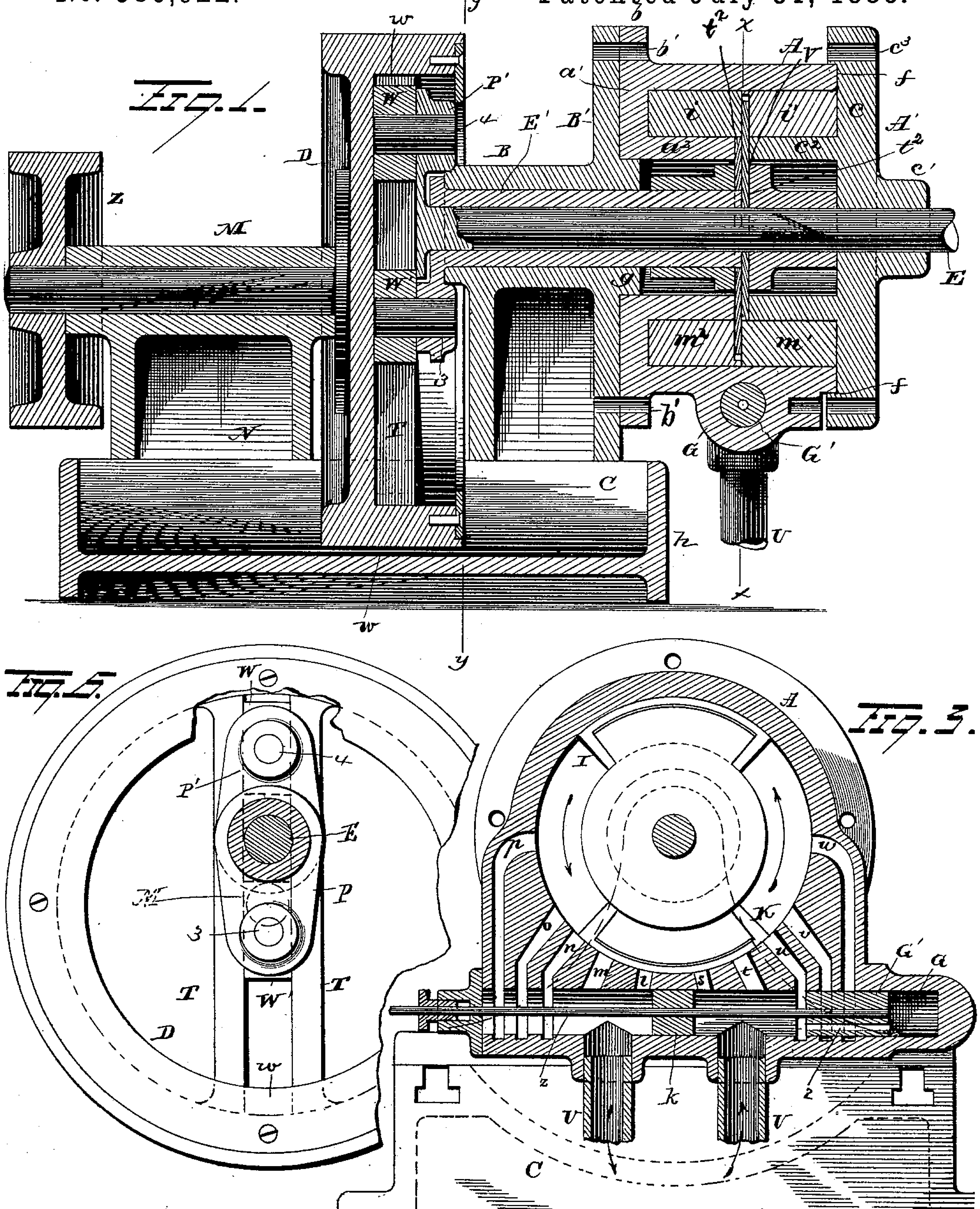
(No Model.) 2 Sheets—Sheet 1.

G. W. HUBBARD.

CONCENTRIC PISTON STEAM ENGINE.

No. 386,922. Patented July 31, 1888.



Witnesses.
E. J. Nottingham.
G. F. Downing.

Inventor.
George W. Hubbard
By his Attorney
H. A. Seymour.

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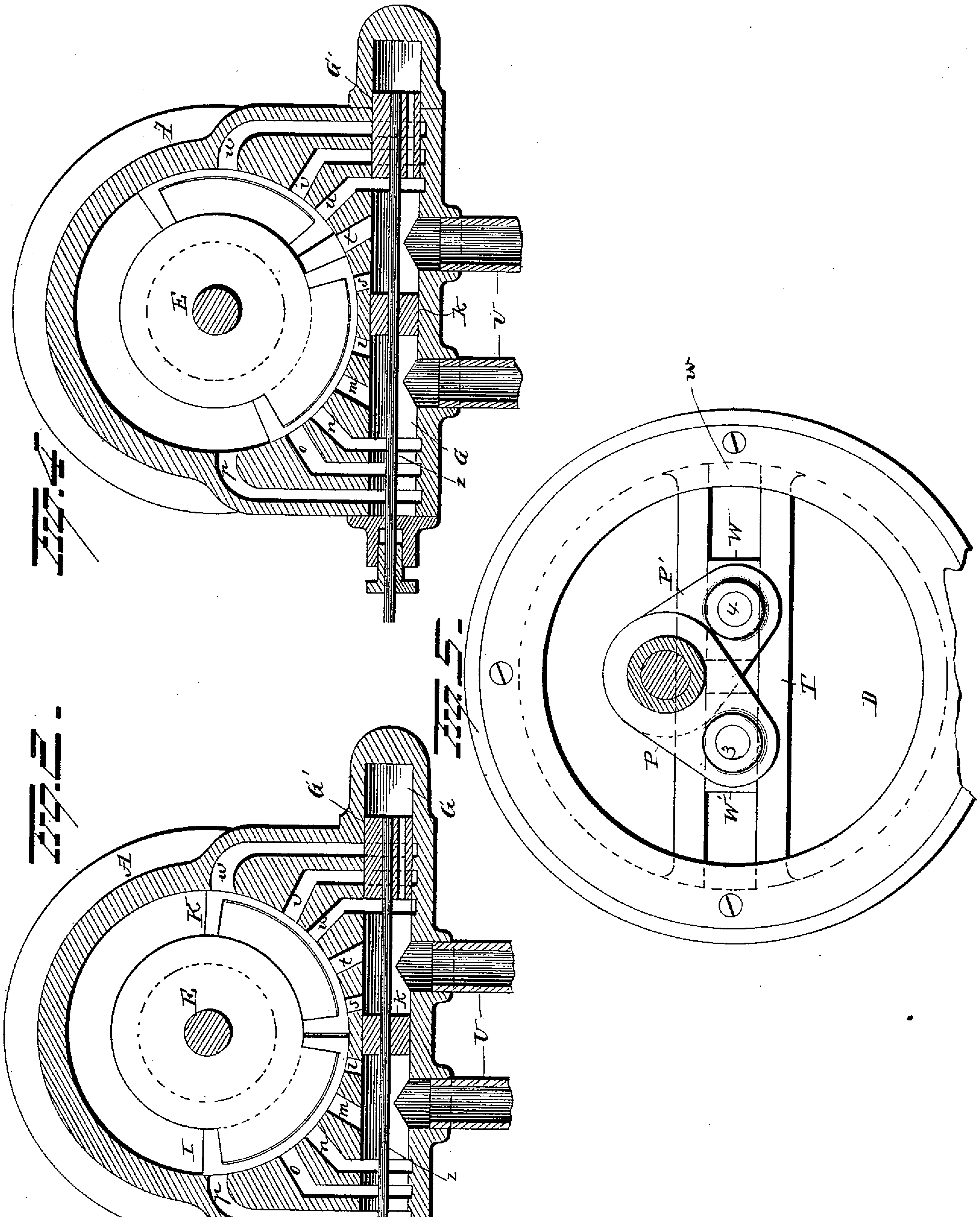

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UNITED STATES PATENT OFFICE.

GEORGE W. HUBBARD, OF WINDSOR, VERMONT.

CONCENTRIC-PISTON STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 386,922, dated July 31, 1888.

Application filed February 18, 1888. Serial No. 264,494. (No model.)

To all whom it may concern:

Be it known that I, GEORGE W. HUBBARD, of Windsor, in the county of Windsor and State of Vermont, have invented certain new and useful Improvements in Concentric-Piston Steam-Engines; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to an improvement in rotary concentric-piston steam engines.

The primary object of my invention is to provide a simple and durable engine of the type indicated which will operate reliably at high speed and work steam expansively, thus economizing the use of the steam, which may be cut off at different points in the revolution of the concentric pistons of the engine while it is in operation.

A further object is to reduce the number of working parts of a concentric-piston rotary steam-engine to a minimum, and by the peculiar form and combination of these parts afford a compact, powerful, and substantial steam-engine at a low cost.

With these objects in view my invention consists in certain features of construction and combinations of parts, that will be hereinafter described, and pointed out in the claims.

Referring to the drawings, Figure 1 is a side elevation in section of the engine, taken through the axial center of its driving-shaft. Fig. 2 is a transverse section taken on the line $x\ x$, Fig. 1, or through the longitudinal center of the steam-chest, with the concentric pistons of the engine located near their lowest point of adjustment in the cylinder. Fig. 3 is a cross-section of the engine-cylinder on the line $x\ x$, Fig. 1, exhibiting the concentric pistons at their point of greatest separation from each other or in a vertical position oppositely. Fig. 4 is a transverse sectional view of the engine-cylinder through the line $x\ x$, Fig. 1, the concentric pistons being located in the relative positions they assume when the engine is in motion and working by expansion of steam, live steam being cut off from the cylinder. Fig. 5 is a transverse section of the engine on the line $y\ y$, (see Fig. 1,) showing the construction of the fly-wheel and attached cranks visible on that line, said cranks being adjusted so that their pins will lie in the same horizontal plane. Fig. 6 represents a cross-section on the same line as shown in Fig. 4, with the pins of the cranks in a vertical line.

The cylinder of the engine is preferably constructed of two portions, A A′, the outer cylindrical shell, A, (see Fig. 1,) representing the full length of the cylinder. It is attached or made integral with a radial wall, a', on which is also formed or secured the inner circular wall, a^2, at right angles thereto and concentric with the outer shell, A. The inner wall, a^2, is preferably made one-half of the length of the outer shell, A, and of such a relative diameter thereto as to allow an annular space to intervene between their adjacent surfaces, said space representing the half of the cylinder-cavity. The other portion, A′, of the cylinder consists of a radial flange, c, that has a centrally-perforated hub, c', which is adapted to receive a piston-shaft, E, this hub projecting from the outside face of the flange c. On the opposite side surface of the flange c a circular wall, c^2, is formed, which is of such a diametrical size and thickness as to exactly correspond with the annular wall a^2, that is attached to the other portion, A, of the cylinder.

The length of the two circular walls a^2 c^2 is such, as compared with the length of the outer wall or shell, A, that a narrow radial opening or slit, V, is allowed to intervene between their inner ends, and it will be seen that there is a central circular recess or cavity produced which is bounded by these walls a^2 c^2. (See Fig. 1.)

A short radial flange, b, is projected from the portion A of the cylinder in the same plane with the radial wall a', said flange b having holes b', for the insertion of bolts, made at spaced intervals in it, and similar holes, c^3, are made through the flange c at points opposite to the holes b', to permit the bolts which are inserted through the holes in one flange to pass through mating holes in the other flange, and by screw-nuts applied to their ends or other similar means secure the two portions of the cylinder together.

It will be noticed in Fig. 1 that the inner surface of the flange c on the portion A′ of the cylinder is slightly recessed or cut away to produce an offset shoulder at f, the inner diameter of this overhanging shoulder being such as to afford a neat fit, diametrically considered, of the offset portion of the flange upon the outer edge of the end of the shell A, that it has contact with.

By the provision just mentioned the connected portions A A′ of the cylinder are held so that the annular walls a^2 c^2 are exactly coincident or in line with each other, and, with exception of the radial slit between them, represent a continuous inner wall of the annular cylinder-cavity previously mentioned.

The cylinder of the engine is supported by a bolted attachment of its flange b against the true steam tight surface of a flange, B′, which is formed on one end of the bracket-stand B, there being a short offset annular flange, g, formed on the adjacent face of the radial flange B′, at right angles to it, of such a diameter as to fit steam-tight the inner surface of the annular wall a^2, formed on the portion A of the cylinder.

The holes b′, made in the flange b, are mated by similar perforations formed near the peripheral edge of the radial flange B′, so that the bolts that hold together the two portions A A′ of the steam cylinder are utilized to secure the cylinder in place steam-tight against the supporting-flange B′ of bracket-stand B.

A bed-plate, C, that is recessed on its upper side to produce an oil-retaining chamber, affords a supporting-base for the bracket-stand B, which is mounted upon the side edges of said bed-plate and secured by bolts, as shown in Fig. 1, the transverse position of the bracket-stand with regard to the bed-plate and its location near one end of the latter-named piece causing the supported cylinder to overhang or extend beyond the end h of the bed-plate.

The upper portion of the bracket-stand B is cylindrically rounded and perforated in axial line with the concentric walls of the cylinder and the base of the hub c. The diametrical size of the circular perforation in the top portion of the bracket-stand B is such as to admit a hollow shaft, E′, and permit it to revolve therein. This shaft E′ will be further described in its proper connection with other important parts of the engine.

Upon the lower surface of the outer shell, A, of the steam-cylinder, and at right angles to its annular cavity or bore, the cylindrical steam-chest G is secured or integrally formed. It is of sufficient length to permit it to project beyond the cylinder on each side of the same.

The steam-chest G is bored out to render its inner wall true throughout its length, and a cylindrical plunger-valve, G′, is fitted to slide steam-tight in the bore of the chest.

In Fig. 2 will be seen the form given the wall A of the steam-cylinder to permit the construction of a series of live-steam ports, s t u v w, in said wall, so as to form passage for introduction of live steam from the chest G into the cylinder at spaced intervals, these ports being located between the valve G′ and a steam-tight plug or dividing-wall, k, which is introduced into the bore of the steam-chest near its center of length to separate the live-steam ports from the exhaust-ports l m n o p, which are formed on the opposite side of the cylinder, so as to communicate with the exhaust side of the steam-chest G in the same manner that the live-steam ports s t u v w. A valve-rod, z, is attached to one end of the valve G′. This rod passes through a steam-tight hole in the dividing-wall k and extends outside of the end of the steam-chest, any suitable provision being made to readily move the valve by its rod and secure it at any desired point in the bore of the chest.

Between the end of the valve G′ and the wall or partition k a steam-inlet pipe, U, is connected to the body of the chest G to introduce live steam into it, and on the opposite side of the partition-wall k an exhaust-pipe is attached to conduct away exhaust-steam and discharge it.

In order to counterbalance the valve G′, a hole, 2, is drilled or otherwise formed through the body of the valve from one end to the other, so as to permit live steam to pass through, and hence afford equal pressure on each end of the valve. As a result, the valve may be moved with ease to adjust it at any desired point in the chest and will remain where it is placed.

In the annular cavity of the steam-cylinder two segmental pistons, I K, are located. These are so formed that they will fit the curvature of the concentric walls a^2 c^2 of the cylinder in steam-tight manner, and, if desired, the ends may be provided with any proper packing device to facilitate the production of a steam-tight sliding joint between the pistons and the cylinder-walls. Each piston is preferably made in two equal portions, i i′ m′ m^2, the line of division corresponding with the radial slot or opening V between the inner concentric walls, a^2 c^2, of the cylinder.

In the adjacent faces of the equal portions of the curved segmental pistons I K shallow recesses of proper width are made. These recesses taken together represent one-half of the distance or width of the radial slit V between the walls a^2 c^2 of the cylinder A A′.

A hollow shaft, E′, that has been previously mentioned as being revolubly located in the perforated upper portion of the bracket-stand B, is extended toward the center of length of the cylinder A A′, and upon this end of the shaft a thin metallic flange, t^2, is connected rigidly, which projects into the space or recess between the piston-sections m′ m^2 of piston K and fits edgewise therein, so as to avoid lateral motion between the parts, and adapt this flange to become a driver to revolve the hollow shaft E′ when the piston K is rotated in the cylinder by action of steam upon its ends.

The other segmental piston, I, is made an exact duplicate of the piston K, just described, and in the recess provided between its two equal sections, *i i'*, a similar plate or flange is inserted to fit in the recess neatly. This driving-flange *t'* is secured to the end of a shaft, E, which latter is inserted within the hollow shaft E', and is of such a relative diameter thereto as to revolve freely in it as a box-bearing.

A pedestal, N, for the revoluble support of a shaft, M, is secured on the bed-plate C, a proper distance intervening between it and the bracket-stand B to allow the fly-wheel D to be supported upon and secured to the end of the shaft M, as shown in Fig. 1, and at the opposite end of this shaft a pulley or band-wheel, Z, for transmission of motion and power developed by the engine, is secured.

The fly-wheel D is recessed on the side toward the bracket-stand B, and across its center two parallel guide-bars, T T, are secured, the length of these bars being determined by the diameter of the wheel-rim D', considered on its inner face. The opposite faces of the guide-bars T T are rendered true and smooth to allow the blocks W W' to move freely in the intervening space and have a sliding contact with said faces of the guides.

Both of the shafts E E' are extended toward the guide-bars T T, as is also the end of the perforated head of the bracket-stand B, which gives support to these shafts, and upon this end of the hollow shaft E' a crank, P, is secured, the crank-pin 3 of which is inserted through a neatly-fitting hole in the block W'. A similar crank, P', is attached to the interior shaft, E, which projects sufficiently outside of the hollow shaft E' to allow the two cranks to be revolved by their shafts and not strike against each other. The crank-pin 4 of the crank P' is inserted through a perforation made for its reception in the slide-block W.

A pocket, *w*, for the retention of oil or other lubricant, is made at each end of the guide-bar T T, the recesses being formed in the rim of the wheel at these points, and from their location the liquid lubricant will be retained by centrifugal action, so that the ends of the moving blocks W W' will dip into the oil, and thus be automatically and continuously lubricated when the engine is in motion.

It will be noticed that the pedestal-block N is lower than the bracket-stand B, this difference in height being represented by the length of the cranks P P', considered from the centers of the interior shaft, E, to the center of the crank-pins 3 4, both shafts lying in parallel planes, as shown in Fig. 1.

In operation, steam being admitted to the steam chest, if the engine is to work by direct and continuous pressure of live steam, the valve G' is adjusted to admit steam through all the ports *s t u v w* into the cylinder, the two pistons I K having been previously located as shown in Fig. 2, or with their ends nearly in contact at the bottom of the annular cylinder-bore. By slightly moving the fly-wheel the segmental piston K, which is now in position over the live steam ports *s t u v w*, covering them entirely to prevent steam access to the cylinder, will move upwardly and away from the other piston, I, it being understood that the guide-bars T T have been in a horizontal position when the pistons had their ends in contact, as was explained. When the piston K separates from the other piston, I, the first live-steam port, *s*, will be uncovered and steam will enter the cylinder. Simultaneously with the movement of the leading piston K, as has been mentioned, the fly-wheel will be correspondingly moved and the guide-bars will incline from a horizontal plane. This will give accelerated motion to the crank P by reason of the rising of its attached block W' above the plane of the shaft M, on which the fly-wheel D rotates. At the same time the crank P is driven rapidly above the plane of the shaft M, the crank P', which is attached to the interior shaft, E, and through it and driving-flange *t'*, connected to the segmental piston I, moves nearer the vertical plane in which both the fly-wheel shaft M and piston-shafts E E' lie, and also nearer the center of the shaft M. Consequently the motion of the crank P', while it is following the other crank, P, is rendered slower than the other crank, as is also the motion of piston I as compared to that of piston K. In consequence of the increased leverage of the leading crank P, its attached leading piston K will become the driver, and the slower-moving piston I, which follows it, acts as a steam-abutment, against which the steam that enters the port *s* will press and counteract on the other piston, K, to drive it around in the cylinder. As the piston K moves toward the exhaust-ports on the opposite side of the cylinder, the other piston, I, will slowly follow it and successively close the several live-steam ports *s t u v w*, the leading piston meanwhile covering the exhaust-ports *p o n m l*, from the upper one, *p*, downward in the order named. Just after the last live-steam port, *w*, is covered by the slow-moving piston I the other piston, K, will have passed the upper exhaust-port, *p*, and the steam contained between these pistons escapes through the port.

The length of the two pistons I K, as compared to the position of the ports and the diameter of the cylinder, is such that when the exhaust-port *p* is opened the two pistons will have changed their functions, the piston I becoming the leading piston and the piston K the following or slow-moving abutment. This alternate functional change continues to be repeated at every half-revolution of the engine.

If it is desired to use the steam expansively, the valve G' is set to cover one or more of the steam-inlet ports *u v w*, as if these are stopped off by the valve, steam will be cut off from the cylinder by the slow-moving abutment-piston as soon as it passes over the other two inlet-ports, *s t*, and consequently the quick-moving piston that is in the lead will be driven through the remainder of its stroke, or until the exhaust-port is opened by the expansion of steam that has been introduced between the two pistons, as has been explained.

Among the advantages claimed for this engine the following may be mentioned:

First. By simple manual adjustment of the valve, which may be instantly made when the engine is running, the steam may be cut off at several different points in a semi-revolution, and consequently different degrees of expansion may be obtained at will of the operator.

Second. The high speed rendered practicable by the construction of this engine is also favorable to an economical use of steam as compared to power developed.

Third. The manner in which the working parts of the engine are constructed and connected obviates to a great extent undue wear or frictional resistance between them.

Fourth. The complete and easy lubrication of the moving parts that are subjected to the greatest wear is another feature of advantage and merit afforded in this engine.

It is evident that there might be changes made in some of the parts of this engine and their relative positions altered without departure from the spirit of my invention—as, for instance, by a slight modification of parts and arrangement of said parts the engine may be made reversible or capable of running toward the right or left hand; again, the steam-chest may be placed on the side or top of the cylinder instead of below it, and equally good results be attained; and, if desired, the relative height of the pedestal and bracket-stand, which support the piston-shafts and fly-wheel shaft, respectively, may be altered so as to make the pedestal extend above the bracket-stand and have the fly-wheel shaft located in a plane above the plane of the piston-shafts, the crank connections remaining the same in both cases. I prefer to construct the engine as herein shown; but in view of the modified forms that are possible to produce I do not wish to limit its construction to the exact forms and combinations herein shown; but,

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

1. In a concentric-piston steam-engine, the combination, with a cylinder and segmental pistons adapted to revolve therein, of a steam-chest having a series of live-steam and exhaust-steam passages leading thereto from the cylinder, a partition in the steam-chest between the live and exhaust steam passages, and a sliding valve adapted to open or close the live-steam passages, substantially as set forth.

2. In a concentric-piston steam-engine, the combination, with a cylinder and segmental pistons adapted to revolve therein, of a steam-chest having a series of live and exhaust steam passages leading therefrom to the cylinder, a partition in the steam-chest between the live and exhaust steam passages, pipes leading out of the two chambers of the steam-chest, and a sliding valve for opening or closing the live-steam passages, substantially as set forth.

3. In a concentric-piston steam-engine, the combination, with a cylinder and segmental pistons adapted to revolve therein, of a steam-chest having live and exhaust steam passages leading therefrom to the cylinder, a partition in the said chest between the live and exhaust steam passages, pipes leading out of the two chambers of the steam-chest, and a sliding valve for opening and closing the live-steam passages, said valve having a perforation therein to allow the steam to pass therein to equalize the pressure on the ends of the valve, substantially as set forth.

4. In a concentric-piston engine, the combination, with an annular cylinder, a steam-chest, a series of live-steam passages, and an equal number of exhaust-passages, of a central partition-wall located between the live-steam and exhaust-steam passages, a balanced sliding valve, and a valve-rod to move the valve endwise, so as to cover one or more live-steam passages, substantially as set forth.

5. In a concentric-piston engine, the combination, with a fly-wheel, a fly-wheel shaft, and a pedestal that revolubly supports the fly-wheel shaft, of an annular steam-cylinder, a pair of shafts, one within the other, said shafts having cranks on adjacent ends, these cranks having sliding connection with the fly-wheel, segmental pistons mounted on the shafts, adapted to move steam-tight in the cylinder, a steam-chest, live-steam passages leading from the chest into the cylinder, exhaust-passages connecting the steam-chest and cylinder, a valve, a partition in the steam-chest to separate the live-steam and exhaust passages, a hollow shaft, a shaft located in the hollow shaft, a bracket-stand that supports these shafts in a plane removed from the plane of the fly-wheel shaft, independent devices to connect the two concentric shafts to the pistons, and mechanism to connect the concentric shafts to the fly-wheel and cause the fly-wheel to rotate by the movement of the pistons, substantially as set forth.

6. In a concentric-piston steam-engine, the combination, with a cylinder, segmental pistons adapted to revolve therein, concentric shafts connected with the segments, and a fly-wheel, with which said shafts have a sliding connection, of steam-chest having a series of live-steam and exhaust-steam passages leading thereto from the cylinder, a partition in the steam-chest between the live and exhaust steam passages, and a sliding valve adapted to open or close the live-steam passages, substantially as set forth.

7. In a concentric-piston steam-engine, the combination, with a cylinder, segmental pistons adapted to rotate therein, a pair of con-

centric shafts having connection with these segmental pistons, said shafts having cranks on one end, and a fly-wheel mounted on a suitable shaft, said fly-wheel having a pair of guides therein, with which the cranks on the ends of the concentric shafts have a pivotal sliding connection, of a steam-chest having a series of live-steam and exhaust-steam passages leading thereto from the cylinder, and a sliding valve adapted to open or close the live-steam passages, substantially as set forth.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

GEORGE W. HUBBARD.

Witnesses:

WILLIAM BATCHELDER,

SEYMOUR LEE.