(No Model.) 3 Sheets—Sheet 1.

# C. A WRIGHT.

## STEAM ENGINE.

No. 541,519. Patented June 25, 1895.

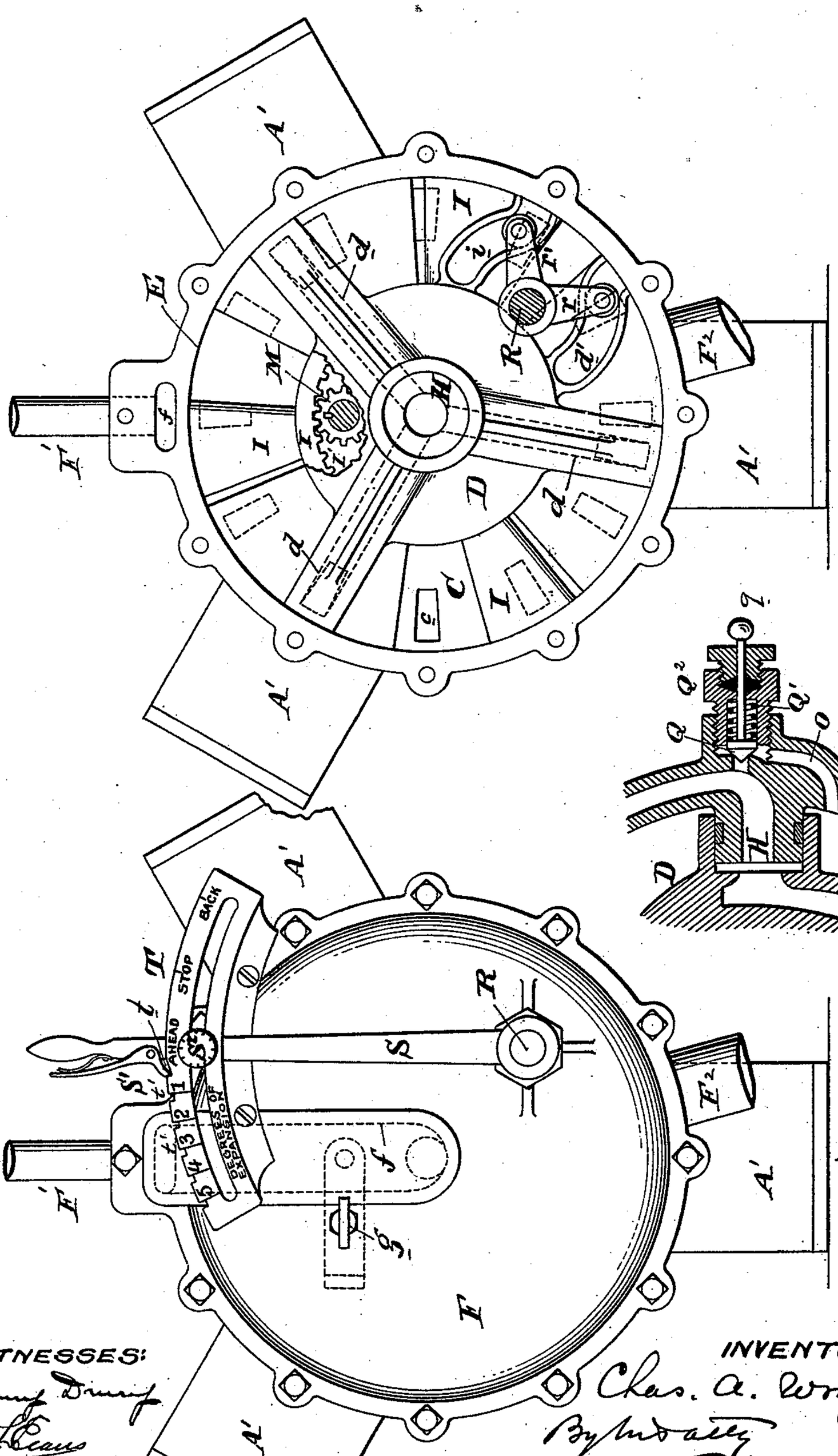

FIG. 2



FIG. 11



FIG. 1

WITNESSES:
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Wm. L. Evans

INVENTOR:
Chas. A. Wright
By his Atty
[illegible]

(No Model.) 3 Sheets—Sheet 2.

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## STEAM ENGINE.

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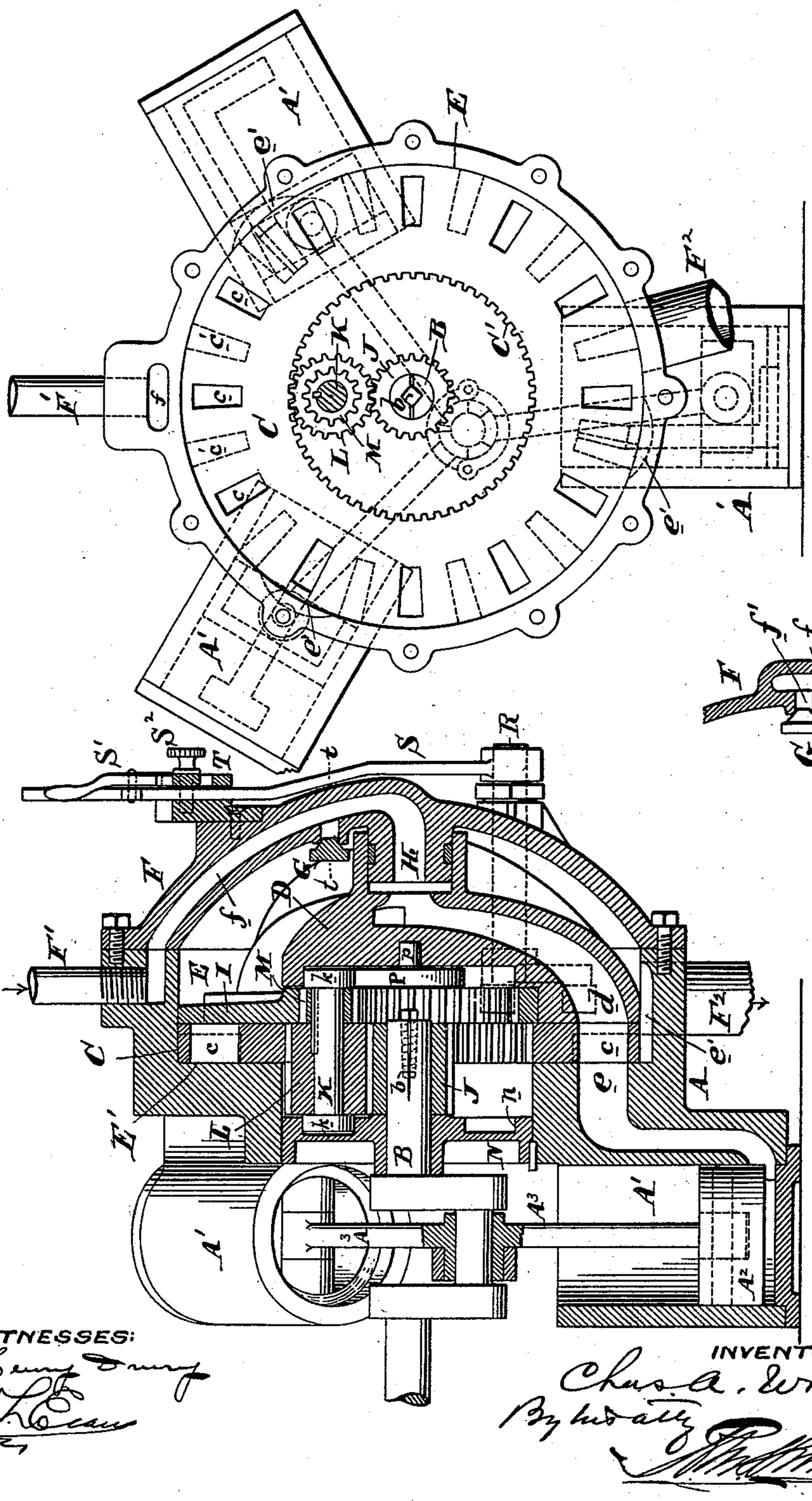

FIG. 3

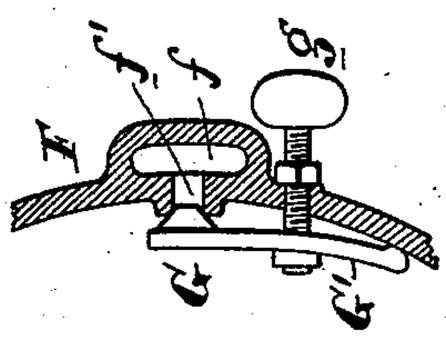

FIG. 10



FIG. 4

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(No Model.) 3 Sheets—Sheet 3.

# C. A WRIGHT.

## STEAM ENGINE.

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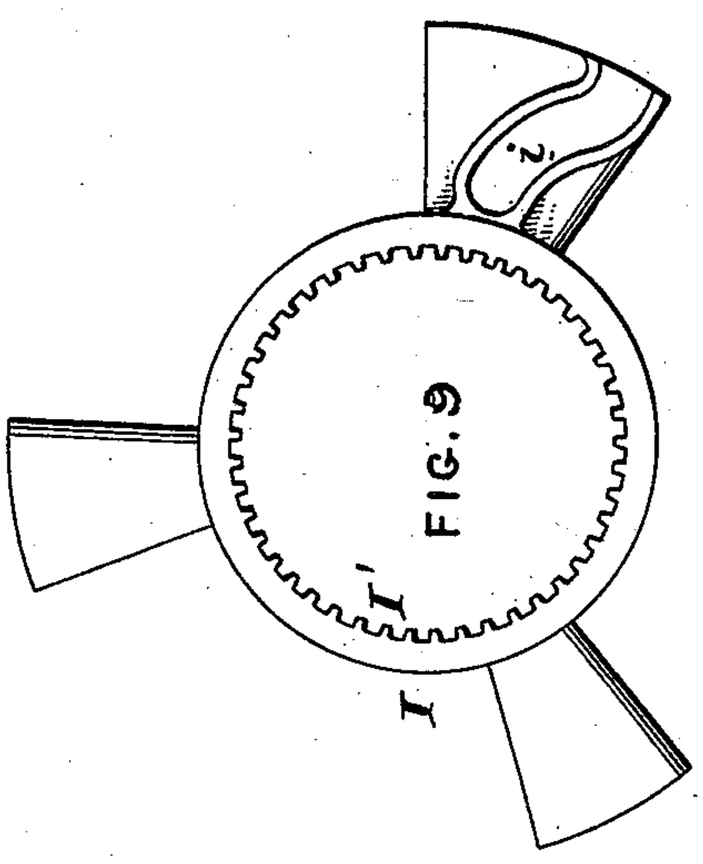


FIG. 9

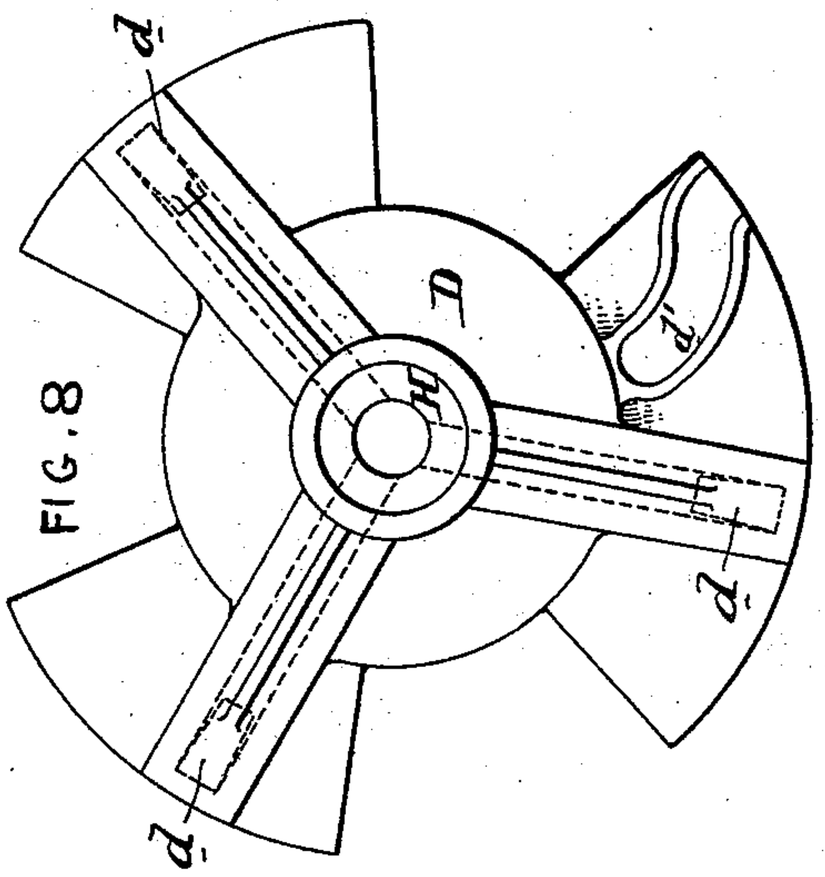


FIG. 8

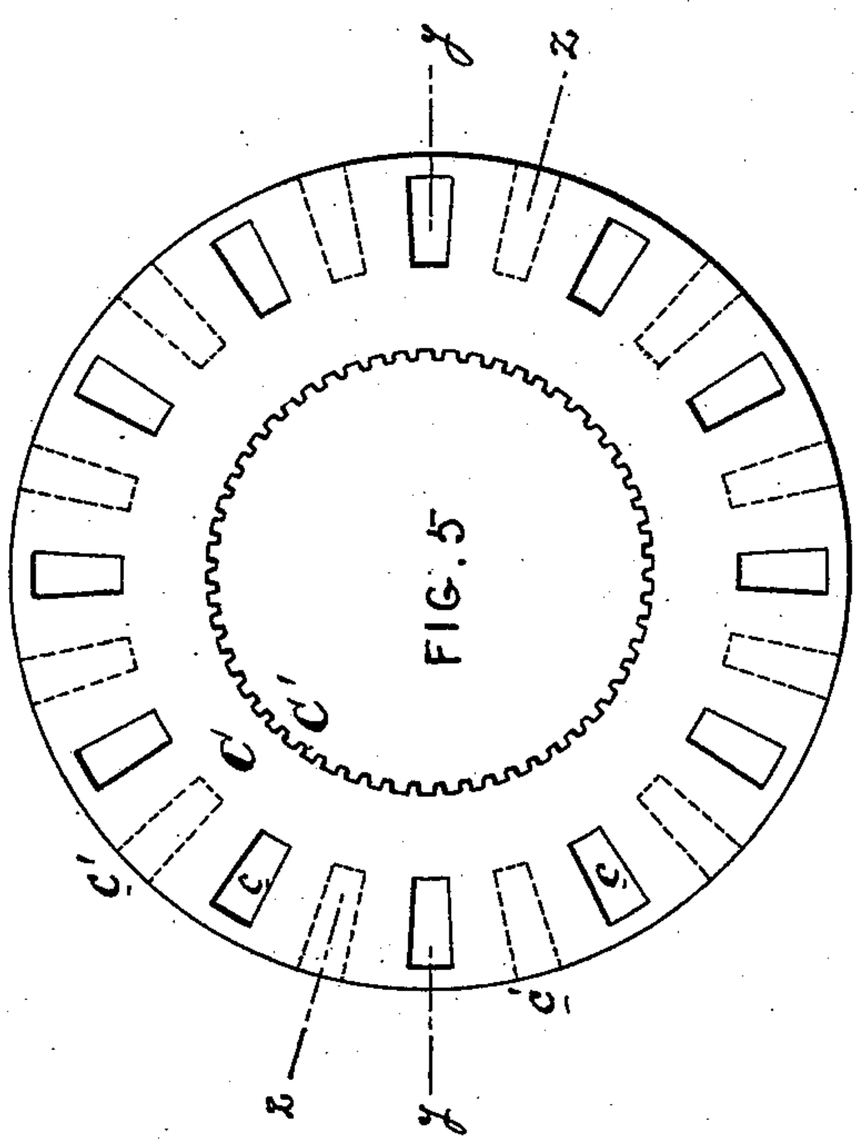


FIG. 5


FIG. 6

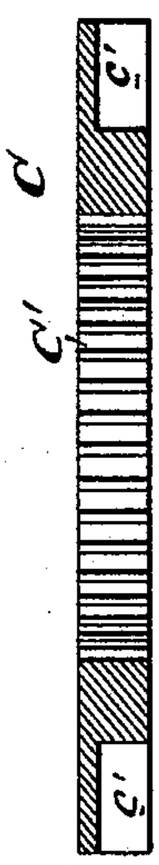


FIG. 7

WITNESSES:

Edward Drury

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By his attys

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# UNITED STATES PATENT OFFICE.

CHARLES A. WRIGHT, OF PHILADELPHIA, PENNSYLVANIA.

## STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 541,519, dated June 25, 1895.

Application filed March 9, 1895. Serial No. 541,128. (No model.)

*To all whom it may concern:*

Be it known that I, CHARLES A. WRIGHT, of the city and county of Philadelphia, State of Pennsylvania, have invented an Improvement in Steam and Vapor Engines, of which the following is a specification.

My invention has reference to steam and vapor engines, and consists of certain improvements which are fully set forth in the following specification and shown in the accompanying drawings, which form a part thereof.

Heretofore it has been customary to build multi-cylinder engines having their pistons working in connection with a common crank shaft, and in which the cylinders were arranged at an angle to each other and operating in connection with the single crank, or in which the cylinders were arranged in the same plane with the shaft and operating upon different cranks set at an angle to each other. It has been customary in these types of engines to employ slide valves, either made flat or cylindrical. In high speed engines of this class great difficulty has been had from the high surface speed of the valves relatively to their seats, and also to the valve gear necessary for operating them. Furthermore, in the practical use of engines of this class reversing gear have to a large extent been unsatisfactory, in many cases failing to act promptly with frequent mishaps to the launch. Furthermore, engines of this class have been made to work under a fixed admission of steam, and were not suitable to operate under varying expansions at the will of the engineer. Consequently they were very wasteful when the duty was light, such as occurs after the boat has been gotten under fully headway.

My invention is designed to provide a construction of an engine adapted to overcome all of these objections, and I have secured these improvements after careful experiment.

In carrying out my invention I provide three cylinders arranged at an angle to each other of one hundred and twenty degrees, and connect the pistons of the several cylinders through their connecting rods with a common crank upon the power shaft. To the rear of the cylinders I arrange a valve chest of large diameter and circular, through the face of which the steam ports from the cylinders are arranged. Upon this valve seat I place a large circular rotary valve having a large number of ports for admitting steam to the cylinder and for permitting the exhaust therefrom, the ports in the said valve being adapted to be brought into line with the ports in the valve seat. Resting upon the circular valve is a valve cap which may hold the valve in place upon its seat and at the same time supply live steam to the valve, and has its ports approximately in line with the ports in the valve seat, but capable of lateral adjustment relatively thereto so as to vary the point of cut off when desired. The cap of the valve chest has a port through which steam enters and finds its way into the valve cap, the connection between the chest cap and the valve cap being by means of a piston and cylinder connection. In this manner, by the proper proportioning of the parts, the requisite degree of pressure may be secured to enable the valve cap to hold the valve positively to its seat and yet avoid excessive friction. By this contrivance I am enabled to dispense with the use of springs and also to make my valve closely approximate a balanced valve. The main portion of the valve chest is formed into a chamber communicating with the exhaust, and is thus reversed in order with the usual custom. To insure the circular valve rotating, I employ what may be termed a type of planetary gear more specifically consisting of a pinion upon the crank shaft meshing with a pinion which in turn meshes with an internal gear on the valve. The pinion is also provided with a smaller pinion which in turn meshes with an internal gear of smaller diameter than the internal gear of the valve and which rests upon the valve and is capable of rotary adjustment. From this it will be evident that there will be a differential movement imparted by the various gears, and that while the pinions travel around the pinion on the crank shaft, the valve itself is only moved a fraction of a revolution for each complete revolution of the crank. In this manner the valve moves slowly but positively, and hence it is not subjected to excessive wear. Furthermore, by simply adjusting the valve cap, the cut off may be varied so as to work the steam under any degree of expansion desired. By operating the internal gear last above de-

scribed the position of the valve may be shifted in relation to the crank so as to make the engine run in the reverse direction. These movements may be accomplished by means of a lever which when thrown in one direction runs the engine backward, and when thrown in the other direction makes it move forward, and vary its expansion by each additional movement in the last mentioned direction.

It is evident that the particular arrangement of the cylinders or the cranks are immaterial, as my improved valve may be applied to any multi-cylinder engine.

There are numerous details of improvement employed in connection with the general features of construction, and these will be better understood by reference to the accompanying drawings, in which—

Figure 1 is a rear elevation of my improved engine. Fig. 2 is a similar view with the valve-chest cap removed. Fig. 3 is a similar view to Fig. 2 with the valve-cap and reversing internal gear removed. Fig. 4 is a sectional elevation on the line *x x* of Fig. 1. Fig. 5 is an elevation of the steam-valve. Fig. 6 is a cross-section of the steam-valve on the line *y y*. Fig. 7 is a cross-section of the valve on the line *z z*. Fig. 8 is an elevation of the valve-cap. Fig. 9 is an elevation of the reversing internal gear. Fig. 10 is a cross-section on the line *t t* of Fig. 4, showing the safety-valve; and Fig. 11 is a modified form of safety-valve adapted to be used in place of that shown in Fig. 10.

A is the main casting of the engine and may be of any suitable shape or configuration.

A′ are three cylinders arranged at an angle of one hundred and twenty degrees with respect to each other, the said cylinders having pistons $A^2$ to which are hinged connecting rods $A^3$ working upon a common crank shaft B. It is quite evident that the three cylinders might be arranged in any other suitable manner if so desired as is well known in the common practice of manufacturing multicylinder engines. I prefer to arrange the cylinders at an angle to each other so as to be permitted to place them in the same transverse plane and employ a single crank as such construction is more durable and permits the use of a stronger crank shaft. At the rear of the cylinder I arrange a valve chamber E which is circular in form having a valve seat E′ through which the steam ports *e* from the outer ends of the cylinders A′ open.

C is a steam valve and is made circular in shape and is provided near its periphery and entirely about its circumference with a series of steam ports *c* and exhaust ports *c′* arranged alternately. In my preferred form the said steam ports extend transversely through the valve, while the exhaust ports open into the edge thereof as very clearly shown in Figs. 3, 5, 6 and 7. The valve chest has recesses *e′* in its sides at the points where the steam is permitted to exhaust into the valve chamber E. Resting upon the opposite face of the valve C and preferably holding it in position upon the valve seat is a cap D which is clearly shown in Figs. 4, 2 and 8. This cap has enlarged faces resting upon the valve and has steam ports *d* opening through said faces in alignment with the ports *e* of the cylinders. The said ports *d* are three in number corresponding to the number of cylinders, and united at the center where they receive steam in the manner to be now described.

F is the cap of the valve chest and is bolted to the rear thereof and receives steam from the steam pipe F′ through the port *f* cast therein, the said port extending to the center of the cap and opening into the central part of the valve cap D through a cylinder and piston connection H which is clearly shown in Fig. 4.

$F^2$ is the exhaust pipe leading from the interior of the valve chest. It will now be seen that steam enters the pipe F′, passes through the port *f*, and thence through the ports *d* to the valve, which by its ports controls the admission of the steam to the ports *e* of the cylinders. The clear passage for this steam is shown in Fig. 4 from the steam pipe F′ to the lower cylinder A′. As the valve C rotates, the ports are so arranged as to supply steam successively to the several cylinders. In exhausting, the steam passes from the cylinder through the port *e* into one of the ports *c* of the rotary valve and thence into the recess *e′*, thence into the valve chest and out by the exhaust pipe $F^2$.

It will be observed that my improved method of admitting the steam to the cylinders enables me to make the valve C substantially balanced and thereby secure its movement with a minimum degree of friction. This is advantageous in a case such as the present on account of the large size of the valve. In the particular construction it is only necessary for the valve C to make one-twelfth of a revolution for each revolution of the crank shaft. Consequently provision must be made between the crank shaft B and the valve C to secure this slow movement. I will now describe the mechanism which I employ for this purpose and which experience has shown me to be remarkably well adapted to the purpose. The inner end of the crank shaft B is supported in a bearing plate N suitably secured to the frame A of the engine. To the rear end of the crank shaft is secured a pinion J which is capable of proper adjustment. To secure the minutest adjustment of the said pinion upon the crank shaft I split the end of the shaft over which the pinion is placed and screw in a tapered screw *b* which expands the shaft and firmly locks the pinion to it. In this manner I need not be particular as to the exact location of the teeth upon the valve as the most perfect adjustment can be secured. The pinion J is made of considerable length so as to offer a long surface or bearing to the pinion L which

meshes with said pinion J and at the same time travels about it. The pinion L is keyed upon a shaft K having at each end circular journals *k*. The journal *k* at one end works in an annular groove *n* in the bearing plate N, the said groove preventing the outward movement of the pinion at this end. The other end of the pinion L meshes with the internal gear C′ on the valve C. Also secured upon the shaft K is a smaller pinion M, and this smaller pinion works in connection with the internal gear I′ of a reversing frame I which is clearly shown in Figs. 4, 2 and 9. This reversing frame is provided with enlarged flat surfaces or wings which rest upon the surface of the valve and thereby secure support. It is of the same diameter as the valve chest and valve and consequently, as in the case of the valve and valve cap D, is sustained against lateral displacement by the valve chest itself. The valve cap D and the reversing frame I are normally stationary, and it is evident that as the internal gear I′ is of smaller diameter than the internal gear C′, and likewise the pinion M is of smaller diameter than the pinion L, the rotation of the pinion J must necessarily cause a positive rotation of the pinions L and M relatively upon their own axes and at the same time about the crank shaft and pinion J. In the particular construction shown, the said movements are intended to secure one complete revolution of the pinions L and M about the pinion J for every twelve revolutions of the crank shaft B. The effect of this movement is to cause a corresponding movement to the valve C. As the gear M works against the internal teeth of the reversing frame I, there is a tendency to move that end of the shaft K toward the shaft B and thereby cause excessive wear on the teeth, and ultimately the disengagement of the parts M and I. To prevent this, I cause the journal *k* upon the adjacent end of the shaft K to roll in contact with a roller bearing P which is journaled at *p* to the valve cap D. By means of the bearings *n* and roller bearing P the shaft K with its pinions L and M are required to travel positively about the pinion J and at the same time maintain absolute parallelism with the crank shaft B.

It is evident that to reverse the engine, some provision must be made to cause a relative shifting of the valve C with respect to the position of the crank, and this is readily secured by a slight movement of the reversing frame I. To secure this movement, the reversing frame I is provided with a cam groove *i* with which a crank *r′* engages, the said crank being operated by a shaft R extending through the cap F and provided with a lever S adapted to be moved by the hand. It is evident that if the lever S be moved to the right, the crank *r′* will cause a rotation of the frame I, and with it the internal gear I′. The effect of this is to turn the valve C backward a corresponding degree so that the relative moment of bringing the ports *c* and *e* in alignment is changed relatively to the position of the crank, thereby causing the engine to move in the reverse direction. The cam groove *i* is so arranged that a movement of the lever S in the opposite direction or that to the left, will not shift the reversing frame I (if the said frame be set in a normal position) for the forward running of the engine.

To cause the engine to cut off and work expansively under different degrees of adjustment, I provide the valve cap D with a cam groove *d′* similar to the groove *i* but in the reverse direction. Working with the said groove is arranged a crank *r* also secured to the shaft R, as is very clearly shown in Fig. 2. It is evident now that when the lever S is moved to the right, the ports *d* remain immediately over the ports *e*, but the lead of the valve is changed by the shifting of the frame I so that the engine runs backward under full head of steam. When the shaft R and the cranks *r*, *r′*, are in the position shown in Fig. 2, the valve is in position to cause the engine to run forward with a full head of steam. If the lever S be turned to the right as if to reverse the engine it will move the valve in the act of changing its lead of the ports into such positions that the action of the steam on the pistons will be balanced, and hence the engine will stop if the lever S is held for a moment intermediate of the forward and reversing positions.

To enable the engine to work expansively, it is only necessary to throw the lever S farther to the left, and this secures a movement of the valve cap D in the same direction as the movement of the crank shaft B so as to cause the valve to cut off the supply of steam to the cylinders sooner or later according to adjustment. When the lever S is operating to move the frame I, the valve cap D remains in its normal position and without cut off adjustment, and when the valve cap is moved to produce cut off the reversing frame I remains in its normal position or with the adjustment for forward motion. These two parts never move simultaneously.

Referring to Fig. 1 we see that the upper part of the hand lever S moves over a segment T which has upon it the words and positions for the stop, ahead and back movements for the engine. The free end of the lever S on the left hand side is provided with a pivoted detent S′ which catches in a beveled notch *t* in said segment when the lever S is thrown to the left, thereby holding the lever at the "ahead" position. The tendency of further movement to the leyer under the ordinary running of the engine is to the left, and consequently there is no tendency of the lever being moved in the opposite direction, and hence need not be secured against such movement. When the lever is moved to the "stop" position the engine comes to rest, and then, of course, there is no tendency to move the lever S. When it is thrown fully over to

the "back" position the tendency to move the lever is in the opposite direction, and hence it remains in that position. If desired, it may be locked in any of these positions by the clamping nut $S^2$. The segment is, furthermore, provided with a series of notches $t'$ corresponding to the various points of cut off, and when the detent S' is adjusted to any of these notches a corresponding degree of cut off will be insured. These notches may be similar to the notch $t$ or may be rectangular. The advantage of this controlling device is evident, for, assuming that the yacht was at a condition of rest, the party in charge has simply to move the lever S to the left as far as it will go and the boat goes ahead with full head of steam. If there is any reason for instantly reversing the engine, he has simply to push the lever S fully to the right as far as it will go. The lever will remain in either of these two extreme positions when once moved to them. If the boat is moving forward, and there is no occasion to change the direction of running of the propeller the engineer may then at his leisure adjust the lever and the detent to any one of the expansion notches which he desires. In any of these, the lever S is locked against further movement to the left, but should sudden danger occur requiring instant backing of the boat it is simply necessary for the engineer to press the detent and lever to the right as far as it will go and instantly the engines will be reversed. It is clear, therefore, that the most ordinary common sense alone is necessary to fully control this engine, and the controlling parts are always in such condition that there is no possibility of their being in any condition which might interfere with instant control. The most ignorant man could not fail to control the engine at a moment's thought.

To prevent excessive action of steam upon the valve cap D, I provide the port $f$ with a safety valve which is shown in Figs. 1 and 10. In this construction, more clearly shown in Fig. 10, the port $f$ opens by a port $f'$ into the interior of the valve chest, and, of course, into connection with the exhaust $F^2$.

G is a safety valve carried upon a spring arm G', the tension of which may be adjusted by an adjusting thumb screw $g$. By this means any degree of pressure may be insured upon the valve cap, and excessive or sudden strain prevented. In place of the particular construction just described, I may employ that shown in Fig. 11 in which the central portion of the chest cap F is provided with an escape port O opening into the valve chest and controlled by a safety valve Q, which safety valve is pressed forward by a spring Q', the tension of which may be adjusted by an adjusting nut and stuffing box $Q^2$. The spindle of the valve extends to the outside of the engine and terminates in a ball $q$ which may be pulled if desired to relieve the pressure upon the valve, if from any cause instant relief was necessary in starting.

I have described my most approved construction for carrying out my invention, but I do not wish to be understood as confining myself to the details of said construction herein described, as they may be modified or varied in numerous ways without departing from the spirit of the invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having steam ports approximately in line with the ports in the seat of the valve chest for admitting steam to the ports in the valve, and gearing connecting the crank shaft with the rotary valve, whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft.

2. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, and means for adjusting the valve cap for the purpose of shifting its ports relatively to the ports in the valve seat for varying the degree of cut off.

3. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, and means for forcing the valve cap upon the valve with an elastic pressure.

4. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, means for adjusting the valve cap for the purpose of shifting its

ports relatively to the ports in the valve seat for varying the degrees of cut off, and means for forcing the valve cap upon the valve with an elastic pressure.

5. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, a steam port in the casing of the engine for supplying steam, and a cylinder and piston connection between the said casing and valve cap through which the steam passes, whereby the steam is supplied to the cap and the cap is held against the valve.

6. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, and hand controlled devices for adjusting the gearing for the purpose of changing the lead of the rotary valve to reverse the engine.

7. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, hand controlled devices for adjusting the gearing for the purpose of changing the lead of the rotary valve to reverse the engine, and hand controlled devices for adjusting the valve cap for the purpose of varying the degree of cut off of the rotary valve.

8. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, and hand controlled devices for alternately adjusting the lead of the valve to make the engine run backward and for adjusting the valve cap to vary the degree of cut off when the engine is running forward.

9. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve, whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, and a lever mechanism for alternately adjusting the gearing or valve cap for varying the lead of the valve and point of cut off respectively and for holding said parts in their adjusted positions.

10. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat containing steam ports and provided with a series of steam ports arranged in a circle about its axis, a valve cap having ports approximately in line with the ports in the rotary valve for controlling the steam passing through the steam valve, a steam supply pipe communicating by suitable ports with the ports in the valve cap, gearing connecting the crank shaft with the rotary valve whereby the latter makes a portion of a revolution for each complete revolution of the crank shaft, means for adjusting the valve cap for the purpose of varying the degree of cut off, and means for holding the valve cap upon the valve.

11. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, a lever mechanism for independently adjusting the gearing or valve cap for respectively varying the lead of the valve and point of cut off, and hand controlled devices for locking the lever mechanism in its adjusted positions for varying the cut off of the engine.

12. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolu-

tion of the crank shaft, a steam port in the casing of the engine for supplying steam, and a cylinder and piston connection between the said casing and valve cap through which the steam passes, whereby the steam is supplied to the cap and the cap is held against the valve.

13. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, a steam port in the casing of the engine for supplying steam, a cylinder and piston connection between the said casing and valve cap through which the steam passes whereby steam is supplied to the cap and the cap is held against the valve, a safety valve arranged in said steam port to relieve the said piston from excessive pressure, and means extending therefrom to the outside of the engine casing whereby the said safety valve may be adjusted by hand.

14. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve, whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, a lever mechanism for alternately adjusting the gearing or valve cap for varying the lead of the valve and point of cut off respectively and for holding said ports in their adjusted positions, a piston and cylinder device for producing a pressure of the valve cap upon the rotary valve, and a steam port leading from the steam supply pipe of the engine to the cylinder last described.

15. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, a lever mechanism for alternately adjusting the gearing or valve cap for varying the lead of the valve and point of cut off respectively and for holding said parts in their adjusted positions, a piston and cylinder device for producing a pressure of the valve cap upon the rotary valve, a steam port leading from the steam supply pipe of the engine to the cylinder last described, and a safety valve arranged in said steam port to relieve the said piston from excessive pressure.

16. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, a lever mechanism for alternately adjusting the gearing or valve cap for varying the lead of the valve and point of cut off respectively and for holding said parts in their adjusted positions, a piston and cylinder device for producing a pressure of the valve cap upon the rotary valve, a steam port leading from the steam supply pipe of the engine to the cylinder last described, a safety valve arranged in said steam port to relieve the said piston from excessive pressure, and means extending to the outside of the casing for adjusting the said safety valve.

17. In a multi-cylinder engine the combination of a valve chest having independent ports to each cylinder, a circular valve containing steam ports and adapted to a valve seat through which the cylinder ports open, a valve cap adapted to supply steam to the ports of the valve, and gearing between the crank shaft of the engine and rotary valve consisting of a pinion secured upon the crank shaft, an internal gear upon the rotary valve, a pinion meshing with the pinion on the crank shaft and internal gear of the valve and free to travel about the crank shaft, a pinion of smaller diameter rotating positively with the pinion interposed between the gear of the valve and pinion on the crank shaft, and a stationary gear into which the last mentioned pinion meshes for the purpose of producing a differential movement between the several parts and causing the valve to make a portion of a revolution for each revolution of the crank shaft.

18. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve containing steam ports and adapted to a valve seat through which the cylinder ports open, a valve cap adapted to supply steam to the ports of the valve, and gearing between the crank shaft of the engine and rotary valve consisting of a pinion secured upon the crank shaft, an internal gear upon the rotary valve, a pinion meshing with the pinion on the crank shaft and internal gear of the valve and free to travel about the crank shaft, a pinion of smaller diameter rotating positively with the pinion interposed between the gear of the valve and pinion on the crank shaft, a stationary gear into which the last mentioned

pinion meshes for the purpose of producing a differential movement between the several parts and causing the valve to make a portion of a revolution for each revolution of the crank shaft, and hand devices for adjusting the stationary gear so as to change the lead of the valve relatively to the steam ports.

19. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve containing steam ports and adapted to a valve seat through which the cylinder ports open, a valve cap adapted to supply steam to the ports of the valve, and gearing between the crank shaft of the engine and rotary valve consisting of a pinion J secured upon the crank shaft, an internal gear C′ upon the rotary valve, a pinion L interposed between the gear C′ and the pinion J, a pinion M of smaller diameter than the pinion L and secured to it, an internal gear I′ meshing with the pinion M, a frame I carrying the internal gear I′, and hand controlled devices for adjusting the frame I.

20. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve containing steam ports and adapted to a valve seat through which the cylinder ports open, a valve cap adapted to supply steam to the ports of the valve, and gearing between the crank shaft of the engine and rotary valve consisting of a pinion J secured upon the crank shaft, an internal gear C′ upon the rotary valve, a pinion L interposed between the gear C′ and the pinion J, a pinion M of smaller diameter than the pinion L and secured to it, an internal gear I′ meshing with the pinion M, a frame I carrying the internal gear I′, hand controlled devices for adjusting the frame I, journals *k*, *k*, extending beyond the ends of the pinions L, M, an annular guide *n* arranged about the crank shaft adapted to receive one of the journals *k*, and a circular guide bearing P adapted to receive the other journal *k*, the said bearings being adapted to cause the pinions L M to travel about and remain parallel to the crank shaft and maintain connection with the other gears without binding.

21. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve containing steam ports and adapted to a valve seat through which the cylinder ports open, a valve cap adapted to supply steam to the ports of the valve, and gearing between the crank shaft of the engine and rotary valve, a pinion J secured upon the crank shaft, an internal gear C′ upon the rotary valve, a pinion L interposed between the gear C′ and the pinion J, a pinion M of smaller diameter than the pinion L and secured to it, an internal gear I′ meshing with the pinion M, a frame I carrying the internal gear I′, journals *k*, *k*, extending beyond the ends of the pinions L, M, an annular guide *n* arranged about the crank shaft adapted to receive one of the journals *k*, and a circular guide P adapted to receive the other journal *k*, the said bearings being adapted to cause the pinions L M to travel about the crank shaft and in connection with the other gears without binding.

22. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, and hand controlled devices for adjusting the gearing for the purpose of changing the lead of the rotary valve to reverse the engine and for adjusting the valve cap for the purpose of varying the degree of cut off of the rotary valve, consisting of a controlling lever S provided with a detent device S′, a segment T for guiding the said hand lever and provided with the notches *t*, *t′*, substantially as described, whereby said hand lever may freely move in one direction but not in the other without specially operating the detent device.

23. In a multi-cylinder engine, the combination of a valve chest having independent ports to each cylinder, a circular valve adapted to a valve seat through which the cylinder ports open and provided with a series of steam and exhaust ports arranged in a circle, a valve cap having ports approximately in line with the ports in the seat of the valve chest, gearing connecting the crank shaft with the rotary valve whereby the rotary valve makes a fraction of a revolution for each complete revolution of the crank shaft, hand controlled devices for adjusting the gearing for the purpose of changing the lead of the rotary valve to reverse the engine and for adjusting the valve cap for the purpose of varying the degree of cut off of the rotary valve consisting of a controlling lever S provided with a detent device S′, a segment T for guiding the said hand lever and provided with the notches *t*, *t′*, substantially as described, whereby said hand lever may freely move in one direction but not in the other without specially operating the detent device, and means for clamping the lever in any definite position upon the segment desired.

In testimony of which invention I hereunto set my hand.

CHARLES A. WRIGHT.

Witnesses:
R. M. HUNTER,
ERNEST HOWARD HUNTER.