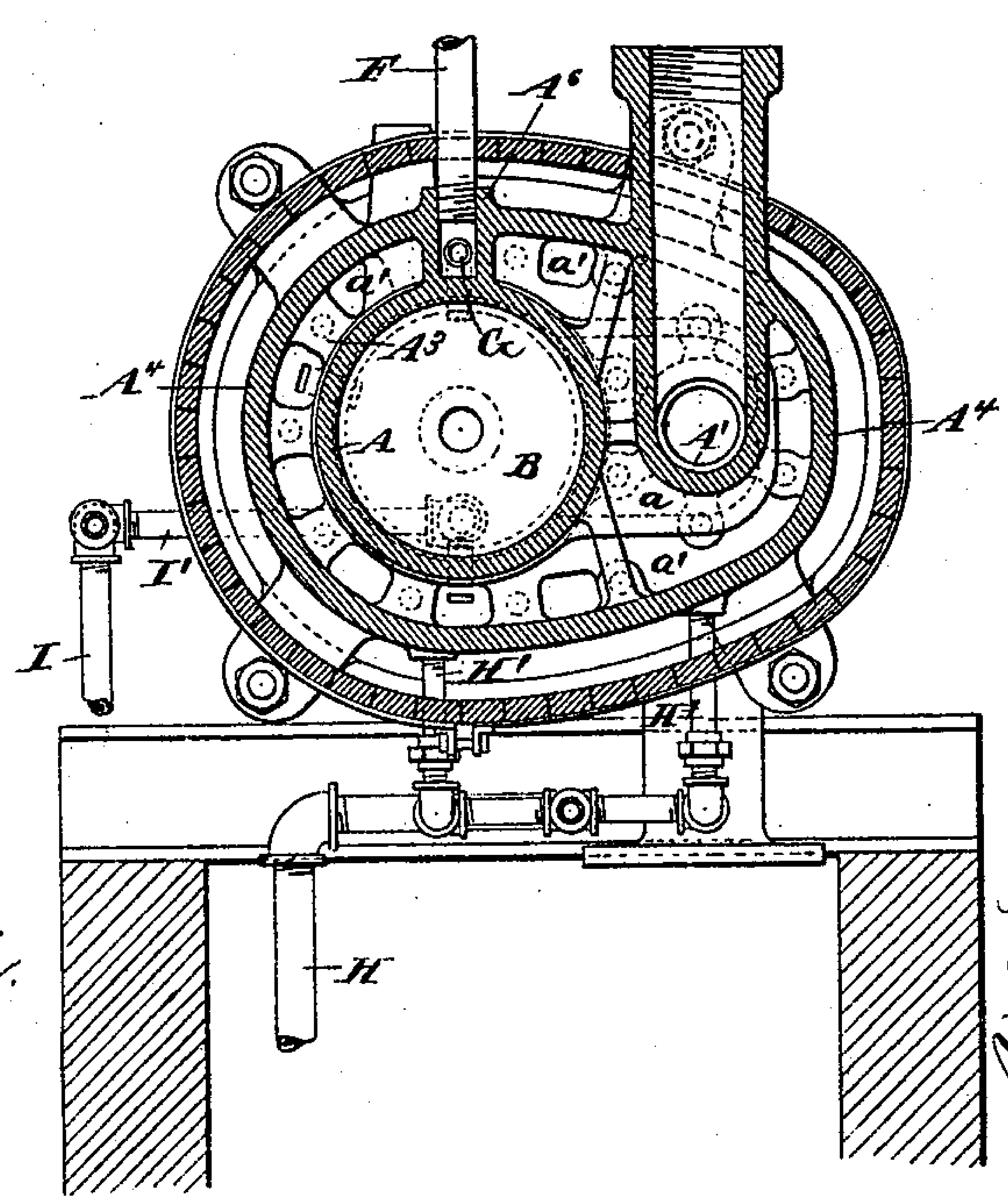


Fig: 6.



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STEAM ENGINE.

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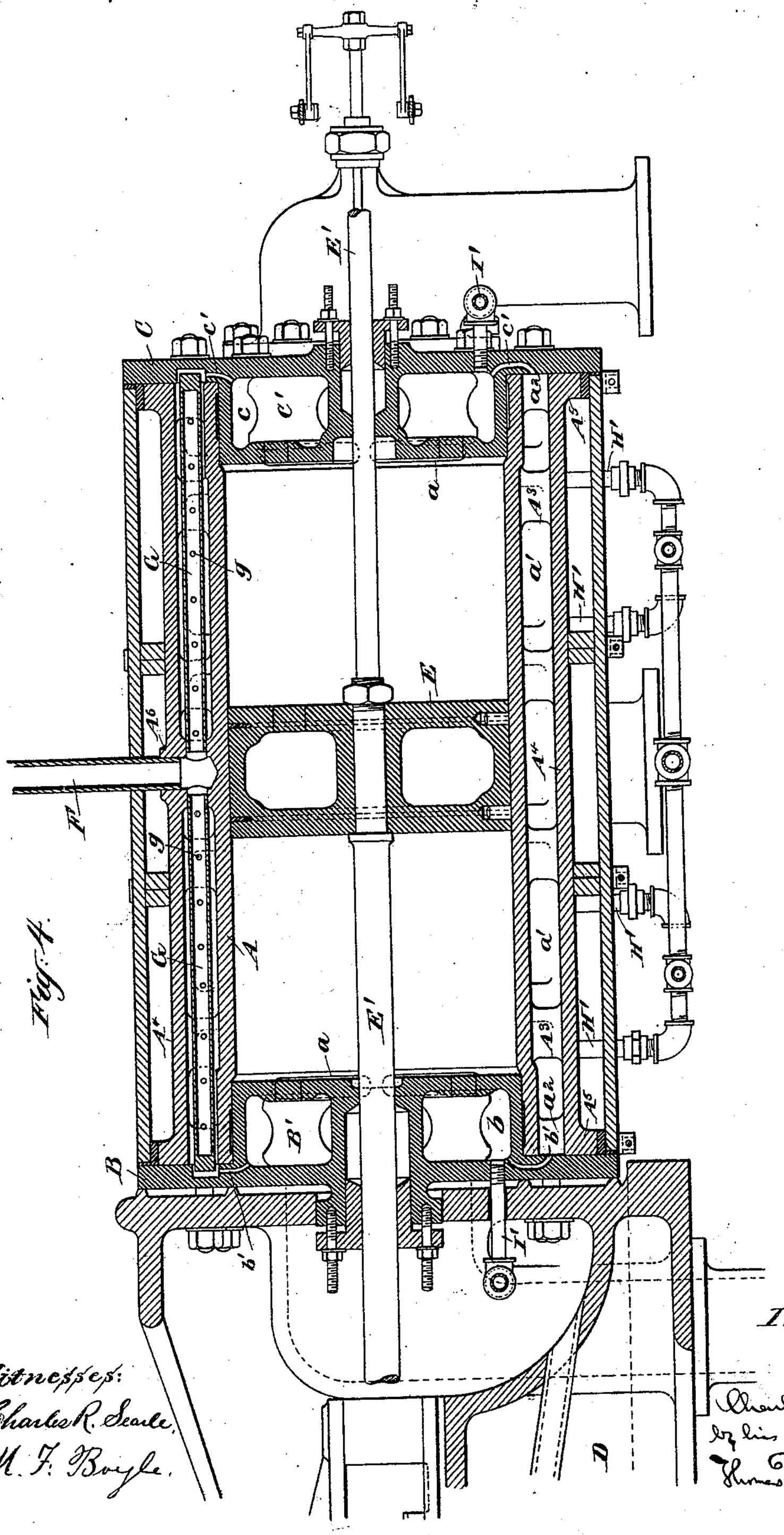

Fig. 4.

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C. T. PORTER.

STEAM ENGINE.

No. 517,982. Patented Apr. 10, 1894.

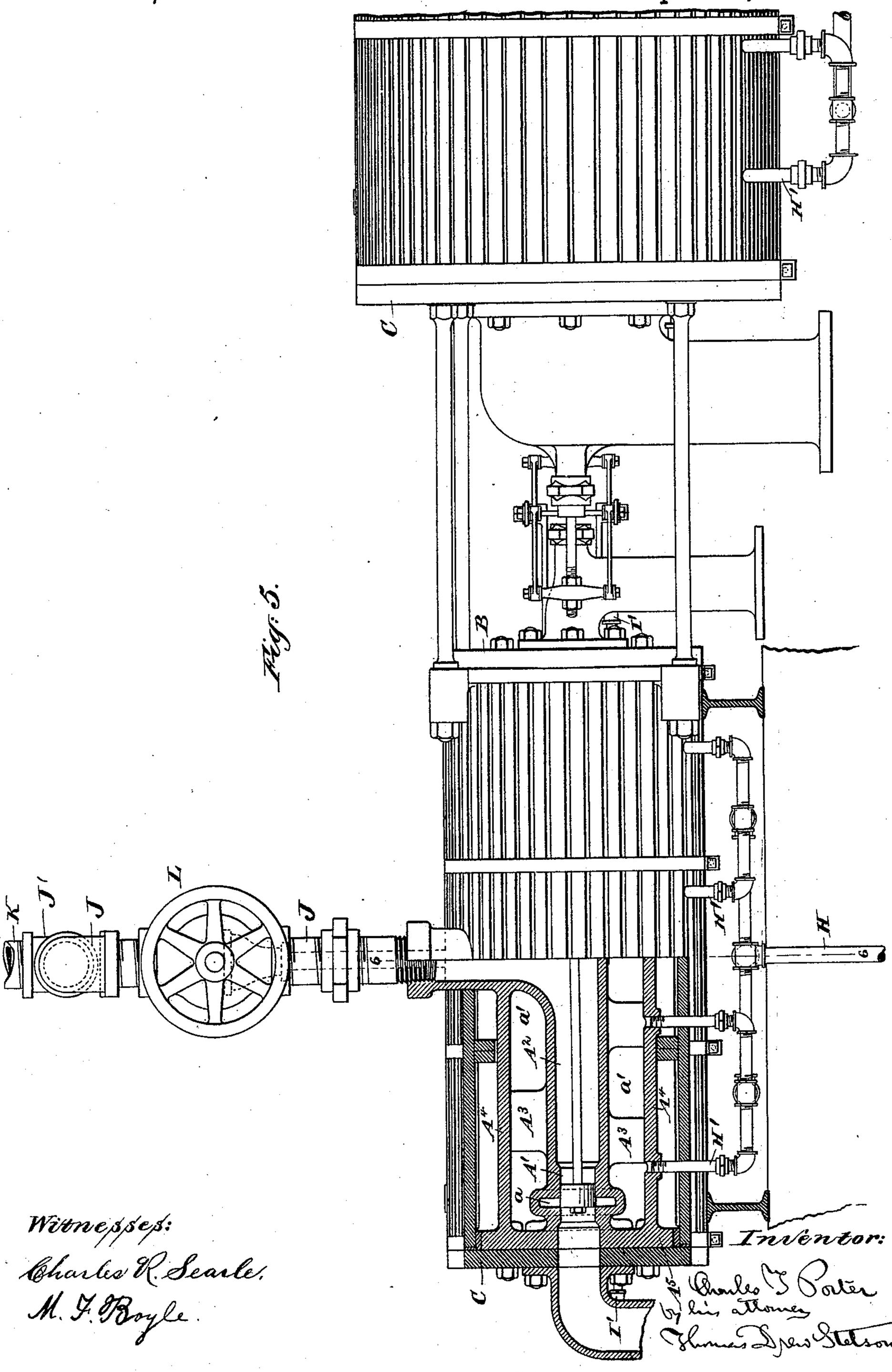

Fig. 5.

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C. T. PORTER.

STEAM ENGINE.

No. 517,982. Patented Apr. 10, 1894.

Fig: 7.

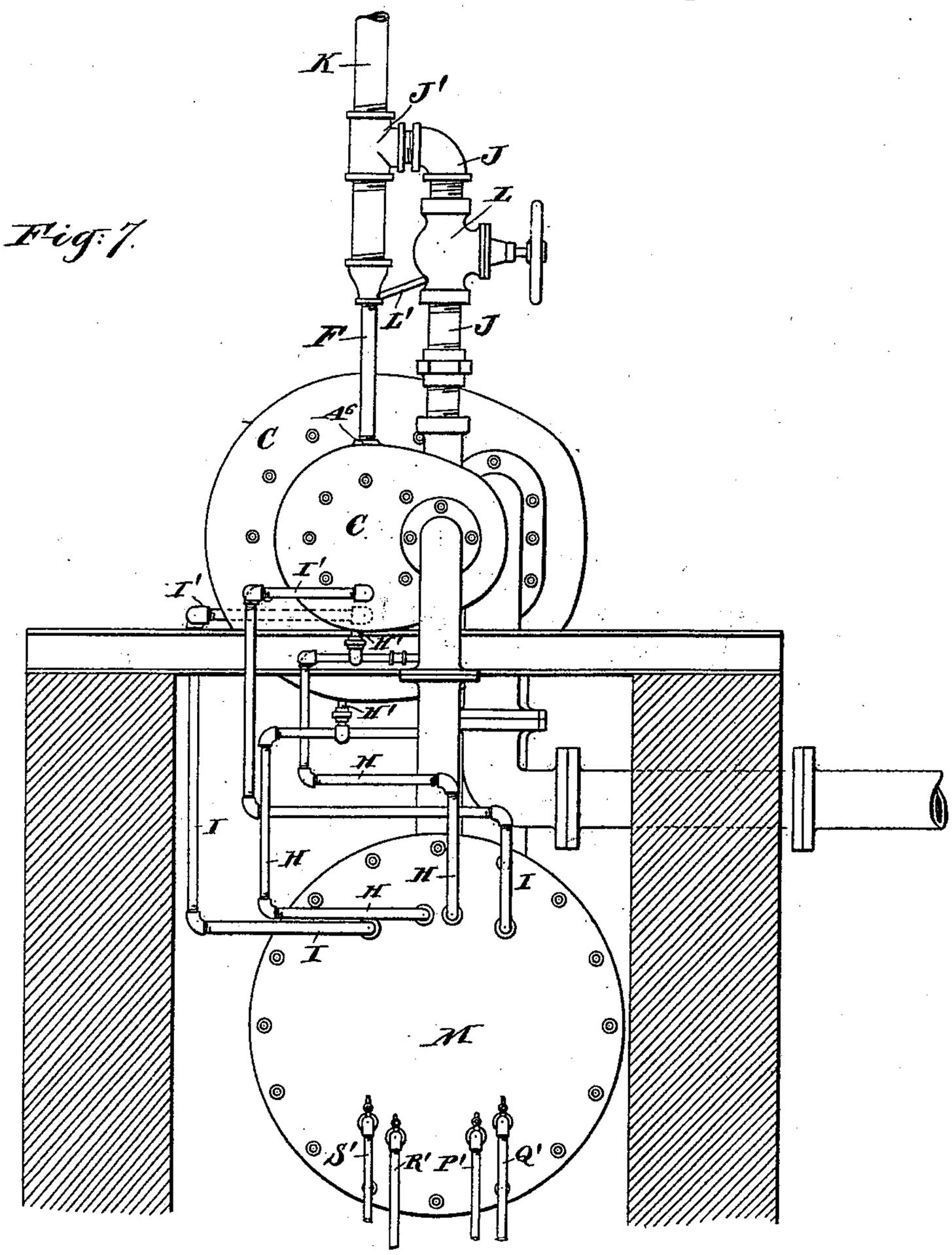
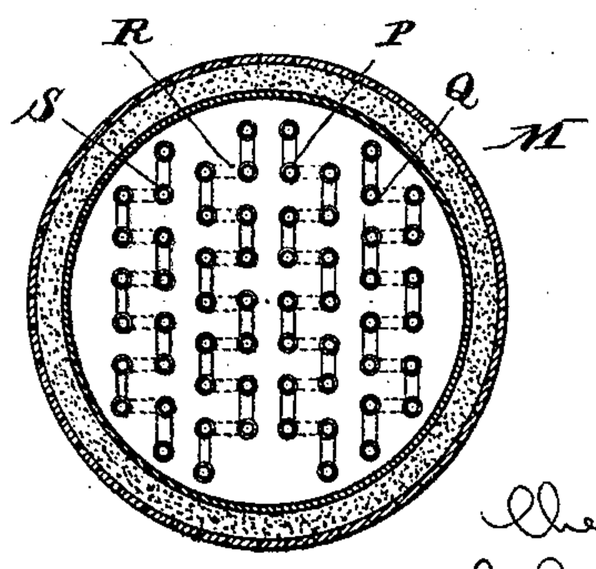


Fig: 8.



Witnesses:
Charles R. Searle.
M. F. Boyle.

Inventor:
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UNITED STATES PATENT OFFICE.

CHARLES T. PORTER, OF MONTCLAIR, NEW JERSEY.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 517,982, dated April 10, 1894.

Application filed April 13, 1893. Serial No. 470,224. (No model.)

To all whom it may concern:

Be it known that I, CHARLES T. PORTER, a citizen of the United States, residing at Montclair, in the county of Essex and State of New Jersey, have invented a certain new and useful Improvement in Steam-Engines, of which the following is a specification.

In the reciprocating steam-engines, the use of the piston valve for steam distribution, according to existing methods, is attended with serious objections.

First. The common slide valve acts as a relief valve, being lifted from its seat by excessive pressure in the cylinder before this reaches an injurious amount; but the piston valve cannot perform this function, and if, on the closing of the exhaust, water is imprisoned in the cylinder in excess of the capacity of the clearance and passage between the piston and valve, some part of the engine must be strained or broken. This is most liable to occur on starting. An unknown quantity of water is often present in the steam pipe, and a great deal is condensed in heating up the cylinder. This must be worked off carefully, and starting is always attended with anxiety. Only the large area of waste room, in clearance and port, adding, as an average in high speed engines, from seven to eight per cent. at each end of the cylinder to the piston displacement, enables these engines to be run without constant liability to break-down from water in the cylinder. Such an amount of waste room is well known to be fatal to economy in the use of steam, but this consideration compels it, even in cases where it would not otherwise be required, and even with large waste room water in the cylinder is the most fruitful cause of disaster.

Second. Again the valve is always heated sooner than its seat, especially sooner than the seat on the exhaust side of the port, and, if it is a proper fit, it will at first be seized by its more rapid expansion, and time must be allowed for the temperature to become equalized, or a break-down is certain from this cause also; and with all possible care the surfaces almost always become torn and really good fits cannot safely be employed.

Third. The steam jacket is certain to become filled, after a little time, with air which is abandoned by the steam in being condensed, unless special provision is made for getting rid of it. The efficiency of the jacket is thus much impaired, since to the extent that air is present it prevents the space from being occupied by steam, bringing heat.

Fourth. When the cylinder and the steam chest and the exhaust passages are separated from each other only by partitions, a loss of heat is suffered by conduction through these partitions; such loss varying in amount according to the extent of the surfaces, and the difference between the temperatures to which the opposite surfaces are exposed, and also according to the quantity of water present. Sometimes the loss suffered in this way is very great, and it is always considerable.

These defects in engine construction it is the object of this invention to avoid. I accomplish this object in the following manner:—I admit the steam between the ports of the cylinder into a pipe or pipes connecting the ports, but not otherwise connected with the cylinder, and I take away the exhaust through continuations of this pipe or of these pipes at each end, leading to external pipes. I envelop these pipes and the ports and the valve seats formed in the pipes on both sides of the ports, as well as the cylinder, in a steam-jacket, which thus embraces all the working parts. I take the steam into this jacket in the following manner:—The main steam-pipe is continued direct to the jacket, and a branch from this pipe, leaving it at right angles, conducts the steam to the controlling valve of the engine. By this means, as soon as steam is admitted to the pipe from the boiler, it fills the jacket, and all water coming from the boiler or condensed in the pipe, passes into the jacket. After two or three minutes, the jacket being properly drained, but maintaining the pressure of the steam therein and consequently attaining the high temperature of the steam the cylinder, pipes and valve-seats have reached the temperature of the steam. The engine may then be started with absolute safety. Little or no water passes into the cylinder, and very little is condensed in it except to supply the heat transformed into work. The valves may also be snugly fitted, and no abrasion of the surfaces will take place. The waste room in clearance and port can also be safely reduced

to the lowest practicable point. My construction requires at each end of the cylinder, for clearance and port, only about two per cent. additional to the piston displacement. However the boiler may prime, the construction of the steam pipe causes it to act as an efficient separator. The momentum of the water, carries it past the angle in the pipe, and the steam goes on to the cylinder practically dry. The important result is thus obtained of extremely small waste-room with absolute immunity from injury by water in the cylinder.

The problem of getting rid of air in the jacket I meet as follows:—In a compound cylinder engine I use an intermediate chamber, whether the compounding be on the tandem or the cross plan, and employ such chamber as a re-heater. I maintain a continuous flow through the jackets and the heads of both high and low pressure cylinders into the pipes of this re-heater. This current carries the air with it. To insure a current through each of the jackets and heads, I make the pipes in the reheater in four sections, and connect the pipe from each jacket and from each pair of heads to a separate section. By this arrangement I am enabled also, when found desirable, while maintaining a sufficient current through the jacket and heads of the low pressure cylinder, to take into them steam of a lower temperature than that of the boiler, by means of a reducer, or otherwise; returning the condensed water to the boiler separately.

To insure that the current shall move through every part of each jacket without permitting air to accumulate anywhere, I introduce the steam through a perforated pipe extending the whole length of the jacket on the upper side, and take it away at several points equally distributed at the bottom. I admit the steam to the heads of each cylinder by internal passages from the jacket, and take the current from the bottom of the interior of each head, connecting the pipes in such a manner that an equal current will be drawn from each one. Finally, the air and water are drawn equally from each of the four sections of pipes in the re-heater, the air is liberated and the water is returned by any suitable means to the boiler.

In the jacket of a non-compounding cylinder no strong current such as above described, is possible. The water is drawn from the bottom of the jacket in such cylinders and returned to the boiler, and the air is necessarily abandoned. To remove this, I employ a small blow-off pipe drawing equally from two or more points as remote as possible from the point or points at which steam is admitted, and provide at the end of this pipe a valve which is left slightly open.

The feature of making the jacket to envelop the steam passages is considered also to increase the economic value of the jacket.

The accompanying drawings form a part of this specification and represent what I consider the best means of carrying out the invention.

Figure 1 is a general side elevation. Figs. 2, 3, 4 and 5, show the low-pressure cylinder and its attachments on a larger scale. Fig. 2 is a side elevation partly in vertical section, the section being taken on the line 2—2 in Fig. 3. Fig. 3 is a transverse section in the midlength of Fig. 2. Fig. 4 is a central longitudinal section. Fig. 5 is a side elevation partly in vertical section showing the high-pressure cylinder and a portion of the low pressure cylinder and the connecting parts. Fig. 6 is a cross section on the line 6—6 in Fig. 5. Fig. 7 is an end elevation partly in section. Fig. 8 is a cross section on the line 8—8 in Fig. 1.

Similar letters of reference indicate corresponding parts in all the figures where they appear.

In common with some of the standard styles of construction, I make the cylinder and an outer casing or inclosing shell and the required valve-chamber in a single casting. I will designate the whole of this casting as A, using super-numerals, when necessary, to distinguish certain portions.

B is the front head, that nearest the shaft, and C the back head, using super-numerals as B′, C′, when necessary, to designate certain parts of these. The cavities or chambers in each will be designated by the corresponding lower-case letters, as *a*, *b*, *c*. The stout "bed" casting which connects the cylinder strongly to the bearings of the shaft, not shown, is marked D. The piston E and the piston rod E′ and connections therefrom to the crank, not shown, and to another piston, if the engine is compound, may be all of ordinary constructions.

A′, A′, are valve-seats united with the cylinder by properly formed ports *a*, and connected together and to the ends of the outer shell by straight pipes A^2. Except on small cylinders, I prefer to make two of these valve-seats at each end of the cylinder, the valves in which are connected through their stems, and work together as one valve and have so shown it. At a sufficient distance exterior to the cylinder and to the valve-seats and ports, and these pipes, is a completely inclosing shell A^4 connected to the cylinder by its heads A^5 and by studs A^3, making a steam-jacket space *a*′, which extends continuously around the cylinder and also around the valve-seats A′, ports *a*, and pipes A^2. The pipes A^2 are distinct from and clear of the cylinder, so that the steam in the jacket space *a*′ may completely surround them. This insures a uniform temperature on all sides of these pipes, and that the valve-seats formed in them on both sides of the ports, shall be completely warmed before steam is admitted to the distributing valves to impel the piston, and also, that the valve-seats shall maintain their true cylindrical form.

The piston-valves, reciprocated by proper

connections to the working portions of the engine, fit tightly and easily in their truly bored cylindrical valve-seats A′, and each exposes its corresponding port *a* at the proper periods to the strong steam at a high temperature which fills the pipe A^2 between these valve-seats, and to the exhaust passage which leads axially out and away into a suitable exhaust pipe. The pressure of the strong steam against the inner faces of these piston-valves being perfectly balanced, the valves are practically frictionless. The successive exhausts are led directly away in opposite directions through the ends of the jackets without exposing the relatively cool exhaust steam to the heated surfaces so as to abstract their heat.

A^5 is a sufficiently stout stud or boss which is chambered in its interior, and the use of which will be explained presently. In the interior of the front head B is an annular chamber *b*, and in the interior of the back head C is a circular chamber *c*. These heads are strongly braced and stiffened by radial webs B′, C′. Free communication is made to the chambers *b* and *c*, from the ends of the jacket space *a*′, through passages *b*′, *c*′ formed in the flange of each head, and connecting with openings a^2, in the heads A^5 of the inclosing shell A^4.

The steam is brought from the boiler through a pipe K, which may be provided as usual, with a valve, not shown, near the boiler, but which valve is always open except in emergencies, so that under all ordinary conditions the steam stands in the connected pipe J ready to be admitted to the engine on opening the controlling valve L. The pipe F which brings the steam to the chamber or jacket space *a*′, is connected to the pipe K, so that whether this valve be opened or closed the steam will have access through the pipe F to the jacket space *a*′. At the point J′ where the steam for the cylinder is taken from the pipe K, the current turns abruptly. The pipe F is in line with the motion of the steam as it comes from the boiler, extending directly downward while the pipe J is at a right angle to such motion. It follows from this arrangement that although the steam taken through the pipe F into the jacket-space *a*′ is only a small proportion of the total flow through the pipe K, the particles of water which come along with the steam are projected forward in a straight line by their momentum and also by their gravity, and ultimately flow with a small quantity of steam into the jacket space *a*′, and the steam which turns the abrupt angle and flows away to impel the piston is quite or nearly dry.

In compound cylinder engines I am able to obtain an active circulation through every part of the jacket space *a*′, and the chambers *b* and *c* in the heads B and C, of both the high-pressure and the low-pressure cylinders. This I effect in the following manner:—The hollow stud A^6 in each cylinder receives live steam through the pipe F which connects with the steam pipe K at a point beyond the controlling valve L, as already described, so as to insure that there shall always be steam supplied thereto. I admit into the jacket-space of the high pressure cylinder, steam at the boiler pressure. I provide for distributing the steam uniformly into all parts of the length of the jacket-space *a*′, by means of the perforated pipes G having their outer ends closed and their inner ends tapped into the boss A^6. The steam received through the pipe F is conducted by these pipes G along the whole length of the cylinder and is discharged equally through the perforations *g* distributed throughout its length. I attach importance to the fact that the holes in the pipe G which discharge the jets of steam into the jacket are arranged in two lines, one on each side of the pipe G, so that the jets through the several holes are projected to the right and left. This insures that the steam shall be delivered actively, and with approximate uniformity through all parts of the upper half of the jacket. The distribution of the holes for the connections of the pipes H over a large portion of the lower part of the jacket insures the removal of the water and a small quantity of the steam and air also with approximate uniformity from all portions of the lower part of the jacket. I maintain through all parts of this jacket-space, an active movement of the steam and of whatever water and air may be mingled therewith, by taking it away through a number of apertures distributed over the whole lower half of the shell A^4. This is effected by pipes H′, shown as tapped through the shell at eight points, connecting together first in twos, then in fours and finally all uniting in a pipe H, which conducts away the water, steam and air from the jacket space.

Active circulation through the jacket-spaces in the hollow interiors of the heads B and C, of each cylinder, is secured by providing an exit pipe I′ leading from the lowest point of each. The two exit pipes from the heads of each cylinder are united in a single pipe I in such a manner as to insure an equal current through each of the two heads. I have thus four exit pipes, one from the jacket space *a*′, and one from the heads, of each cylinder. These pipes are continued as follows:

M is a capacious chamber of boiler iron, or other suitable material, liberally incased in felt, wood or other good non-conductor, and which serves as a receiver and a re-heater for the steam in its passage from the high pressure to the low pressure cylinder. However dry the steam may have been brought to the high-pressure cylinder it is certain on its discharge, from the loss of heat due to its exchange into power, and from other sources, to contain particles of unevaporated water. I provide for supplying heat to effect evaporation of such water by circulating steam at a high pressure, through pipes which are inclosed in the receiver. I divide such pipes into

four sets, P, Q, R, S, and circulate steam independently through each of these four sets. The steam for one set, P, is supplied through the pipe H from the main jacket a' of the high pressure cylinder. The steam for an adjacent set, Q, is supplied through the pipe I, from the chambers b and c in the heads of the high pressure cylinder. The steam for the third set, R, is supplied through the pipe H', from the main jacket a', of the low pressure cylinder, and the steam for the fourth set, S, is supplied through the pipe I' from the chamber b in one head and the chamber c in the other head of the low pressure cylinder. I trap out the water and discharge the air from each set through separate pipes P', Q', R', S'. The cocks or analogous provisions for the latter purpose may be of any ordinary or suitable construction. It is essential that the traps be capable of discharging all the water, both that which is received with the steam through the pipe F, and that which is produced by condensation in its work of maintaining the heat of the cylinder, and in its further work of re-heating the steam in the receiver or re-heater M. The pipes P', Q', R', and S' may discharge their water through separate traps, or may be united in pairs discharging through two traps, or may all be connected and discharge through a single trap, according to the requirements of each case. Pumps may be used instead of traps. This equipment effects the highest economy in the use of steam, and is indispensable for this purpose. When such a degree of economy is not required, the re-heater and the return of water of condensation to the boiler may be omitted, by which omission the construction is much simplified.

In the case of non-compounding cylinders there can be no current into a re-heater. The hollow stud A^6 as well as the perforated pipes G, and the multiple exit pipes H' and separate exit pipes I from the heads, are in those cases dispensed with. The steam from the pipe F may be taken into the jacket-space a' in any suitable manner, the water is drawn from the bottom of this space, and of the jacket spaces in the cylinder heads, by a single pipe, and returned to the boiler. The internal communications with the heads are made sufficient to insure a practical equilibrium of pressure throughout. The air abandoned by the steam in being condensed must be permitted to escape from all the jacket-spaces. The pipes for this purpose I locate in such manner that a current from the points of admission carries the air as it is abandoned along to the points of discharge. A small quantity of steam is necessarily lost with the escaping air, but with proper regulation this loss is not appreciable.

L' is an inclined pipe connecting the valve L with the pipe F so conditioned as to convey into the latter any water produced by condensation in the pipe above during a stoppage.

Modifications may be made without departing from the principle or sacrificing the advantages of the invention. Parts can be used without the whole.

Although I have described my invention as a "steam" engine, it is obvious that it may be used with any volatile fluids. It aids to maintain the temperature of the interior surfaces at a uniform point, notwithstanding the variations in the temperature of the vapor under the varying pressures experienced in the direct stroke and the return stroke of the piston.

In some cases it may be desirable to supply the jacket space of the low pressure cylinder with steam at lower pressure. This I can do by passing the current for these jackets through a reducing or regulating valve, not shown.

I attach importance to the leading away of the exhaust axially from each end because it avoids all contact of the hotter parts therewith. When, as usual, the hot metal surrounds or lies adjacent to the exhaust passages, such metal uselessly superheats the exhaust, and to do so abstracts heat from the live steam, thus exerting a refrigerating influence on the engine.

I claim as my invention—

1. In a steam engine, the outer shell A^4 formed and arranged as shown so as to inclose a practically continuous steam-jacket space a' surrounding the cylinder A, valve-seats A', ports a and admission pipes A^2, such outer shell being formed integral with the cylinder, all substantially as herein specified.

2. In a steam-engine, the admission-pipes A^2 connecting the valve-seats, having a shell A^4 inclosing the whole, and arranged as shown, so as to allow the steam in the jacket space a' to flow completely around said pipes, the parts being braced by studs A^3 all formed integral, as herein specified.

3. Two steam-pipes, one straight and the other connected thereto at an angle, bringing steam from the boiler to the cylinder, and a jacket around the same, arranged as shown, so that the steam for the jacket is allowed to move in a straight line past the junction, and the steam to be used in the cylinder is caused to turn a sharp angle, in combination with provisions as the pipes H', H, for conveying away the water with a small proportion of the steam from the jacket, all substantially as specified.

4. The two steam pipes F and J, and junction J', in combination with the steam jacket A^4, and with the pipe K supplying steam, arranged as shown, so that any water mingled with the steam received through the pipe K shall be projected by its momentum and gravity past the angle and be delivered through the pipe F in a straight line and thence into the jacket-space a', and that the pipe J shall receive mainly dry steam, as herein specified.

5. In a steam-engine having an outer shell A^4 inclosing a jacket-space a', the pipes J, K, turning an angle and supplying steam to

the cylinder to impel the piston, and the pipe F supplying steam to the jacket-space, connected to the pipe K at the angle J′, and the valve L and pipe L′ combined and arranged as shown, so that the particles of water in the steam shall tend, by their momentum, to be thrown into the pipe F and be led to the jacket space, and the drier steam shall be led to the interior of the cylinder, and any water collected in the valve shall be removed, all substantially as herein specified.

6. In a steam-engine, in combination with piston-valves reciprocating within the cylindrical valve-seats A′ and with a jacket A^4 inclosing both the main cylinder A and such valve-seats, the exhaust passages leading axially away from such piston valves in opposite directions into external pipes, substantially as herein shown and described.

7. In a steam-engine having a jacket, provisions as the branched pipe H, H′, for draining the cylinder from a number of widely distributed points in the lower portion of the jacket, in combination with means as the perforated pipe G for introducing the steam at a number of widely distributed points in the upper portion of the cylinder, with apertures for such induction of the steam to the jacket being arranged in two series at or near the line of the highest point of the cylinder, and discharging the steam in jets in opposite directions from such line, all substantially as herein specified.

8. In a compound steam-engine having on each cylinder a shell A^4 inclosing the steam jacket space a', and heads B, C, having inclosed chambers b, c, serving also as steam jackets, and a receiver M in which the steam is retained in its passage between the cylinders, the series of separate heating pipes P, Q, R, S, traversing such receiver, in combination with the separate connections H, H′, I, I′, to each from the several jackets, arranged to carry steam independently from each jacket through the said receiver, all arranged for joint operation substantially as herein specified.

9. In a compound steam-engine having the shells A^4 inclosing the steam jacket spaces a' and heads B, C, having inclosed chambers b, c, serving as steam-jackets, and a receiver M in which the steam is retained in its passage between the cylinders, containing the series of separate heating pipes P, Q, R, S, the separate discharge pipes P′, Q′, R′, S′, for conveying away the water and air independently from each, so as to insure an active and approximately uniform movement of the steam through the whole, as and for the purposes herein specified.

In testimony that I claim the invention above set forth I affix my signature in presence of two witnesses.

CHARLES T. PORTER.

Witnesses:
M. F. BOYLE,
H. A. JOHNSTONE.