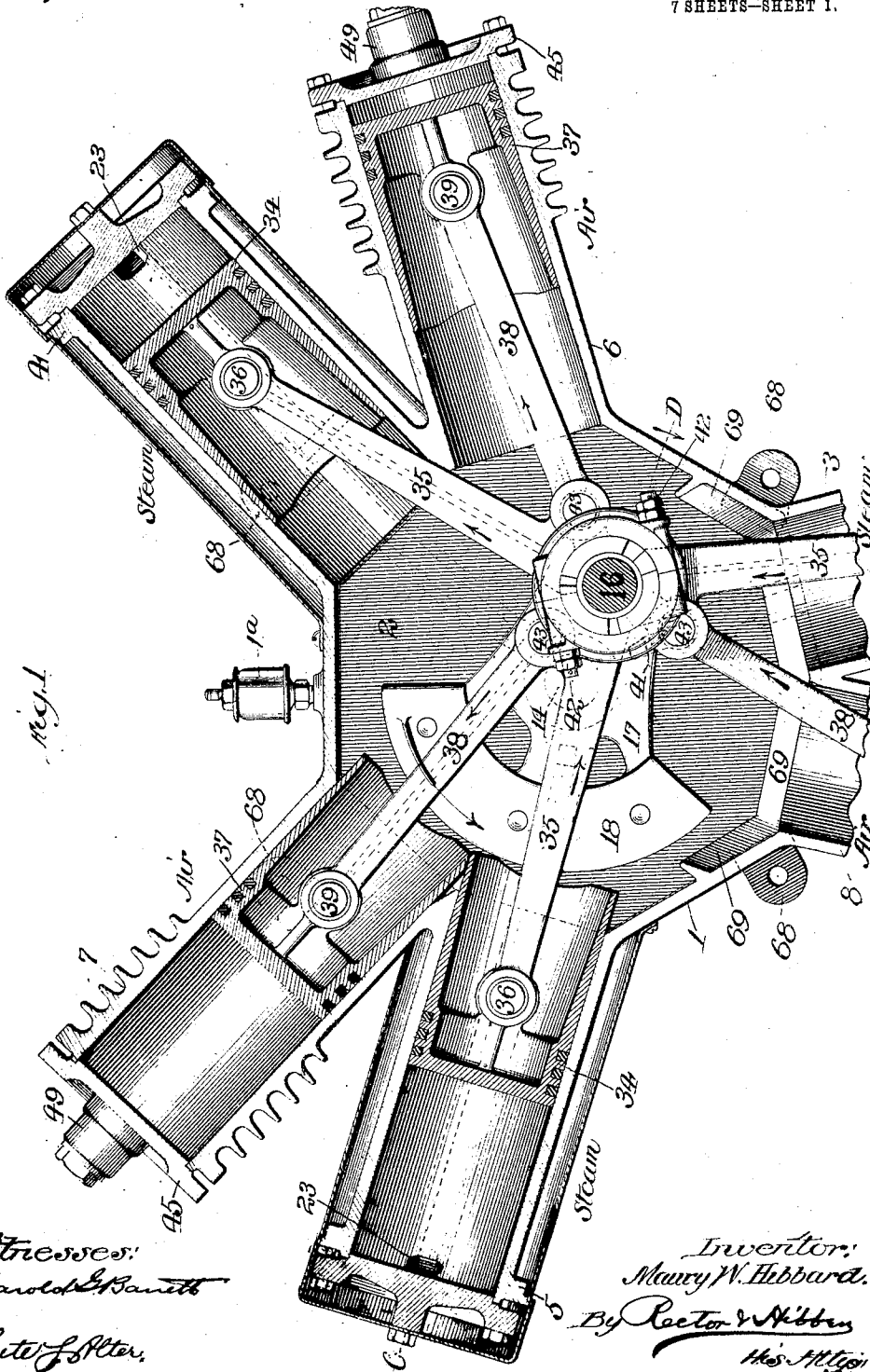


M. W. HIBBARD.
STEAM PUMPING ENGINE.
APPLICATION FILED JAN. 22, 1902.

938,146.

Patented Oct. 26, 1909.
7 SHEETS—SHEET 1.



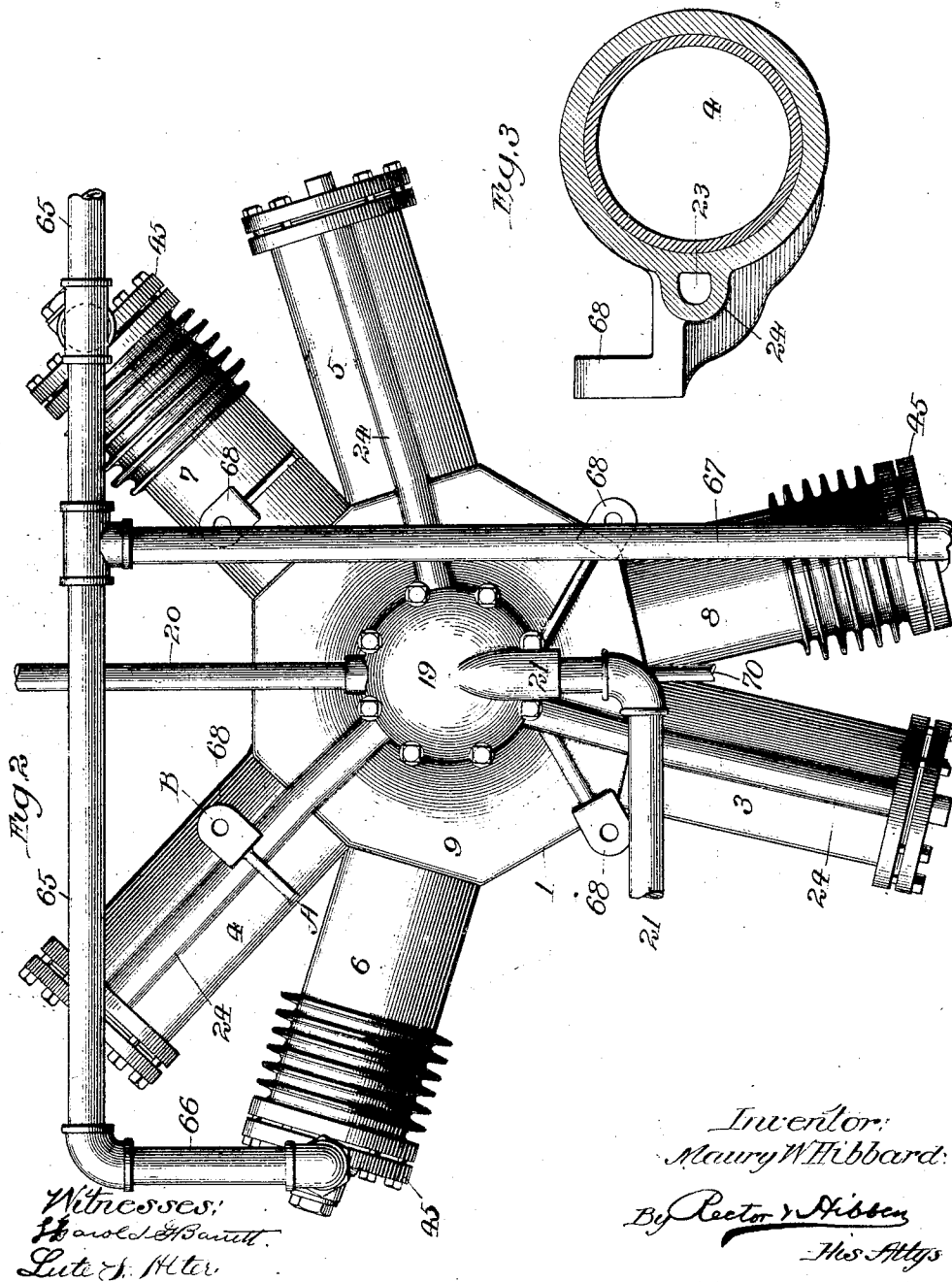
Witnesses:
Harold E. Barrett
Lester L. Allen

Inventor:
Maurice W. Hubbard.
By Rector & Allen
Attorneys

M. W. HIBBARD.
STEAM PUMPING ENGINE.
APPLICATION FILED JAN. 22, 1902.

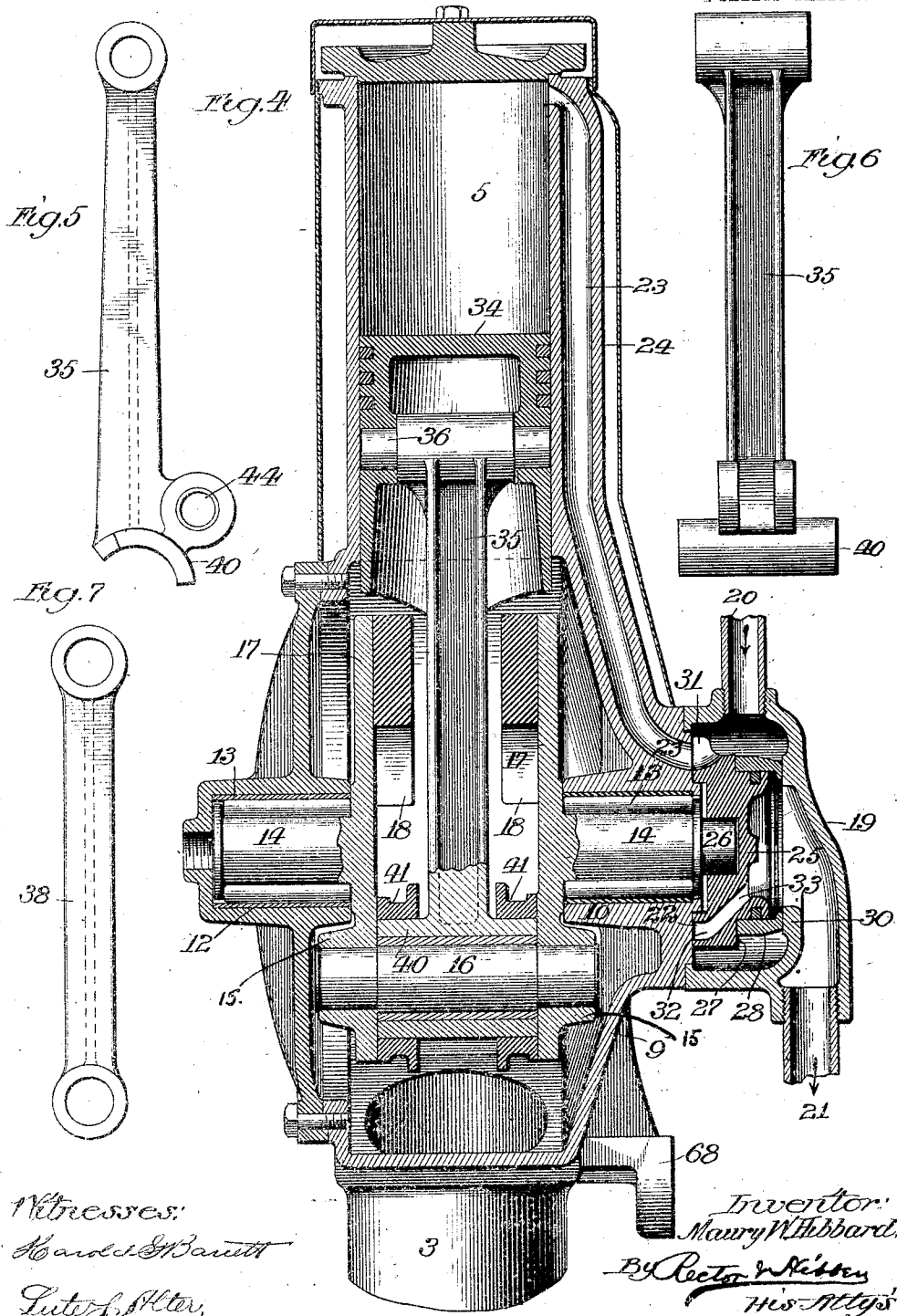
938,146.

Patented Oct. 26, 1909.
7 SHEETS—SHEET 2.



938,146.

7 SHEETS--SHEET 3.

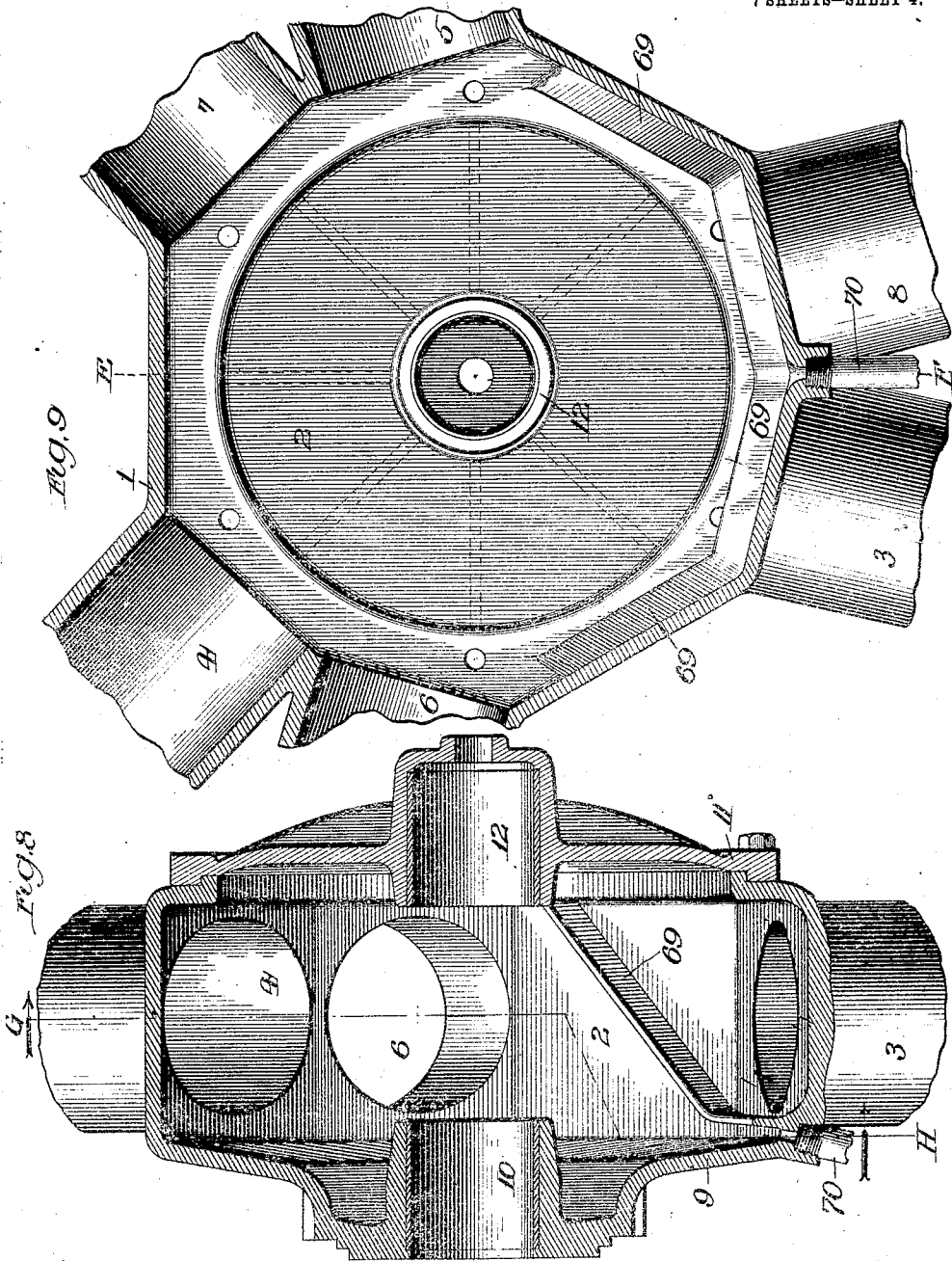


M. W. HIBBARD.
STEAM PUMPING ENGINE.
APPLICATION FILED JAN. 22, 1902.

Patented Oct. 26, 1909.

7 SHEETS—SHEET 4.

938,146.



Witnesses
Abraham B. Bant
Lester A. Alter,

Inventor
Maury W. Hibbard.
By Rector & Hibber
His Attys.

M. W. HIBBARD.
STEAM PUMPING ENGINE.
APPLICATION FILED JAN. 22, 1902.

938,146.

Patented Oct. 26, 1909.
7 SHEETS—SHEET 5.

Fig. 10

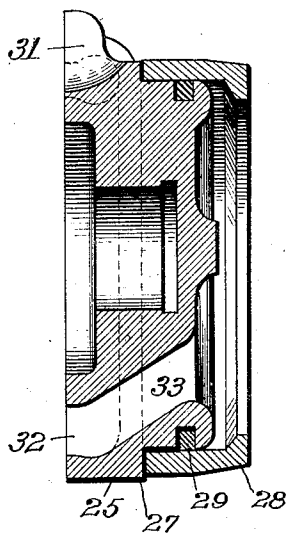


Fig. 11

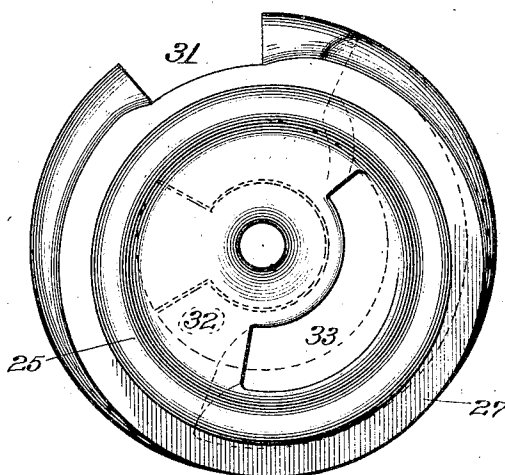


Fig. 13

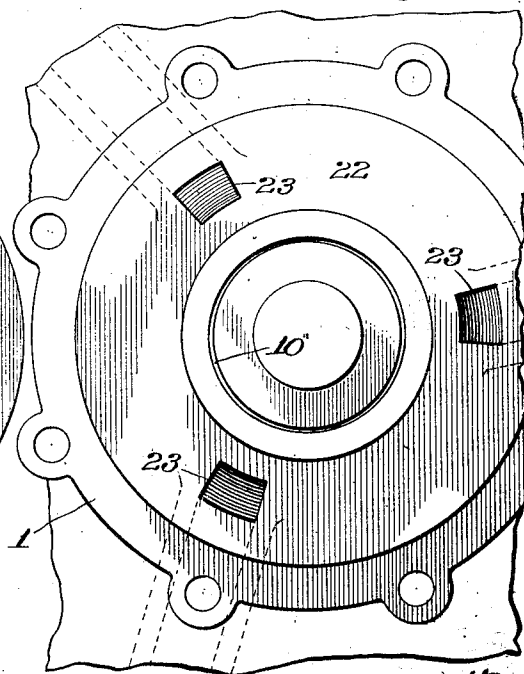
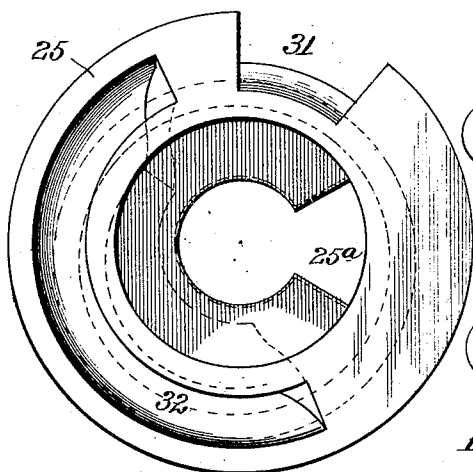


Fig. 12



Witnesses:

Edward E. Baugh

John J. Miller

Inventor:
Maurice W. Hibbard

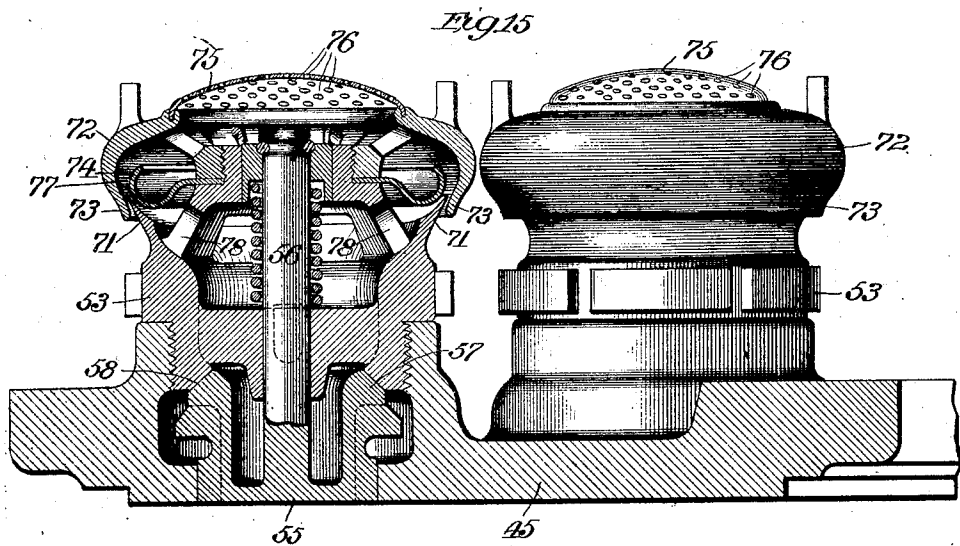
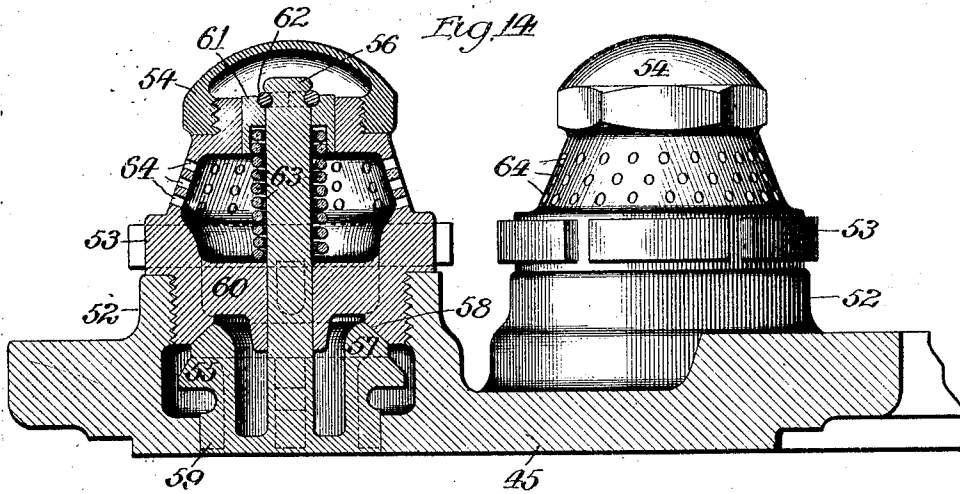
By Hector J. Hibbard
His Atty

M. W. HIBBARD.
STEAM PUMPING ENGINE.
APPLICATION FILED JAN. 22, 1902.

938,146.

Patented Oct. 26, 1909.

7 SHEETS—SHEET 6.



Witnesses
Hendrick B. Smith
Lute L. Alter,

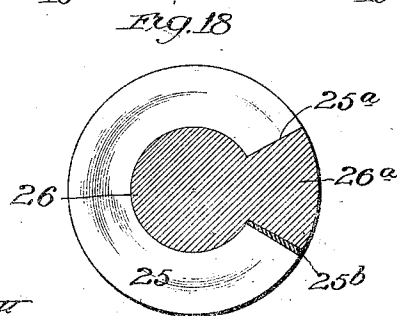
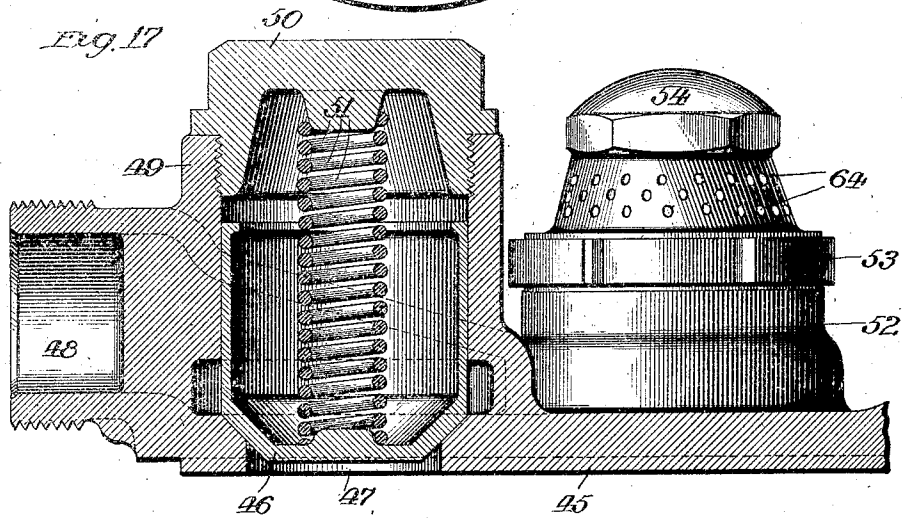
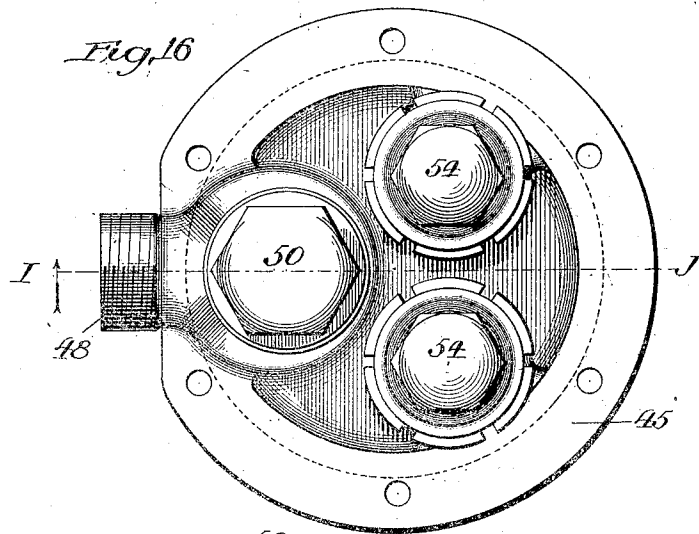
Inventor:
Maury W. Hibbard.
By, Rector & Mission
His Attys.

M. W. HIBBARD.
STEAM PUMPING ENGINE.
APPLICATION FILED JAN. 22, 1902.

938,146.

Patented Oct. 26, 1909.

7 SHEETS—SHEET 7.



Witnesses:
Harold S. Bennett
Lute L. Altier

Inventor
Mauvy W. Hubbard
By Rector & Hibbard
His Atty's

UNITED STATES PATENT OFFICE.

MAURY W. HIBBARD, OF CHICAGO, ILLINOIS, ASSIGNOR TO RICHARD FITZGERALD, OF CHICAGO, ILLINOIS.

STEAM PUMPING-ENGINE.

938,146.

Specification of Letters Patent.

Patented Oct. 26, 1909.

Application filed January 22, 1902. Serial No. 90,822.

To all whom it may concern:

Be it known that I, MAURY W. HIBBARD, residing in Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Steam Pumping-Engines, of which the following is a specification.

My invention relates to steam pumping engines used for the purpose of compressing fluids; and its object is to provide an engine of this class economical in consumption of steam and showing great efficiency in results.

While my engine may be employed for compressing any fluid, yet it has been primarily designed for the compression of air, more particularly to supply compressed air for air brake systems and air operated appliances on railway trains. Consequently my engine is herein shown of a portable character with means of attachment to a locomotive so that such engine may be readily substituted for the standard air brake engines or pumps now in common use, and my engine will without intention of limitation to any particular application, be described as capable of compressing air and will be compared in efficiency to such air brake pumps or engines.

It is well known to those skilled in the particular art that the present standard air brake pumps are open to a number of serious objections chief among which may be mentioned their wasteful consumption of steam and inability to work continuously for any great length of time without injurious heating of the compression cylinder and the consequent burning out and destruction of packing rings, and packing in the stuffing boxes as well as the destruction of inlet and outlet valves. The practical demands on such air brake pumps or engines have increased with the increased length of railway trains and increased use of air-operated appliances thereon, and the consequent increase of compressed air required and the present standard devices have been unable to satisfactorily meet such demands either by increase of cylinder diameter or by duplex arrangement or two stage compression.

In my engine hereinafter fully explained a series of steam and air cylinders are, in the present instance, connected to a single crank pin. The arrangement is such that the steam is cut off and the steam pistons caused to complete their stroke on the ex-

pansion and furthermore, the connecting rods of both the steam and air pistons are caused to act as a series of toggles or knee levers whereby great air compression is obtained with a minimum of steam pressure.

The many features of advantage and utility in construction and operation of my engine will be apparent from the description hereinafter given.

In the drawings Figure 1 is a sectional elevation of my engine; Fig. 2 a rear elevation thereof; Fig. 3 a section on line A—B of Fig. 2; Fig. 4 a section line C—D of Fig. 1; Figs. 5 and 6 elevations of a steam cylinder connecting rod; Fig. 7 an elevation of an air cylinder connecting rod; Fig. 8 a section on line E—F of Fig. 9; Fig. 9 a section on the irregular line G—H of Fig. 8; Figs. 10, 11 and 12 detail views of the rotary steam valve; Fig. 13 a plan view of the valve seat; Fig. 14 a view showing one of the inlet valves in section and the other in elevation; Fig. 15 a similar view of a modified form of inlet valve device; Fig. 16 a plan of the end cap of an air cylinder; Fig. 17 a section of a discharge, and Fig. 18 a detail view showing the projecting crank shaft.

My invention comprises, as herein shown, a casing 1 providing a crank chamber 2 and having a series of radially extending cylinders herein arranged in three pairs or groups of one steam cylinder and one fluid cylinder, the latter cylinders being hereinafter for convenience termed air cylinders. While I prefer to use six cylinders, three steam and three air cylinders which has been found practical, yet the plurality of cylinders may comprise a greater number of cylinders. The three steam cylinders are herein marked 3, 4 and 5, and the three air cylinders are marked 6, 7 and 8. By preference the cylinders and crank chamber are cast in one piece, but this is of course not essential.

Referring to Figs. 4, 5 and 6, the crank chamber is closed on one side by a wall 9 herein shown integral with the casing and provided centrally with the inwardly extending bearing sleeve or box 10. The opposite wall of the crank chamber is formed by a removable cap or plate 11 which is bolted or otherwise secured to the casing and provided centrally with a bearing sleeve or box 12.

To avoid friction or reduce it to a mini-

mum, suitable roller bearings 13 are employed in the two boxes 10 and 12 for the crank shaft 14 which has the cranks 15 and the connecting crank pin 16 which are adapted to rotate in the crank chamber 2, Fig. 4. The cranks have extensions 17 opposite the crank pin and to them are secured weights 18 to act as counterbalances, Figs. 1 and 4. The valve for admitting and exhausting the steam is contained within a steam chest 19, Fig. 4, which is here shown as secured to one side of the crank chamber and provided with the steam inlet 20 and steam exhaust 21. A portion of the outer face of the side 11 of the crank chamber is faced off to form a valve seat 22 provided with the series of three steam ports and passages 23 which extend radially of the crank shaft and through the ribs 24 cast on to the rear face of the steam cylinders into which the ports enter at the top or outer end of the cylinders, Fig. 4. These ports which are arranged on the circumference of a circle with the axis of the crank shaft as the center are governed by a rotary valve 25 which is suitably connected to the extended end 26 of the crank shaft so as to be rotated thereby. As shown in Figs. 12 and 18 such extended end 26 has a segmental lateral projection 26^a adapted to be received by a larger segmental recess 25^a in the valve, the balance of the space being taken up by one or more metal liners 25^b whose position may be changed to one side or the other to change the lap and lead of the valve. The valve 25 has on its outer side a shoulder or seat 27 on which seats a ring 28 working loosely thereon and packed with respect to the valve by a suitable packing ring 29, Figs. 4 and 10. This ring 28 is adapted to bear against an annular flange 30 formed on the inner wall of the steam chest in suitable manner, Fig. 4, and is free to rotate with the valve or the valve to rotate with respect to the ring. The margin of the valve is cut away at one point to form a steam admission port or passage 31 and such valve is provided with a curved recess 32 adapted to register with and control the exhaust of steam from the steam cylinders which in exhaust passes through the recess and through a port or passage 33 in the valve and finally to the exhaust 21. The steam exhaust is through the valve, and as shown is substantially central thereof. Under the above described construction the valve is a balanced valve.

Each steam cylinder has a single acting piston 34 connected to the crank pin by means of a connecting rod 35 pivoted at its outer end to a wrist pin 36. Likewise each air cylinder has a single acting compressing piston 37 here shown as connected by means of a connecting rod 38 to the connecting rod 35 of the steam cylinder in its group and to

a wrist pin 39. The crank end of each steam connecting rod does not embrace the crank pin, but only partially so, such end being formed as an arc occupying approximately one-third of the circumference of the crank pin. This construction of connecting rod is rendered necessary inasmuch as the three rods are mounted on the same pin and hence the circumference thereof must be shared between them. In order to hold these connecting rods 35 in coöperative relation to the crank pin such rods are provided with opposite lateral extensions or partial hubs 40, Figs. 5 and 6, which are all embraced by the pair of clamping rings 41 which are drawn up or tightened by the bolts and nuts 42.

Owing to the lack of space for direct attachment to the crank pin the connecting rods 38 of the air pistons are pivoted to the connecting rods 35 of the steam pistons, each rod 38 being connected to the rod 35 of its group, but although the shown arrangement is preferred as the more desirable and practical one it will be understood that the connecting rods of the air cylinders might be the ones connected to the crank pin. In the present instance both ends of the rods 38 of the air pistons are similarly provided with eyes, the eye on the outer end embracing the wrist pin 39 and the eye on the inner end embracing a pivot pin 43 arranged in an extension or lug 44 on the inner or crank end of the connecting rods 35, Figs. 5 and 6. As will be hereinafter made apparent the various connecting rods in coöperation with the cranks act as members of toggles or knee levers.

As shown in the drawings, Figs. 1, 5, 6 and 7 the connecting rods are provided on one side with ribs which are in the same vertical plane as the discharge orifice of a suitable lubricator such as the lubricator 1^a arranged on the top of the casing 1. These ribs thus not only constitute a strengthening provision for the connecting rods, but also serve both to conduct oil to the crank pin bearing and to throw the oil around the crank chamber and into the cylinders whereby the latter are thoroughly and efficiently lubricated. The oil will also be thrown as far as the wrist pin bearings for the purpose of oiling these bearings also.

Each air cylinder has a removable end cap 45 in which are mounted the inlet or suction valves and the outlet or discharge valves. In order that sufficient volume of air may be promptly admitted on the suction stroke, a plurality of inlet valves is preferred and in the present instance two such valves are shown.

Referring to Figs. 16 and 17 the outlet or discharge valve 46 comprises a cylinder adapted to seat across the outlet port 47 and thereby govern communication between such port and the discharge or delivery passage

48. The outlet valve is movable in a chamber formed in a boss 49 formed on the head 45 and closed by the screw plug 50 between which and the outlet valve is interposed a suitable spiral spring 51. Obviously the compressed air raises the outlet valve against its tension and is then delivered through the discharge passage 48. Any other suitable form of outlet valve may, however, be used.

10 As both the inlet or suction valves are the same in construction and operation a description of one will apply to both. Preferably integral with the cylinder head are two bosses 52 into which screws a casing 53 closed at its outer end by a cap 54. In Fig. 14 the right hand valve is shown in elevation and the left hand valve in section. The inlet valve comprises a valve body 55 and a stem 56. The valve body has a beveled portion 57 adapted to seat on a seat 58 formed on the casing 53 and such valve body is also provided with wings or guides 59. The valve stem works through a spider 60 and is fastened to a collar 61 by the ring 62. A spring 63 coiled around the valve stem abuts at one end against the collar 61 and at the other end against the spider 60, with the result that on the suction stroke of the air cylinder piston the inlet valve will move inward and off its seat against the tension of the spring, the collar 61 being guided by the upper end of the casing 53, whereby air will be drawn into the cylinder through the inlet holes 64 in the valve casing. The above described inlet valves are suitable but others might be adopted.

I do not herein claim the above described inlet valve, but have made it the subject matter of a divisional application filed April 10 1902, Serial No. 102,115 for improvements in air compressors.

All the discharge passages from the air cylinders may be connected to a common discharge or delivery pipe by means of suitable pipe connections, and in Fig. 2 is shown a convenient arrangement in the case of the present and illustrated particular application of my invention. As herein shown the common discharge pipe 65 is connected with the discharge of air cylinder 6 by a pipe 66, with air cylinder 8 by a pipe 67 and with air cylinder 7 by a substantially direct connection.

In order that the engine may be attached to the same base plate which receives the present standard locomotive pumping engines a series of four lugs 68 are provided whereby the engine may be bolted to such base plate. Two of the lugs are arranged on the engine casing and the other two on the cylinders 4 and 7.

Referring to Figs. 1, 8 and 9 provision is made for drawing away any moisture or water liable to collect in the crank chamber

which water would otherwise flow down into the two lowermost cylinders 3 and 8. To this end I have provided the interior of the crank chamber with a flange or rib 69 extending substantially horizontally along one side of the two lowermost cylinders and then extending upwardly obliquely across the crank chamber whereby a trough is formed to conduct the water downwardly to an outlet 70. As shown in Figs. 5 and 6 the bottom trough slopes downwardly from both ends to such outlet 70.

The operation of the pumping engine will be best comprehended from a description of a complete cycle of the operating parts, the movement being anti-clockwise. Referring to the drawings, Fig. 1 represents the position when the steam cylinder 3 having already received steam is moving inward under the direct steam pressure and just about cut off while the other two steam cylinders are at exhaust because the exhaust recess of the rotary valve connects their steam ports with the atmosphere, cylinder 4 being at full exhaust and cylinder 5 just beginning its exhaust. Starting with this position of the parts, the connecting rod of the steam cylinder 3 is now pressing inwardly upon the crank pin which constitutes the joint of a toggle formed by the cranks and the connecting rod 38 of the air cylinder 6. At this time such latter connecting rod is moving outward and its piston has almost completed its outward stroke of full air compression. Also steam cylinders 4 and 5 are exhausting but are in different stages of exhaust. The piston of air cylinder 7 having completed its inward or suction stroke is just beginning its compression stroke while the piston of air cylinder 8 is on its suction stroke. The direction of movement of the six rods is indicated by arrows in Fig. 1. Continued inward movement of the connecting rod of steam cylinder 3 to a point beyond its quarter stroke extends the toggle to straight position completing the outward stroke of the piston of air cylinder 6 and causing a partial compression of the air in cylinder 7. Cylinder 3 is cut off at quarter stroke as shown in Fig. 1, and the steam and its piston works therebeyond on expansion until it reaches its full inward stroke when its exhaust is opened. But just before this period is reached, steam is admitted to cylinder 4 whereupon steam cylinder 4 acts with respect to air cylinders 7 and 8 in precisely the same manner as the steam cylinder 3 did with respect to air cylinders 6 and 7 as above described. Likewise when it comes the turn of steam cylinder 5 for positive action it does its work in similar manner in connection with air cylinders 8 and 6 bringing the piston of cylinder 8 to position of full compression and moving the piston of cylinder 6

to position of partial compression. Following the movement of the particular rod 35 of the steam cylinder 3, such cylinder will become opened to exhaust on completion of full inward stroke, the steam cylinder 5 being already at exhaust. When such rod is substantially at two thirds revolution, the steam piston 5 will take steam and cylinder 4 will shortly thereafter be exhausted and when such rod completes its revolution its cylinder will take steam and after slight movement, the parts will, by completing the cycle, again assume the position from which we started. It will be apparent that each steam cylinder is cut off at about quarter stroke and the piston moves to full inward stroke on steam expansion. Thus each steam cylinder fully compresses the air in the cylinder in the neighboring group of cylinders in the direction of rotation and partially compresses air in the air cylinder in the group next beyond that. It will also be observed that each cycle represents the working of a series of toggles. Starting with the parts as in Fig. 1 the first toggle is that there represented by the crank and the connecting rod 38 of air cylinder 6. The second toggle will consist of the crank and the connecting rod 38 of the air cylinder 7, and the third toggle will consist of the crank and the connecting rod 38 of the air cylinder 8. The toggle being a most powerful type of lever I am enabled to obtain advantageous results from use thereof in my engine. The efficiency of air compression is increased and the consumption of steam is decreased, besides which, injurious effects due to heating are avoided.

As hereinbefore described the six cylinders here shown are arranged in three groups of one steam cylinder and one air cylinder. The proper and efficient as well as practical arrangement as now known requires that the centers of the groups of cylinders be placed 120 degrees apart at their centers and the individual cylinders of each group be placed 30 degrees apart.

In steam pumping engines of the class described, particularly the pumping engines used on locomotives for compressing air for the air brake and signal systems, it is a well known fact that the waste of the power of the steam is enormous, especially for the reason that the pumps do not run on the expansion of the steam and for the reason that the steam and air pistons are directly connected. In applicant's apparatus, on the other hand, the construction and operation are such that the full power is utilized with the result that with steam and air cylinders of equal diameter, steam at 60 pounds boiler pressure results in a delivery of compressed air at 90 pounds pressure which effect has not heretofore been produced.

The inlet valves shown in Fig. 14 are of the ordinary construction, but they, like those of the usual type, are open to objections arising from the clogging and collecting of dust, dirt, or grit and foreign particles generally which are too fine to be practically screened, and entrance thereof into the pump cylinders, thus causing a rapid wearing away of the inner walls of the cylinder as well as a wearing of the piston and its rings, thereby permitting leakage around the piston. These objections are particularly serious in railroad work and to provide for a cleansing of the air before passing the suction valve is the object of the novel construction shown in Fig. 15 which provides for a centrifugal separation of these foreign particles from the air. The suction valve proper is the same as that heretofore described and the parts are correspondingly indicated. The valve casing 53 is however slightly different in that the suction holes are dispensed with and the casing provided with a flaring lip 71 to form a dividing partition as hereinafter explained. On top of the casing screws a curved cap 72 whose lower lip 73 is reentrant to form a restricted passage with the outer wall or side of the lip 71 and leading to the atmosphere. In order to form a second restricted passage with respect to the inner wall or side of this lip a curved trough shaped plate 74 is suitably arranged or supported within the cap 72, in the present instance its flat central portion being clamped and held by the cap. The cap is open at its top and provided with suitable screen or a perforated metal plate 75, with perforations of smaller area than the said restricted passage which leads to the atmosphere, so that such perforated plate will prevent entrance of particles large enough to clog such passage. When the inlet valve opens, air is drawn inward through the perforated plate and through the series of holes 76 in the cap. The currents of air pass in the direction of the arrows and down the passage 77 between the curved plate and cap. The current of air then encounters a sharp turn or deflection just before reaching the flaring lip 71 which forms a division between the cleansed air current (which passes inward to the inlet valve through passages 78) and the foreign particles separated by the action of centrifugal force; these particles falling outside the valve device through the restricted passage along the outer side of the lip 71. The direction of suction in the inlet valve chamber is such as to cause the air to enter through the perforated plate 75 and in the direction of the arrows, instead of being sucked through the dust passages, the proper path of suction as shown, being in the line of least resistance. The air is thus cleansed, and pure, clean air

only is permitted to enter the cylinder whereby the above mentioned objections are overcome.

I claim:

5 1. In an engine, the combination of a series of fluid pressure cylinders having driving pistons, a similar series of air compressing cylinders having driven pistons, a crank, and two series of connecting rods connected
10 to the pistons, one of said series of rods being connected with the crank and both series thereof being adapted to form toggles or knee levers with each other.

15 2. In an engine, the combination of a series of fluid pressure cylinders having driving pistons, a similar series of air compressing cylinders having driven pistons, a crank and two sets of connecting rods connected to the pistons of the two sets of cylinders, the
20 rods of one set being also connected to the crank and the other rods being connected to the first mentioned set to form toggles.

25 3. In an engine, the combination of a series of steam cylinders having pistons, a similar series of air compressing cylinders having pistons, a crank, a set of connecting rods connected respectively to the steam cylinder pistons and to the crank, and a second set of connecting rods connected respectively to the
30 air cylinder pistons and pivotally connected to the first mentioned set of rods to form toggles.

35 4. In an engine, the combination of a series of steam cylinders having pistons, a similar series of air compressing cylinders, a crank, a set of connecting rods connected respectively to the steam cylinders and each having a partial hub secured to the crank and also having an extension, near the crank
40 end, and a second set of connecting rods connected at their outer ends to the air cylinder pistons and at their inner ends to said extensions of the other set of rods to form toggles.

45 5. The combination of a crank chamber having mounted therein a crank shaft 14 having a crank pin 16, a series of radially arranged steam cylinders 3, 4, and 5 having
50 pistons, a series of similarly arranged air cylinders 6, 7 and 8 having pistons, a series of connecting rods 35 connected to the steam pistons and to the crank pin, and having a lateral extension provided with a pivot pin 43, a second series of connecting rods connected to the air pistons and pivoted on said
55 pin 43.

60 6. The combination of a crank chamber having mounted therein a crank shaft 14 having a crank pin 16, a series of radially arranged steam cylinders 3, 4 and 5, having pistons, a series of similarly arranged air cylinders, having pistons, a series of three connecting rods 34 connected at their outer
65 ends to the steam pistons and having their inner ends on an arc which is approximately

one third of the circumference of the crank pin, means for clamping such rods to the crank pin and a second series of three rods 38 connected at their outer ends to the air pistons and pivotally connected at their inner ends to the other series of connecting rods. 70

7. The combination of a crank chamber having mounted therein a crank shaft 14 having a crank pin 16, a series of radially arranged steam cylinders 3, 4 and 5 having
75 pistons, a series of similarly arranged air cylinders having pistons, a series of three connecting rods 35 connected at their outer ends to the steam pistons and having their inner ends formed on an arc which is approximately one third of the circumference of the crank pin, means for clamping such rods to the crank pin comprising a clamping ring 40 engaging said connecting rods 35, 85 and a second series of three rods 38 connected at their inner ends to the other series of connecting rods.

8. The combination of a crank chamber having mounted therein a crank shaft 14
90 having a crank pin 16, a series of radially arranged steam cylinders 3, 4 and 5 having pistons, a series of similarly arranged air cylinders having pistons, a series of connecting rods 35 connected at their outer ends
95 to the steam pistons and having their inner ends provided with lateral extensions on an arc which is approximately one third of the circumference of the crank pin, a pair of clamping rings 40 embracing the said lateral
100 extensions of the connecting rods for holding them in coöperative relation with the crank pin and a second series of three connecting rods 38 connected respectively to the air pistons and to the first series of connecting rods. 105

9. In an engine of the class described, the combination of a crank, a plurality of radially arranged alternating steam and air cylinders provided with pistons, and a similar plurality of connecting rods connected
110 to the pistons and operatively connected to the crank and connected to each other in pairs.

10. In an engine of the class described, the combination of a crank, a series or plurality
115 of alternating steam and air cylinders arranged in pairs and provided with pistons, a series or plurality of connecting rods connected to the steam pistons and to the crank and a series or plurality of connecting rods
120 connected to the air pistons, each rod of the second series of rods being pivotally connected at a point beyond the crank axis to its neighboring rod of the first series.

11. In an engine of the class described, the combination of a crank, a series of radially
125 disposed alternating steam and air cylinders arranged in pairs and provided with pistons, and a series of rods connecting the pistons with the crank, the connecting rod of each 130

air cylinder being pivotally connected to the connecting rod of a piston of an adjacent steam cylinder at a point beyond the crank axis and thereby acting as a toggle in connection with the crank.

12. In an engine of the class described, the combination of a crank shaft, a series of steam and air cylinders having pistons operatively connected to the crank shaft, said shaft having an extension comprising a cylindrical portion and a projecting segmental portion, a rotary valve controlling steam ports to the steam cylinders and having a segmental recess corresponding to said extension, but somewhat larger, and means for adjusting the position of the segmental portion of the shaft in the segmental recess.

13. In an engine of the class described, the combination of a crank shaft, a series of steam and air cylinders having pistons operatively connected to the crank shaft, said shaft having an extension comprising a cylindrical portion and a projecting portion, a rotary valve controlling steam ports to the steam cylinders and having a segmental recess corresponding to said extension, but somewhat larger, and means for adjusting the position of the segmental portion of the shaft in the segmental recess, such means comprising liners adapted to be placed on one or the other side of the segmental extension of the crank shaft.

14. In a device of the class described, the combination of a single crank, a series of

substantially radially disposed air and steam cylinders, pistons and connecting rods for the steam cylinders, said rods being connected directly with the crank, and pistons and connecting rods for the air cylinders, the latter rods being unconnected with the crank but connected with the rods of the steam cylinders.

15. In an engine of the class described, the combination of a crank casing having a series of radiating pressure and compression cylinders, pistons in said cylinders, a crank to which such pistons are operatively connected, and a drain arranged in the casing for the lowermost cylinders to prevent water or moisture from flowing therein from the casing.

16. In an engine of the class described, the combination, of a crank casing having a series of radiating pressure and compression cylinders, pistons in said cylinders, a crank to which such pistons are operatively connected, and a drain for the lowermost cylinders comprising, in combination with a drain pipe or passage in the lower portion of the casing, inclined transverse ribs arranged within the casing and immediately above said cylinders to direct the water away therefrom and conduct it to the drain passage.

MAURY W. HIBBARD.

Witnesses:

S. E. HIBBEN,
LOUIS B. ERWIN.