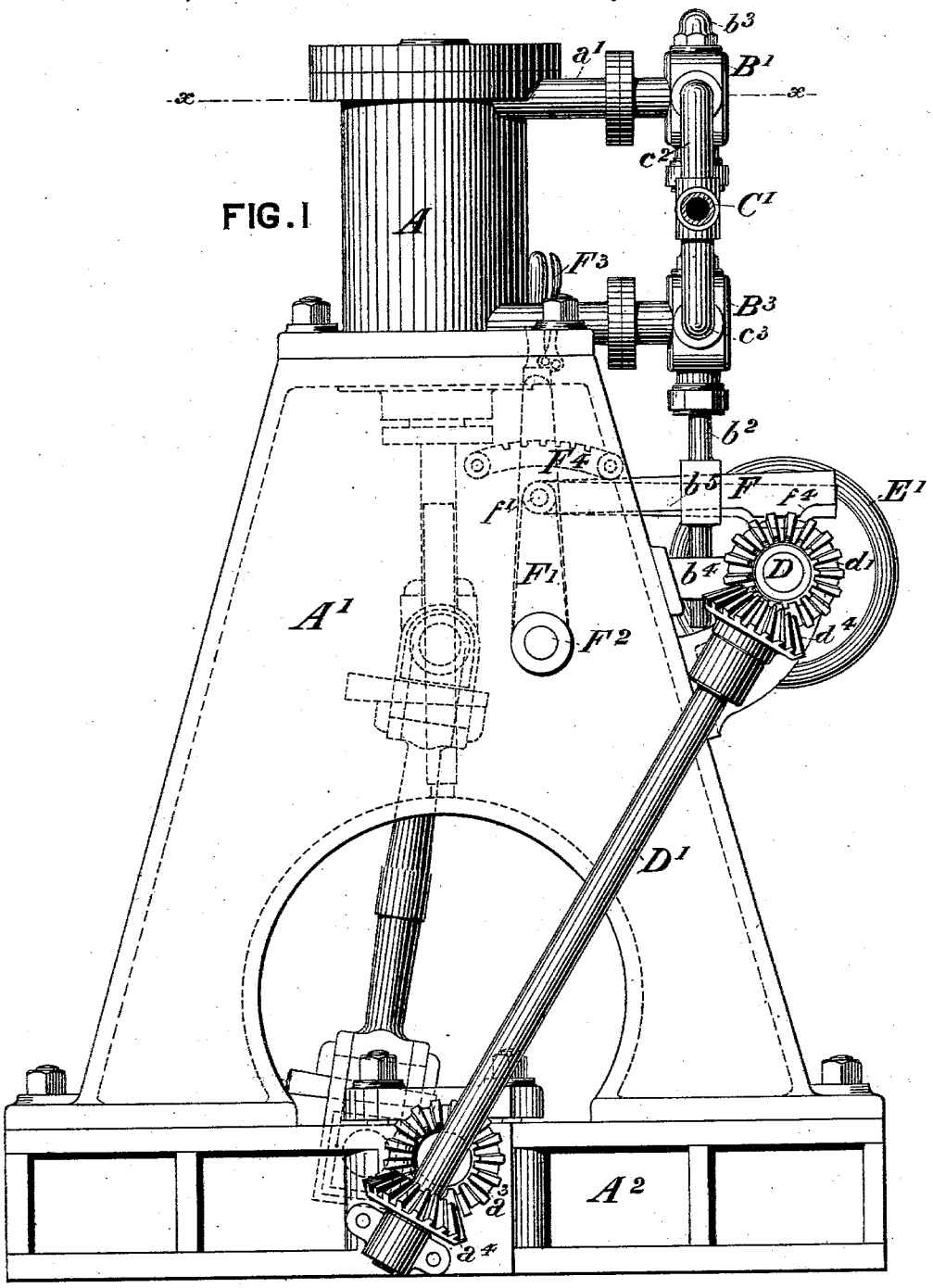
3 Sheets—Sheet 1.

J. EVERDING.

Valve-Gearing for Steam-Engine.

No. 203,128. Patented April 30, 1878.

FIG. 1



Witnesses:

G. R. Wilkinson

Geo. H. Vaillant.

Inventor:

John Everding

by J. Snowden Bell

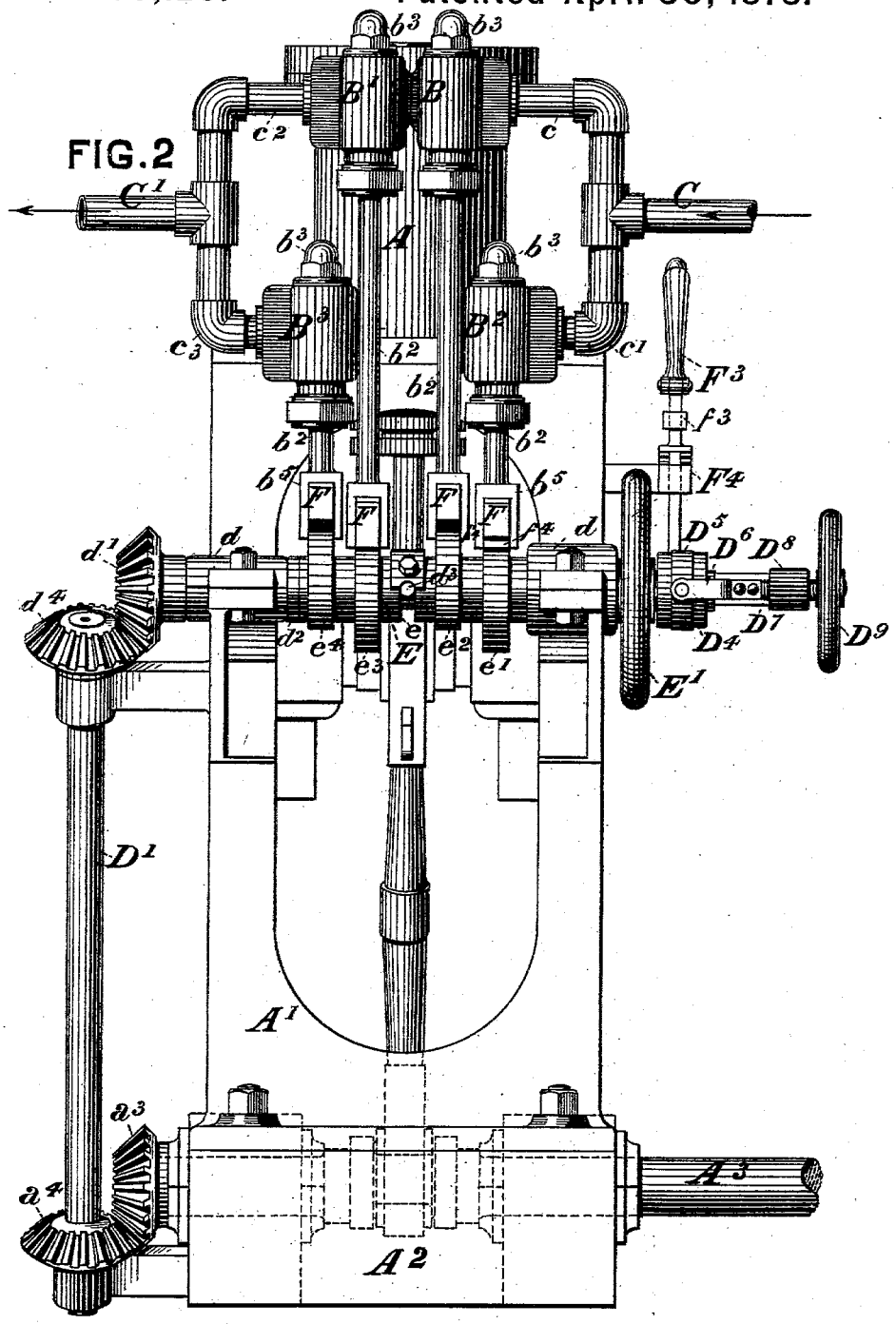
atty.

J. EVERDING.

Valve-Gearing for Steam-Engine.

No. 203,128. Patented April 30, 1878.

FIG. 2



Witnesses:

E. R. Wilkinson

Geo. A. Vaillant.

Inventor:

John Everding

by J. Snowden Bell

atty.

3 Sheets—Sheet 3.

J. EVERDING.

Valve-Gearing for Steam-Engine.

No. 203,128. Patented April 30, 1878.

FIG.3

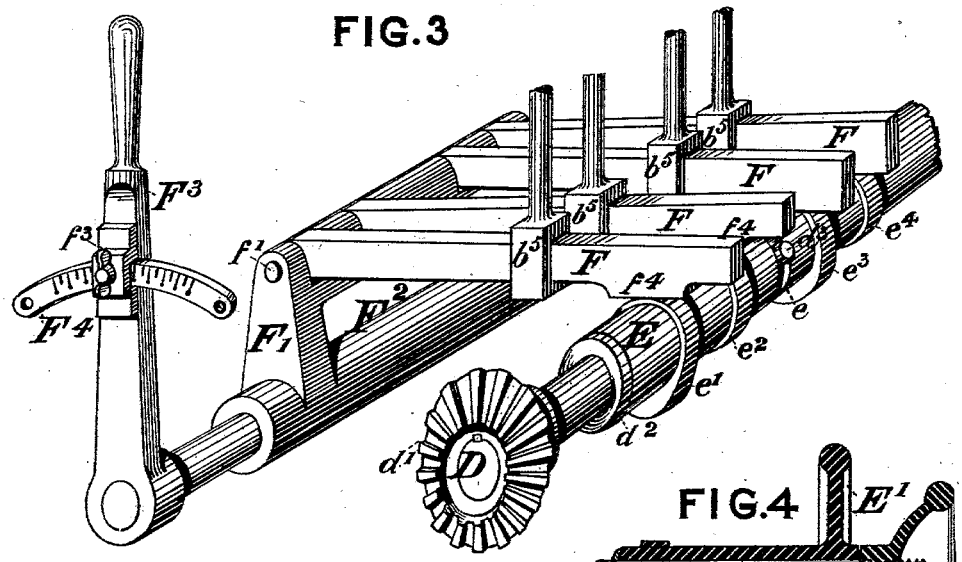


FIG.4

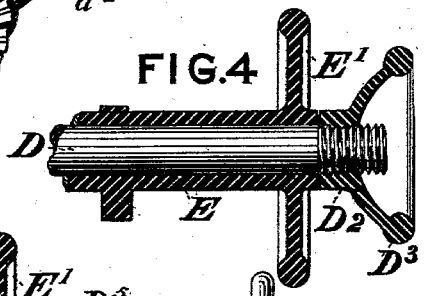


FIG.5

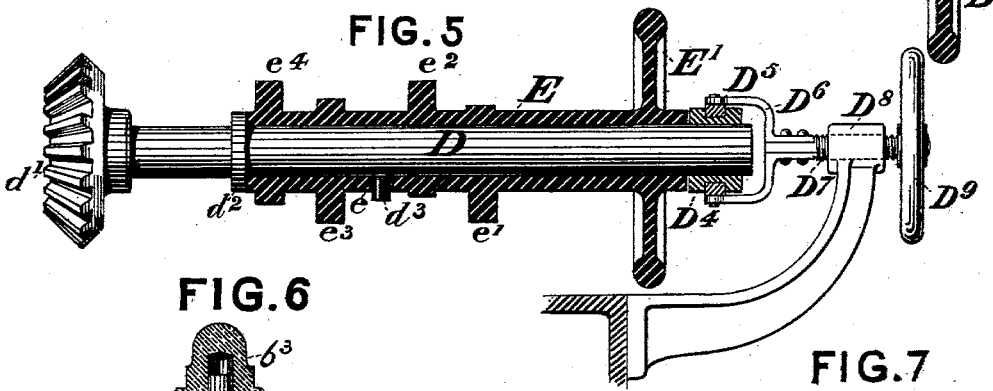


FIG.6

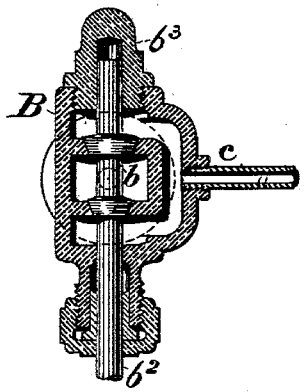
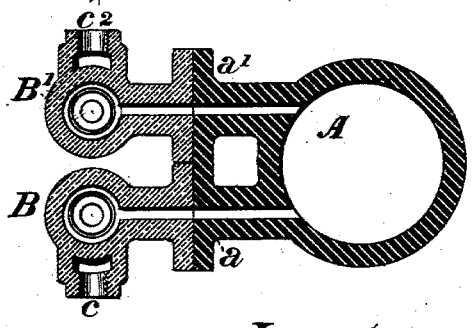


FIG.7



Witnesses:

E. F. Wilkinson

Geo. A Vaillant.

Inventor:

John Everding,

by J. Snowden Bell,

atty

UNITED STATES PATENT OFFICE.

JOHN EVERDING, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF HIS RIGHT TO ABRAHAM S. JENKS, OF SAME PLACE.

IMPROVEMENT IN VALVE-GEARING FOR STEAM-ENGINES.

Specification forming part of Letters Patent No. **203,128**, dated April 30, 1878; application filed December 19, 1877.

To all whom it may concern:

Be it known that I, JOHN EVERDING, of the city and county of Philadelphia, in the State of Pennsylvania, have invented certain new and useful Improvements in Valve-Gearing for Steam and other Engines, of which the following is a specification:

The object of my invention is to provide such means for operating the valves by which the induction and eduction of the motive fluid are controlled in an engine actuated by steam or other vapor having an expansive force as that the degree of expansion of the motive fluid may be momentarily varied and accurately regulated during its motion, as may be required, and that the direction of motion of the driving-shaft of the engine may be reversed with certainty and dispatch, these functions being performed without interference with the free exhaust of the motive fluid, and without involving complex or expensive mechanism.

To these ends my improvements consist in combining, with a reciprocating engine having valves which, at each end of the cylinder, separately govern the admission and exhaust, respectively, of a counter-shaft receiving rotary motion from the main or driving shaft; a tubular cam-shaft, which is mounted loosely upon the counter-shaft, and rotated therewith by means of a clutch or friction-collar thereon, and which carries the valve-operating cams; a device for changing the position of the cams relatively to the engine-crank; a series of cam-levers, through which the cams act upon the valves; and a rock-shaft and lever, by which the position of the cam-levers relatively to the cams is regulated and adjusted in correspondence with the degree of expansion required, all as hereinafter more fully set forth.

In the accompanying drawings, Figure 1 is a front view, in elevation, of a vertical direct-acting inverted-cylinder engine embodying my improvements; Fig. 2, a side view, in elevation, of the same; Fig. 3, a view, in perspective, of the cam-shaft, cam-levers, and rock-shaft and operating-lever detached; Fig. 4, a section through a portion of the cam-shaft, showing one form of lock for the reversing device; Fig. 5, a section through the cam-shaft, showing another form of lock for the reversing device; Fig. 6, a vertical central section through one of the valve-chambers; and Fig. 7, a horizontal section through the cylinder and the two upper valve-chambers, taken at the line *x x* of Fig. 1.

My improvements are, in this instance, described as applied to a marine engine of the ordinary "over-head" type; but they are, by proper modifications of location and constructive detail, and without variation from their operative principle, equally well suited to reciprocating engines of other descriptions.

In the engine shown the cylinder A is secured to and supported by a vertical frame or housings, A^1, resting upon a bed-plate, A^2, which forms its base. The cylinder A has two pipes or nozzles, *a* a^1, cast upon or secured to it at or near its upper end, and two similar nozzles at or near its lower end. An induction-valve chamber, B, is bolted or secured to one of the upper nozzles, *a*, and an eduction-valve chamber, B^1, to the other upper nozzle, a^1. Similar induction and eduction valve chambers B^2 B^3 are secured to the two lower nozzles.

The pipe C, by which motive fluid is supplied from the generator, communicates by branches *c* c^1 with the upper and lower induction-valve chambers B B^2, respectively, and the exhaust-pipe C′ is similarly connected by branches c^2 c^3 with the upper and lower eduction-valve chambers B^1 B^3. A double-beat puppet-valve, *b*, is fitted to seats in the upper induction-valve chamber, B, and a similar valve is fitted in the chamber B^1. These valves are not what are termed "balanced valves," but in each case have disks of unequal diameters, in the induction-valve *b* the upper being the larger, and in the eduction-valve the lower being the larger, so as to be closed and returned to their seats by pressure after they have been elevated therefrom by the cams, hereinafter to be described.

The closing of the valves is facilitated by their gravity united to that of their stems; but, if desired, springs may be attached to the stems to assist in the operation, as has been heretofore done in various forms of valve-gearing.

I have shown and described puppet-valves as being, in my judgment, most desirable; but slide-valves may be substituted and similarly operated, if, in the opinion of the constructor, there should exist any reasons for employing them.

The valves are mounted upon or secured to stems b^2, which are maintained in line, so that the valves may seat truly, by upper guides b^3, one of which is secured to each of the valve-chambers, and by lower guides b^4, secured to the housings A^1, or to a transverse brace thereon.

A counter-shaft, D, is mounted in bearings d on one side of the housings, and is rotated coincidently and in similar direction with the main or driving shaft A^3 of the engine. In the instance shown the motion of the driving-shaft is communicated to the counter-shaft by means of an intermediate shaft, D^1, provided with miter-wheels a^4 d^4 at each end, and mounted in journals or bearings formed upon or fastened to the housings of the engine, a corresponding miter-wheel, a^3, upon the crank-shaft A^3, and a similar wheel, d^1, upon the counter-shaft D. The counter-shaft D may also be connected with and driven directly by the crank-shaft A^3, by means of cranks set upon each end of said shaft at an angle of ninety degrees, and coupled by suitable connecting-rods to insure the passage of the counter-shaft over the centers. A tubular cam-shaft, E, is fitted loosely upon the counter-shaft D, one of its ends abutting against a collar, d^2, on said shaft, adjacent to the bearing d nearest the miter-wheel d^1, and the other end extending through the bearing d on the opposite side of the housings, and having a hand-wheel, E′, secured upon it. The cam-shaft E is caused to rotate with the counter-shaft D by means of a clutch or friction collar upon the counter-shaft D. This friction-collar may be threaded like a nut, as shown in Fig. 4; but I prefer the arrangement as shown in Fig. 5. The cam-shaft has formed upon or secured to it the induction-cams e^1 e^2 and eduction-cams e^3 e^4, which operate the valves through the intermediation of cam-levers. A pin or stop, d^3, upon the counter-shaft D, which enters a circumferential slot, e, regulates the amount of the movement of the tubular cam-shaft E in a manner and for the purpose presently to be described.

To reverse the direction of rotation of the crank-shaft A^3, or to reverse the engine, the clutch or friction collar is disengaged, and the cam-shaft E is turned one-half a revolution upon the counter-shaft D by means of the hand-wheel E′, by which operation it is obvious that each of the cams is moved relatively to the engine-crank through an arc of one hundred and eighty degrees, and that consequently the direction of supply and discharge is transferred relatively from one side of the piston to the other. If any lead is given to the valves, the amount of travel of the cam-shaft around the counter-shaft will, of course, be less than half a revolution by twice the amount of angular advance at which the cams are set. To be enabled to regulate the amount of lead, I provide two segmental abutment-pieces, which are secured to and adjustable upon the cam-shaft by means of set-screws.

Figs. 4 and 5 show devices for clamping and releasing the cam-shaft, either of which may be adopted, as preferred. In each case the end of the counter-shaft is extended outward beyond the hand-wheel E′ of the cam-shaft, and in Fig. 4 it is threaded to receive a nut, D^2, which is formed in a piece with or secured to a hand-wheel, D^3. In the use of this arrangement the cam-shaft is, during the operation of the engine, clamped between the collar d^2 of the counter-shaft and the nut D^2, and, in reversing, the hand-wheel D^3 is moved so as to slacken the bearing of the nut D^2, and the cam-shaft moved by its hand-wheel E′ until the pin or stop d^3 abuts against the opposite end of the groove e, when the nut D^2 is again brought to bear against the end of the cam-shaft. In Fig. 5 the end of the counter-shaft is not threaded, but carries a collar, D^4, fitted on a feather on the shaft, so as to have the capacity of end motion thereon while rotating therewith. The collar D^4 is embraced by a loose ring, D^5, which is connected by a yoke, D^6, to a screw, D^7, working in a nut, D^8, formed in a bracket secured to the housings and operated by a hand-wheel, D^9. In this case the cam-shaft is clamped or released, respectively, by the end motion of the collar D^4, as induced by the hand-wheel D^9 and its connections, as above described.

Movement is imparted to the induction and eduction valves from the cams e^1 e^2 e^3 e^4 by cam-levers F, the outer ends of which rest upon the faces of said cams, and which pass through slots formed in enlargements b^5 on the valve-stems b^2 above their lower guides b^4, the inner end of each cam-lever being journaled to a rod or pin, f^1, which is secured to arms F^1 on a horizontal rock-shaft, F^2, mounted in bearings in the housings.

In order to alter the degree of expansion or point of cut-off, as presently to be described, the rock-shaft F^2 is vibrated in its bearings, so as to vary the distance of the outer ends of the cam-levers F from the center of the counter-shaft D, by a hand-lever, F^3, which is held in any desired position by a spring-latch, f^3, which takes into notches in a graduated segment, F^4.

It will be seen that the opening of the valves is effected by the elevation of the cam-levers by their respective cams, and that each valve is closed coincidently with the depression of the free end of its cam-lever by the withdrawal therefrom of the eccentric portion of the periphery of the cam in the rotation of the latter.

In order that the admission-valves may be closed sooner or later, as required, for the purpose of cutting off the motive fluid at different portions of the stroke of the piston, as

may be desired in the operation of the engine, each of the admission cam-levers has a projection or offset, f^4, formed upon its lower face at a point above the center of the counter-shaft D, and extending inward therefrom toward the center of the rock-shaft F^2, the depth of said projections or offsets below the lower faces of the cam-levers and their length thereon being proportionate to the lift of the valves and the greatest degree of expansion desired to be effected.

It will be obvious that, in the forward motion of the engine, the closer the inner ends of the offsets f^4 are brought to the center line of the counter-shaft the sooner the cam-levers will cease to be sustained by the eccentric portions of their respective cams, and will consequently fall for a distance equivalent to the depth of the offsets, thereby closing their respective admission-valves.

Conversely, the duration of opening of the admission-valves will be protracted proportionately to the moving inward of the offsets toward the rock-shaft F^2. These changes of position of the offsets relatively to the counter-shaft are effected by the movement of the rock-shaft by its hand-lever F^3, the relative degrees of expansion in different positions being indicated by graduations upon the segment F^4.

If it be desired to cut off in back motion, it is only necessary to extend the offsets f^4 a corresponding distance outward toward the free ends of the cam-levers, the operation being similar to that above described, except that the rock-shaft and lever are moved in reverse direction.

My improvements are specially designed for use in engines actuated by steam or other motive fluid of exceptionally high pressure, as in such case they accomplish two desiderata which noticeably obtain under such condition of operation, to wit: first, the capacity of readily effecting a high degree of expansion, and of varying and regulating the same during the movement of the engine; and, second, the employment and convenient operation of puppet-valves in connection with a simple reversing and cut-off gearing, the use of such valves at very high pressures being free from the destructive grinding action which exists with valves which slide over ports or openings in their seats.

I claim as my invention and desire to secure by Letters Patent—

1. The combination, in a steam or other engine, of a main driving-shaft, a counter-shaft coupled to and rotated by the driving-shaft, a tubular cam-shaft which carries the valve-operating cams, and which is mounted on and rotated by the counter-shaft, and a device for varying and adjusting the position of the cam-shaft relatively to the counter-shaft, substantially as set forth.

2. The combination, with an engine having a separate induction and eduction valve at each end of its cylinder, of a rotating cam-shaft and a separate cam thereon for each of the valves, a series of pivoted cam-levers by which the movement of the cams is transmitted to the valve-stems, an offset or projecting bearing on the face of each of the admission cam-levers above the face of its cam, and a rock-shaft and lever for varying the position of the offsets relatively to the axis of the cam-shaft, substantially as set forth.

3. The combination of the counter-shaft and its stop-pin, the tubular cam-shaft mounted loosely thereon, and having a circumferential groove fitting the stop-pin of the counter-shaft, valve-operating cams, and a hand-wheel formed on or secured to the cam-shaft, and a nut or friction-collar on the counter-shaft, by which the cam-shaft may be made fast or loose thereon at pleasure, substantially as set forth.

JOHN EVERDING.

Witnesses:
J. SNOWDEN BELL,
GEO. A. VAILLANT.