No. 731,104. PATENTED JUNE 16, 1903.

D. P. FUQUA, SR.

ROTARY STEAM EXPLOSIVE ENGINE.

APPLICATION FILED MAR. 20, 1902.

NO MODEL. 5 SHEETS—SHEET 1.

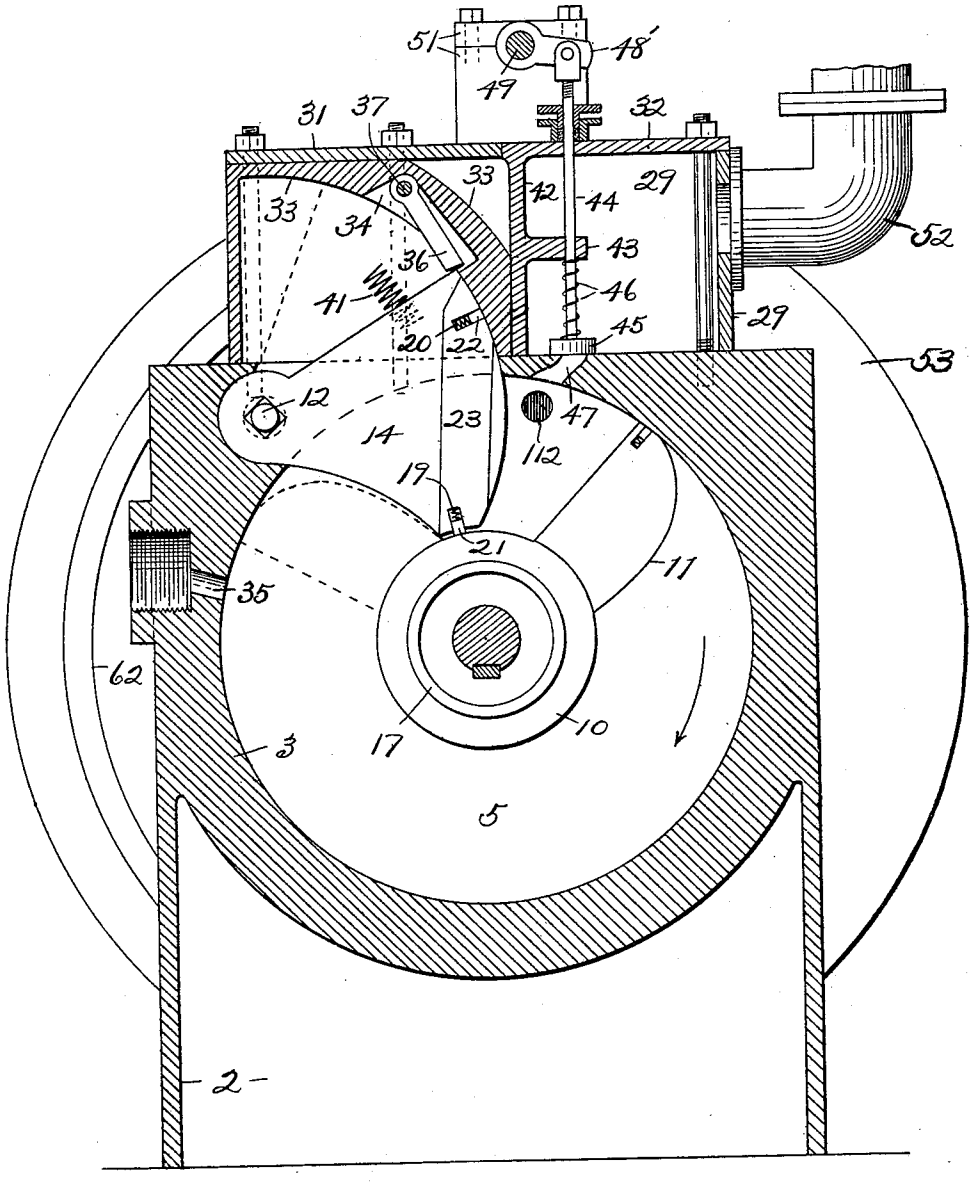


Fig. 1.

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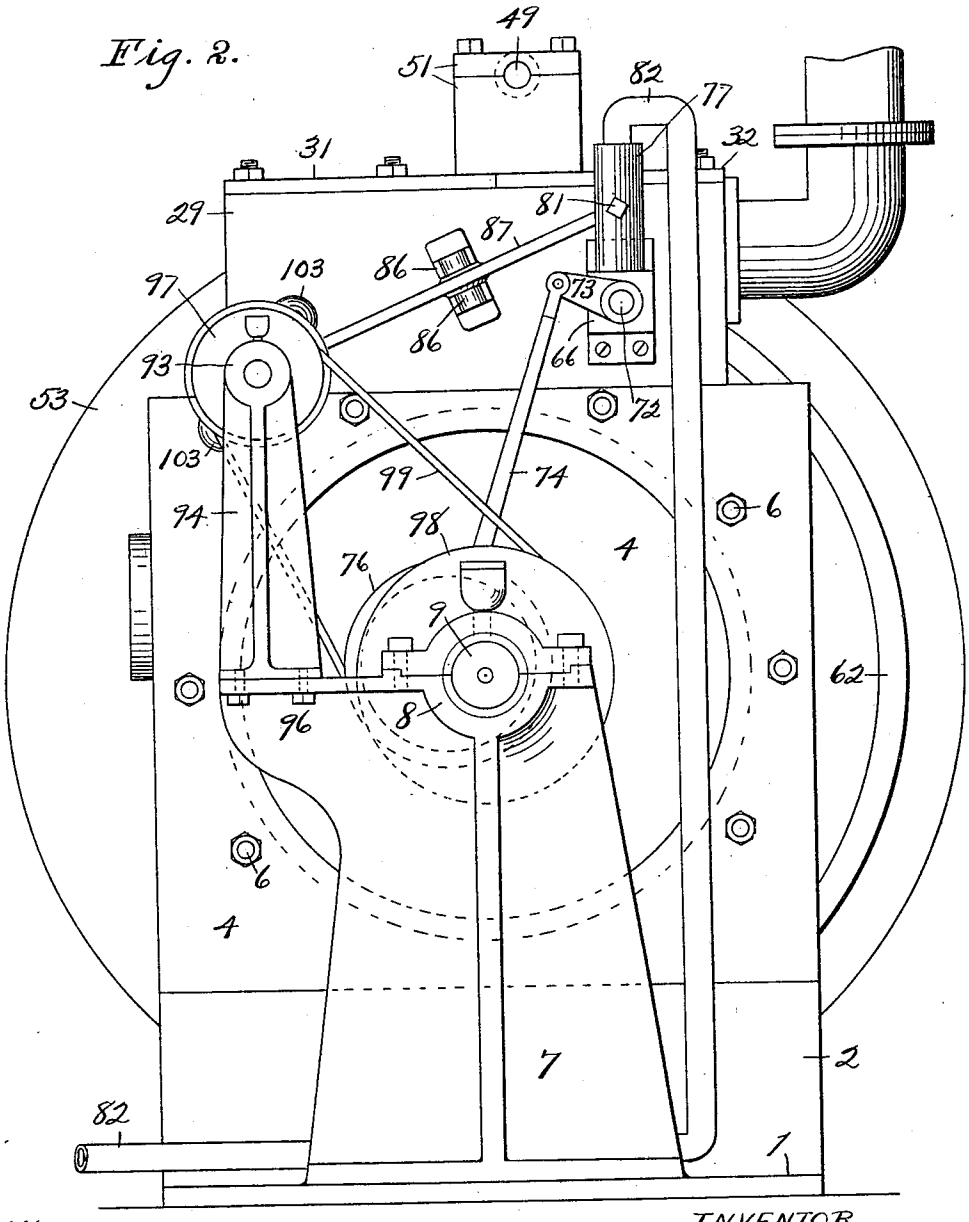
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NO MODEL. 5 SHEETS—SHEET 2.

Fig. 2.



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NO MODEL. 6 SHEETS—SHEET 3.

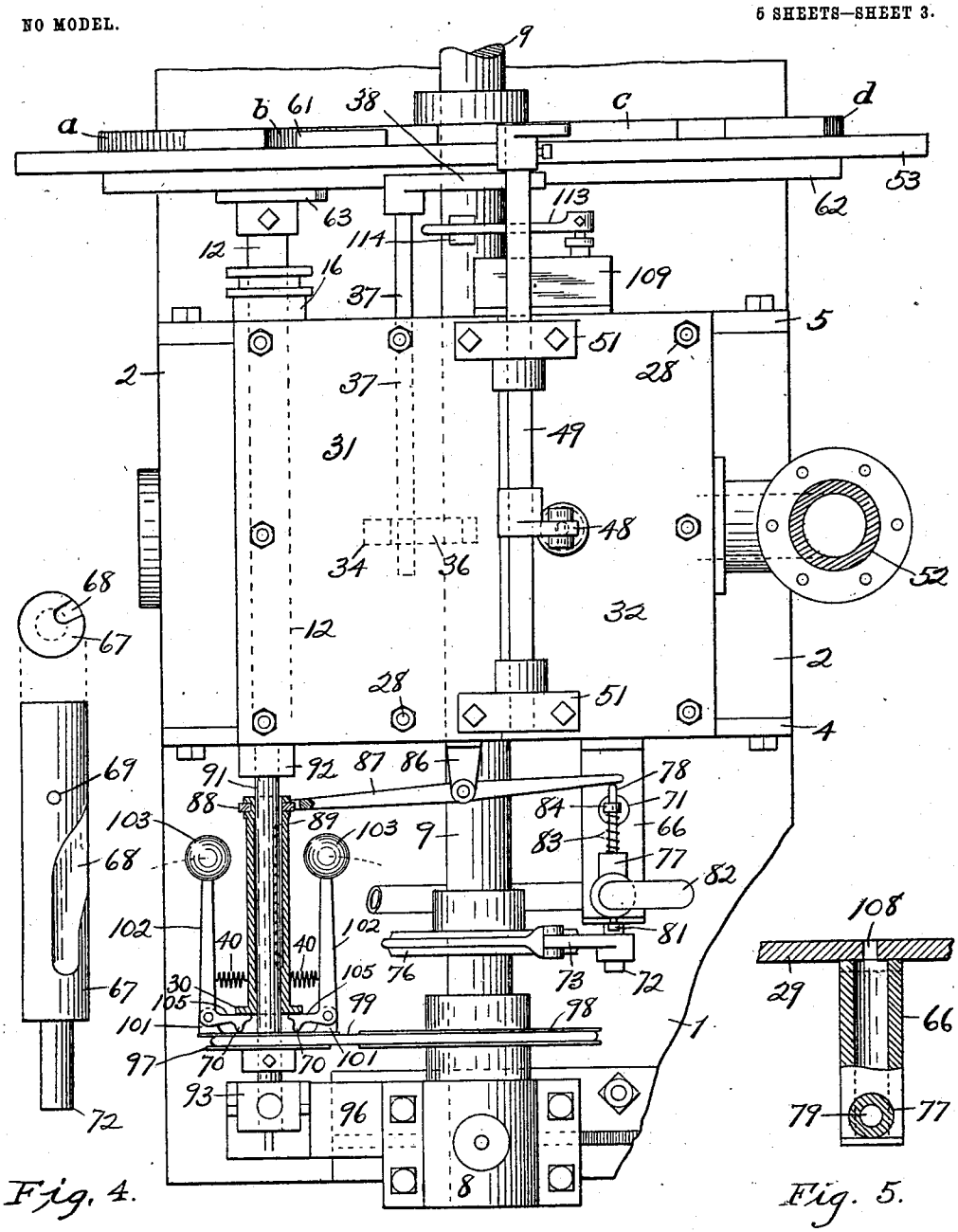


Fig. 4.

Fig. 5.

Fig. 3.

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NO MODEL. 6 SHEETS—SHEET 4.



Fig. 7.

Fig. 6.

Fig. 11.

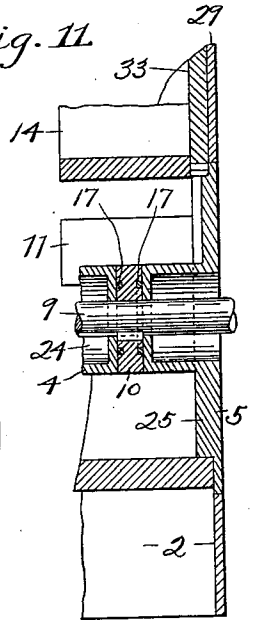
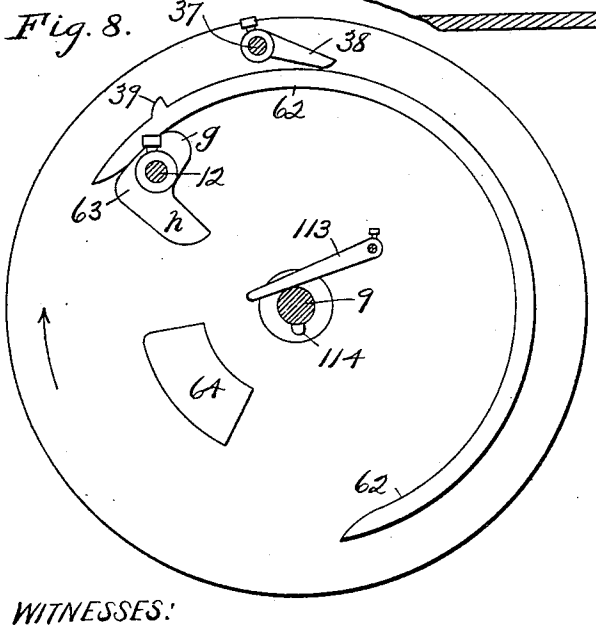


Fig. 9.

Fig. 8.



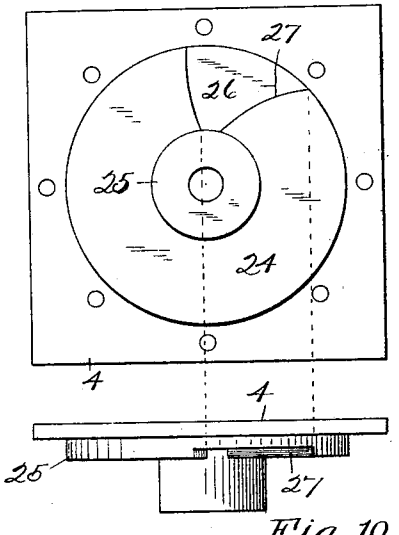


Fig. 10.

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No. 731,104. PATENTED JUNE 16, 1903.

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APPLICATION FILED MAR. 20, 1902.

NO MODEL. 5 SHEETS—SHEET 5.

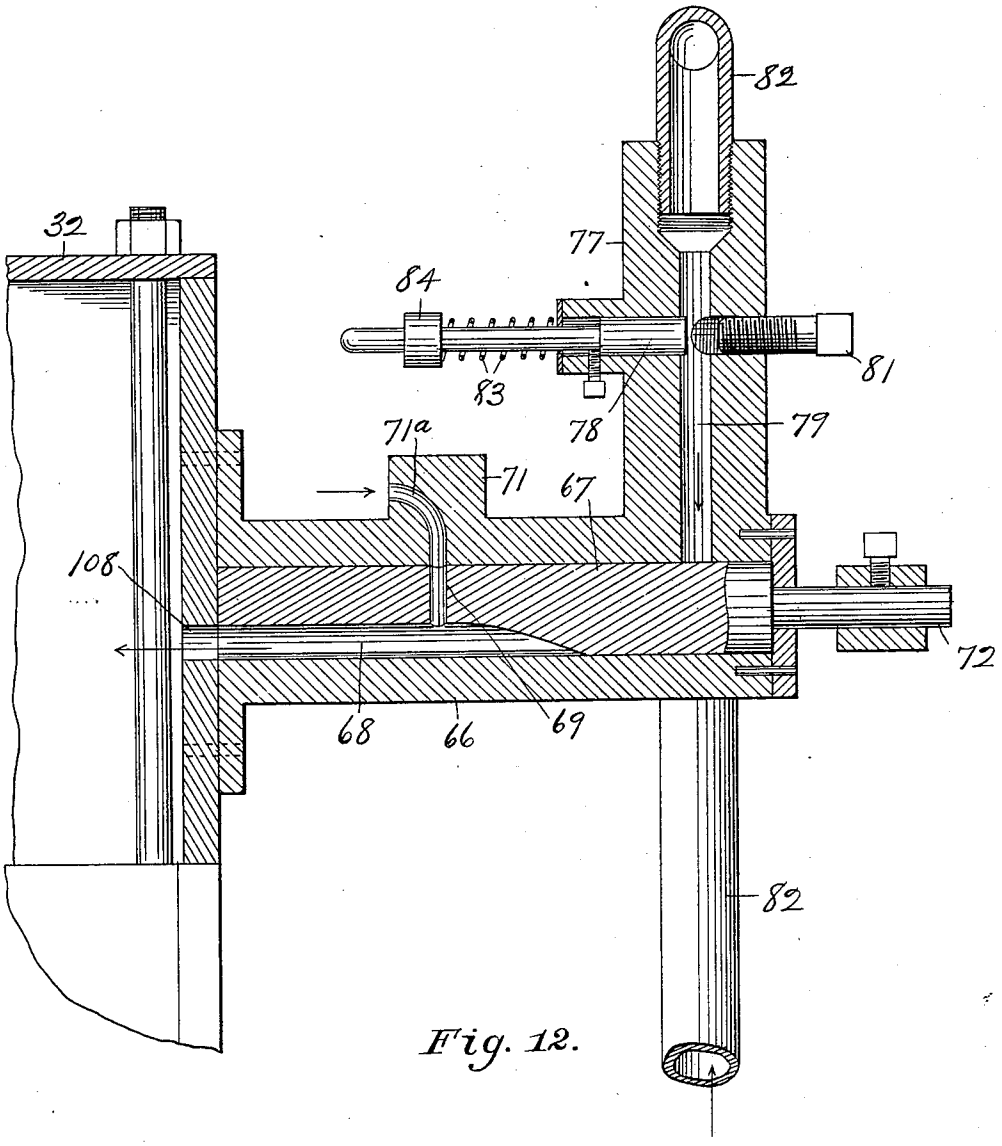


Fig. 12.

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No. 731,104. Patented June 16, 1903.

UNITED STATES PATENT OFFICE.

DAVID P. FUQUA, SR., OF KANSAS CITY, MISSOURI, ASSIGNOR OF ONE-HALF TO FRED BUEHLER, JR., OF KANSAS CITY, MISSOURI.

ROTARY STEAM EXPLOSIVE-ENGINE.

SPECIFICATION forming part of Letters Patent No. 731,104, dated June 16, 1903.

Application filed March 20, 1902. Serial No. 99,152. (No model.)

To all whom it may concern:

Be it known that I, DAVID P. FUQUA, Sr., a citizen of the United States, residing at Kansas City, in the county of Jackson and State of Missouri, have invented new and useful Improvements in Steam and Explosive Engines, of which the following is a specification.

My invention relates to a rotary piston-engine which is adapted to be run by either steam or gas; and my invention consists to that end in the novel construction described hereinafter. The parts by means of which the engine is adapted to be run by gas are made detachable from the frame of the engine, so that they may be removed, if desired, when the engine is using steam.

In the accompanying drawings, Figure 1 is an irregular vertical section of an engine embodying my invention. Fig. 2 is an end elevation of the engine. Fig. 3 is a plan view of the engine, the governor-sleeve being in section and bed-plate partly broken away. Fig. 4 is a plan view and an inner end elevation enlarged of the hydrocarbon-cut-off valve detached. Fig. 5 is a partly-sectional plan view of the cut-off-valve housing and the connected portion of the steam-chest, the valve being removed. Fig. 6 is an elevation of the outer face of the cam-wheel, the frame being partly broken away. Fig. 7 is an elevation of a cam-arm used as an attachment. Fig. 8 is an elevation of the inner face of the cam-wheel, the main shaft and two other shafts being in section. Fig. 9 is an inner side elevation of one of the piston-chamber heads detached. Fig. 10 is a top plan view of the same. Fig. 11 is a central vertical section of one of the piston-chamber heads, showing the piston in section, all of the other parts broken away and the abutment fully raised. Fig. 12 is an enlarged central vertical section of the governor-valve and the rocking valve in connection with a portion of the steam-chest.

1 is the bed-plate, from which rises a rectangular casting 2, containing a piston-chamber 3. The ends of the piston-chamber are closed by heads 4 and 5, secured with bolts 6. Secured to one end of the bed-plate 1 is a bearing-stand 7, supporting a journal-bearing 8, in which is journaled the main shaft 9, which passes concentrically through the piston-chamber 3 and the heads 4 and 5. Rigidly secured on said shaft within the chamber 3 is a piston 10, having an integral piston-wing 11 thereon, shaped substantially as shown. Mounted on a rock-shaft 12 is an oscillating abutment 14, shaped substantially as shown. Its lower curve forms an arc of the piston-chamber 3 when it is in raised position. (Indicated by dotted lines.) One end of rock-shaft 12 is journaled in a hole or bushing in the head 4, and said shaft passes out through the other head, 5, and through a stuffing-box 16, secured to the head 5. Each head 4 5 is dished in, as shown in Fig. 11, so as to meet the sides of the piston 10, which is made much narrower than the piston-wing 11 in order to reduce the steam-pressure upon the piston. In each side of the piston 10 is a packing-ring 17, forming a steam-tight connection between the piston and the adjacent head. At the opposite end of the main shaft 9 from bearing 8 will be another bearing and a pulley-wheel (not shown) by which the engine may be connected by a belt to a counter-shaft for driving machinery. On the outer end of rock-shaft 12 is an angular lever 63, which is actuated by a cam described hereinafter, so as to raise the abutment 14 when the piston-wing 11 touches it in its revolution, as shown by dotted lines in Fig. 1. The lowest portion of the abutment 14 is provided with a transverse groove 19, in which is a metallic packing-strip 21, which is pressed against the piston by springs to prevent live steam from escaping therebetween.

In the curved periphery of the abutment 14 is another transverse groove 20, containing a packing-strip 22, which is pressed by springs against the casting 33, and in each side of the abutment is a groove containing a packing-strip 23, said strips being adapted to bear against the inner sides of the heads 4 5 and of the casting 33.

In Fig. 1 the abutment is shown in its lowest position, and it will be observed that it does not rest on the piston 10. Its weight is supported by recesses 24 in the heads 4 and 5, one of said recesses being shown in Figs. 9, 10, and 11, in which the head 5 is shown in detail. An annular boss 25 is cast integral

with each head and projects into the piston-chamber, fitting against the side of the piston-wing 11.

The inner face of the boss 25 of head 5 is cut away, as at 26, forming a shoulder 27 for supporting the abutment 14 when the latter is in lowered position. The boss 25 of the other head, 4, may be similarly recessed to provide additional support for the abutment. Thus the piston 10 is relieved from the weight of the abutment, while a steam-tight connection is maintained by the packing 21 aforesaid when the abutment is in lowered position.

The top of the casting 2 is flat, and secured thereto with stud-bolts 28 is the steam-chest, which comprises a side casting 29, two top plates 31 32, and a casting 33, recessed, as shown, to receive the abutment 14 when the latter is raised. In the lower face of casting 33 is a recess 34, in which is mounted a detent 36, rigidly secured on a transverse rock-shaft 37. One end of said shaft 37 is journaled in a socket or bushing in the casting 33, and its other end projects from the steam-chest and has secured thereon a finger 38, as shown in Figs. 3 and 8. Said finger is operated by a cam-lug 39, described hereinafter, in such a manner as to disengage the detent 36 from the upper edge of the abutment 14 when the latter is about to be raised. The purpose of the detent 36 is to prevent lifting of the abutment 14 until the latter is raised at the proper instant by the aforesaid cam. In the upper face of the abutment is mounted a helical or coiled spring 41, which impinges upon the inner face of the casting 33 when the abutment is thrown up, and thereby prevents the abutment from striking said casting and also overcomes the momentum of the abutment and tends to start its descending movement during the operation of the engine. The detent 36 being secured on its shaft by a set-screw and the recess 34 being of about the same width as that of the detent, Fig. 3, said shaft 37 cannot move longitudinally.

Integral with one portion 32 of the top of the steam-chest is an upright partition 42. On said partition is a perforated lug or guide 43, through which passes the vertical stem 44 of a puppet-valve 45. Between said guide 43 and the head of the valve is a coiled expansion-spring 46, which holds the valve seated upon the admission-port 47 in the casting 2. The valve-stem 44 extends through the top plate 32 and is connected by a pin-and-slot joint of any suitable kind to an arm 48', rigidly secured on a rock-shaft 49, mounted in bearings 51 and 51.

52 is the steam-supply pipe, connected to the casting 29.

On the main shaft 9 is secured a cam-wheel 53, the faces of which are shown in Figs. 6 and 8, respectively. Secured to the outer face of said wheel is a segmental sectional cam *a b c d*, comprising a plurality of parts fitted together, as shown, and detachable from the wheel 53. The arrow indicates the direction of rotation. The cam *a b c d* intermittently raises an arm 48, secured on rock-shaft 49, and thereby opens the valve 45 at the proper time. The point of cut-off may be changed by removing one, two, or three of the cam-sections *b c d* from the wheel 53. The section *a* in advance remains permanently in position. A small cam 61 (seen in Fig. 6) will be referred to hereinafter.

On the inner face of the wheel 53 are two cams 64 and 62. Cam 62 is a rib forming an arc of about two hundred and twenty degrees. On its periphery is a lug or projection 39. The action of cam 62 is to hold the rock-shaft 12 immovable during a part of each revolution of the cam-wheel by engaging one arm *g* of the bell-crank lever 63, secured on said rock-shaft, as shown. As soon as the cam 62 passes off said arm the segmental cam 64 pushes up the other arm *h* of said bell-crank lever, as will be readily understood, and thereby rocks the shaft 12, which movement raises the abutment 14 out of the path of the piston-wing 11; but just before the cam 64 engages the arm *h* the projection 39 of cam 62 raises the finger 38 on the detent-shaft 37. The detent 36 is thus lifted and permits the aforesaid raising of the abutment 14.

The operation of the engine as run by steam will be readily understood from the foregoing description.

35 is the exhaust-port.

The attachments by which the engine may be operated by explosions of hydrocarbon vapor are shown in Figs. 1, 2, 3, 4, 5, 6, 7, and 8. Referring to Figs. 2 and 3, a valve-housing 66 is secured to the casting 29, and mounted rotatably in said housing is a cylindrical valve 67, having a spiral groove or port 68 therein. A hole 69 connects the port 68 with the opposite side of the valve for admitting atmospheric air to said port to mix with the charge of gas or gasolene in the usual manner. On the housing 66 is a boss 71, in which is an air-port 71^a, connecting the bore of housing 66 to the atmosphere. When valve 67 is turned to the position in which its hole 69 registers with said port 71^a, Fig. 12, atmospheric air will be drawn into the port 68 and thence into the steam-chest by the partial vacuum created by the rotation of the piston-wing 11 away from the admission-port 47. On the stem 72 of valve 67 is an arm 73, which is connected by a rod 74 to an eccentric 76 on the main shaft 9. Rising from housing 66 is a housing 77 for a governor-valve 78. In housing 77 is a vertical passage 79, which is intersected and thus controlled by the governor-valve 78, which is reciprocated by a governor, described hereinafter. Screwed into housing 77, in alinement with valve 78, is a set-screw 81, which acts as a stop, limiting the closing movement of said valve, and when said set-screw is turned to the right or the left it shortens or lengthens the inward stroke of the governor-valve 78,

so that when it is projected into or across the passage 79 said passage will be closed up by only a slight movement of valve 78, while if it is retracted, as shown in Fig. 12, said valve would have to travel entirely across said passage to entirely close the same.

The supply-pipe 82 for the hydrocarbon is connected to the upper end of the passage 79 in housing 77 and descends to the bed-plate of the engine. A pump (not shown) may be employed to force the hydrocarbon up through said pipe and maintain a suitable pressure therein.

When the engine is not running, the governor-valve 78 is held open by a spring 83, pressing on a collar 84. Fulcrumed between ears 86 on the steam-chest casting 29 is a lever 87, one end of which is always in contact with the valve-stem 78. The opposite end of lever 87 is connected pivotally to a ring 88, lying in a groove in a sleeve 89, splined on a governor-shaft 91. This shaft is supported by bearings 92 and 93. Bearing 92 may be a boss cast integral with the steam-chest casting 29 and provided with the usual "brasses." The other bearing, 93, is on a standard 94, which is secured detachably to an extension 96 of the main bearing-stand 7. On the governor-shaft 91 is a grooved pulley 97, and on the main shaft 9 is a grooved pulley 98, connected to pulley 97 by a belt 99. On the inner face of the governor-pulley 97 are two diametrically opposite lugs 101 and 101. Pivoted on said lugs, respectively, are the governor-arms 102 and 102, carrying weights 103 and 103. The sleeve 89 is provided at its outer end with an annular flange 30, and each governor-arm 102 has an inwardly-projecting finger 105 thereon, touching said flange 30, which is pressed against said fingers by the aforesaid spring 83, acting through lever 87. The governor-arms 102 are drawn toward each other by tension-springs 40. On each finger 105 is a stop-lug 70, which limits the inward motion of its governor-arm 102 by touching the pulley-wheel 97. The governor-valve 78 is so adjusted that the quantity of hydrocarbon passed by it to the cut-off valve 67 will be inversely proportional to the speed at which the engine is running and sufficient to give the required power at all speeds within certain limits. When the speed of running increases, the governor-arms 102 will diverge, causing the fingers 105 to push in the sleeve 89, which will move the lever 87, and thereby partially close the governor-valve 78. Reversely, when the speed falls the governor-valve 78 will be partially opened by the pressure of spring 83 against collar 84.

The valve-housing 66 communicates with the steam-chest by an opening 108 in the latter, Fig. 5. The igniter-chamber 109 is secured to the head 5 and communicates with the piston-chamber 3 by an opening 112 in the latter, Fig. 1. The igniter-actuating arm 113 is operated by a cam 114 on the main shaft 9.

When the engine is to be run by gas or gasolene after being run by steam, the arm 48 is removed from the valve-operating shaft 49 and a shorter arm 115 is placed on said shaft in substantially the same position. By reference to Fig. 6 it will be seen that a small cam 61 is secured to the wheel 53 ahead of the cam-section *a*. This small cam 61 is mounted pivotally on a set-screw 116, so that it may be turned to operative position (shown by dotted lines) to operate the arm 115 when the engine is using gas or gasolene. The action of the short arm 115 and the cam 61 is to cause a quick and short opening of the valve 45 to admit a charge of vapor into the piston-chamber just before the igniter acts. When the engine is to be adapted for steam again, the longer arm 48 is substituted for the shorter arm 115 and the cam 61 is turned to the position shown in full lines in Fig. 6, in which position it will not strike the longer arm 48, which is operated by cam *a b c d*.

The operation of the devices for introducing the explosive charge into the piston-chamber is as follows: The amount of hydrocarbon admitted to the valve 67 is determined by the position of the governor-valve 78. When the spiral port 68 of valve 67 registers with the lower end of the passage 79, the charge will enter and fill said spiral port. When the valve 67 is rocked (by the eccentric 76) to the end of its stroke, the outer end of the spiral port will be cut off thereby from said passage 79, its inner end will register with the port 108 in the steam-chest, and the hole or branch port 69 will register with the air-port 71^a. The partial vacuum created by the rotation of the piston-wing will draw through ports 71^a and 68 a certain amount of air, which will mix with the charge and pass into the steam-chest through port 108. At this time the puppet-valve 45 will already be open, it having been opened simultaneously with the raising of the abutment. The charge will be drawn through port 47 into the piston-chamber and will be ignited by a sparking device contained in the chamber 109.

The operation of the governor upon the valve 78 controlled thereby has been described hereinbefore.

When the engine is using steam as a motive power, the igniter-chamber 109 should be removed and the opening 112 should be closed with a screw-plug. The valve 45 must also be held open to admit the steam continuously into the piston-chamber. This may be done by blocking up the valve-operating arm 48′.

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

1. In a combined steam and explosive engine, the combination with a steam or gas chamber and a piston-chamber and a port connecting said chambers, of a main shaft, a cam-wheel rotated thereby, a sectional cam the sections of which are detachably secured

to said cam-wheel, a rock-shaft provided with a tappet oscillated by said cam, an arm 48′ secured upon said rock-shaft, and a valve operated by said arm 48′, said valve controlling said port, substantially as described.

2. In a combined steam and explosive engine, a steam or gas chamber, a piston-chamber, a port connecting said chambers, a main shaft, a sectional cam rotated by said shaft, a rock-shaft provided with a tappet oscillated by said cam, an arm 48′ secured upon said rock-shaft, a valve operated by said arm 48′, said valve controlling said port, a wing-piston fixed upon said main shaft, a swinging abutment normally within the piston-chamber, said abutment being mounted upon a rock-shaft, an angular lever fixed upon said rock-shaft, and an arcuate cam rotated with said cam, and intermittently engaging said angular lever to raise the abutment, substantially as described.

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

DAVID P. FUQUA, SR.

Witnesses:
M. L. LANGE,
K. M. IMBODEN.