

(No Model.)

2 Sheets—Sheet 1.

W. E. CRIST.
VIBRATING PISTON ENGINE.

No. 521,603.

Patented June 19, 1894.

Fig. 2.

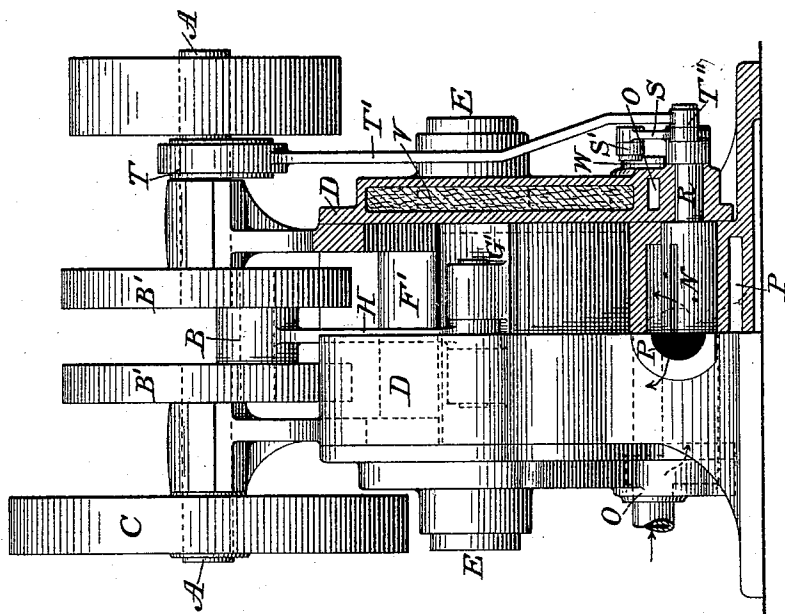
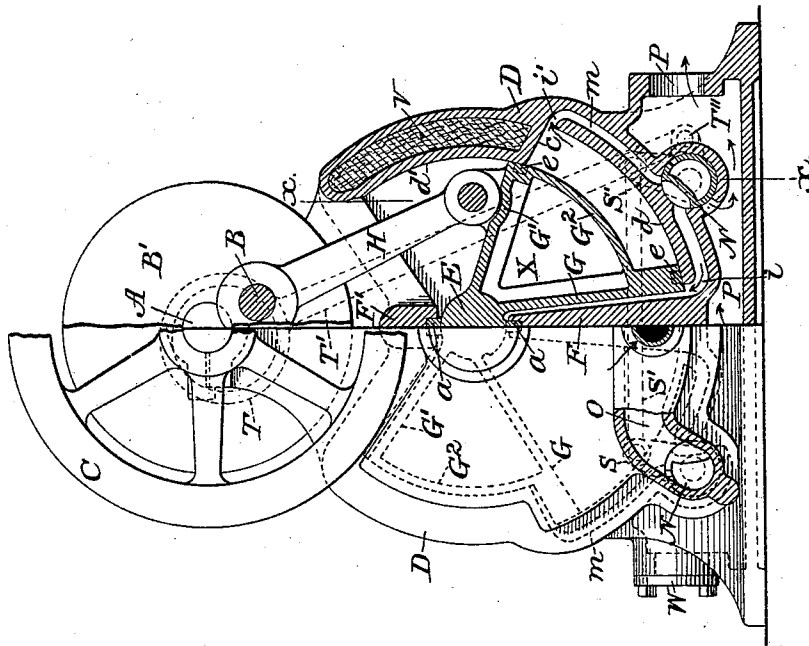


Fig. 1.



Attest:

A. N. Jespersen
C. M. Watson

Inventor:

William E. Crist
By David A. Burr
Atty.

W. E. CRIST.
VIBRATING PISTON ENGINE.

No. 521,603.

Patented June 19, 1894.

Fig. 4.

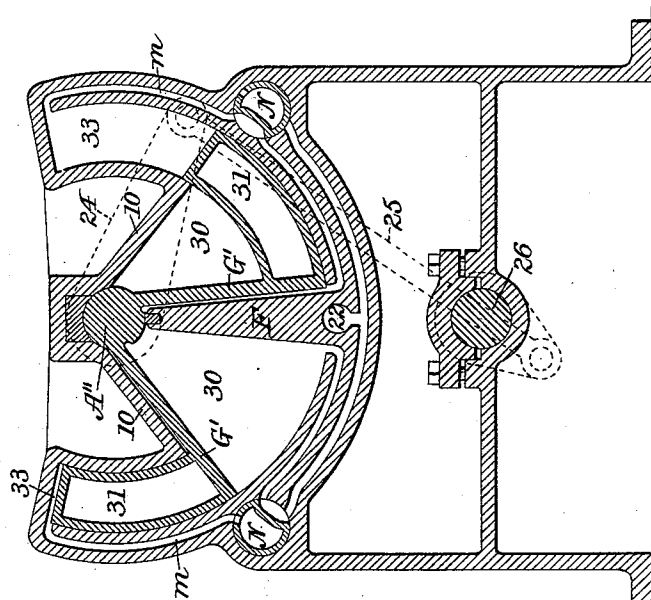
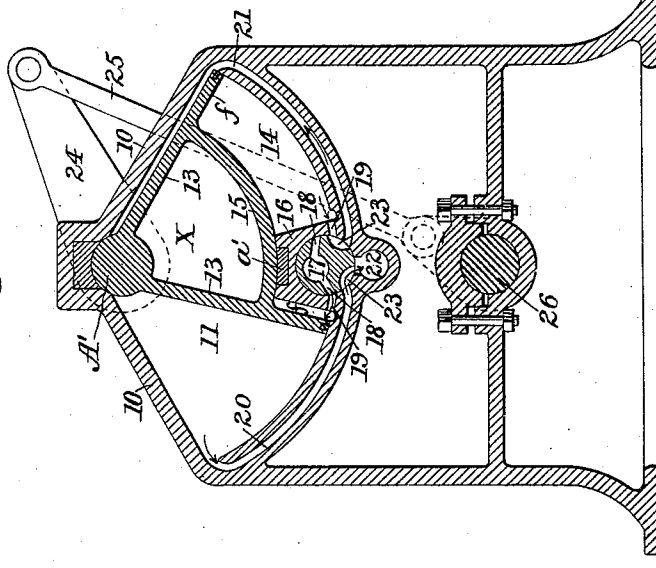


Fig. 3.



Attest:

A. N. Jesbera.
E. M. Watson

Inventor:

William E. Crist
By David A. Brown
Atty.

UNITED STATES PATENT OFFICE.

WILLIAM E. CRIST, OF BROOKLYN, NEW YORK.

VIBRATING-PISTON ENGINE.

SPECIFICATION forming part of Letters Patent No. 521,603, dated June 19, 1894.

Application filed October 12, 1889. Serial No. 326,840. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM E. CRIST, of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Vibrating-Piston Engines; and I do hereby declare that the following is a full and exact description thereof, reference being had to the accompanying drawings, and to the letters of reference marked thereon, making a part of this specification.

This invention relates to that class of engines in which steam, or other expanding gas or gases, is admitted alternately to opposite sides of a radial piston swinging in a sector-shaped chamber.

It has for its object to increase the efficiency of an engine of this class by permitting the steam, or its equivalent, to act upon a portion of the piston at high pressure upon one side and then allowing it to exhaust and expand against an enlarged surface upon the opposite side of the same piston, so that at each stroke of the piston it shall receive alternately the pressure of an initial column of steam at a high pressure upon a comparatively small surface on one side and of the same volume of steam left free to expand further and bear with a reduced pressure against a largely increased surface on the opposite side of the same piston, the chamber in which the steam is allowed to expand being heated by the steam admitted to the engine under high-pressure.

In the accompanying drawings:—Figure 1, is an end elevation, of my improved vibrating-piston engine with one half thereof in vertical section; Fig. 2, a similar, side elevation thereof, partly in section on the line $x-x$ of Fig. 1. Figs. 3 and 4 are sectional views illustrating modifications in the construction and arrangement of the pistons in my improved engine, the valve connections being omitted and the driving-shaft represented as placed under the engine instead of above it.

A, A, Figs. 1 and 2, represents the main shaft of the engine preferably constructed as shown, with a central crank formed by two disks $B'B'$ and an interposed wrist-pin B connecting them.

The casing D inclosing the piston-cham-

bers of the engine is sectoral in form and the shaft A A, is mounted in suitable bearings on top of the casing.

The piston-shaft E is mounted parallel with the main-shaft A, A, to rock in suitable bearings formed in the end-plates of the casing, its axis being made to co-incide with that of the arc described by the curved inner wall of the casing. A central partition F, extends from the rock-shaft E to the bottom of the casing and, dividing it internally into two sectoral piston-chambers, forms an abutment against which the pistons are carried upon the instroke thereof. A bar F' extends above the shaft E in contact therewith to stay it. The joints between the shaft and the partition F and bar F' , are suitably packed by strips a , a , to form a steam-tight joint.

The inner face of the outer or peripheral wall of each piston-chamber is made to embrace an arc of about one hundred and forty-five degrees, having the axis of the shaft E as its center, and is formed with an offset c , therein which, extending from end to end thereof parallel with the shaft E, divides the wall into two equal sections d , d' , of which the upper or outermost, d' , is of least radius and forms an abutment within the piston-chamber against which the piston is carried in its outstroke.

A piston-plate G is made to project longitudinally from the rock-shaft E into each piston-chamber with its outer edge in contact with the inner section d , of its peripheral wall. A second piston-plate G' , is also projected from the shaft into the same piston-chamber to contact with the outer section d' of the peripheral wall, the interval between the two piston-plates G, G' , being made to correspond with that between the partition F and the offset or abutment c , so that when the inner piston-plate G is carried inward against the partition or inner abutment F, the outer piston-plate G' shall be brought close to the outer abutment c , as shown in Fig. 1.

A transverse plate G^2 , is extended from the outer end of the piston-plate G' to connect with the piston-plate G, upon a line parallel with the shaft E, and at a distance therefrom corresponding with the length of the radius of the piston plate G, and said connecting-plate is preferably curved upon an arc con-

centric with the peripheral wall of the chamber. The space X, inclosed between the plate G² and the two piston-plates G G', is preferably inclosed by end-walls formed integral
 5 with said plates. The joints between the ends of the two piston-plates G G' and connecting-plate G², with the walls of the piston-chamber, are packed with suitable, spring-seated packing-strips e, e, as is customary in
 10 engines of this class, to prevent an escape of steam from one side of the piston to the other. The two pistons thus severally constructed to project from the central rock-shaft E into the piston-chambers on each side of the central
 15 partition F, are so located upon said shaft, as that when the one piston is at the end of its instroke the other shall be at the end of its outstroke,—see dotted lines Fig. 1,—and vice-versa. The outer face of one of the pistons
 20 is connected with the wrist-pin B on the main crank-shaft A, A, by a coupling-rod H, whereby the oscillation of the piston is made to impart a rotary movement to said shaft; and the shaft is fitted as is customary with a
 25 fly-wheel C.

Steam ports i, i', are formed at the extreme inner end of each piston-chamber and also at the angle formed by the abutment c with its peripheral wall, and these ports are connected
 30 by a communicating passage m, which is governed by a suitable steam-valve N, controlling likewise communication between said passage m, a steam supply pipe O and an exhaust port P.

By preference, the valve N is rotary and its passages are so arranged, substantially as shown in the drawings, as that when communication is established through it between the
 35 ports i, i', the communication is cut off between the passage m and the steam-pipe and exhaust-port, while, by a change in the position of the valve, the port i at the inner end of the piston chamber will be brought into communication with the exhaust-port P, and
 40 simultaneously the steam-pipe O will be brought into connection with the port i', at the outer end of the piston-chamber.

Each valve N is mounted on an independent rock-shaft R, the two rock-shafts R R, being
 50 made however to move in unison by crank-arms S, S, and a connecting-rod S',—see Fig. 2 and dotted lines Fig. 1,—and they are actuated by means of an eccentric T on the main-shaft connected by a coupling-rod T' with a
 55 crank-arm T'',—Fig. 2,—on the valve-shaft R.

The steam passages in the valve N are so arranged, and the eccentric T so adjusted with reference thereto and to the piston in the chamber whose ports are controlled by
 60 the valve, substantially as shown in the drawings, as that, when the piston has fully completed its outstroke and the end of the inner piston-plate G is brought up against the abutment c, in the piston-chamber, steam at its
 65 initial pressure is admitted through the port i' against said piston-plate within the space bounded and inclosed between the plate G²

connecting the piston-plates G and G', the inner piston-plate G, the abutment c, and the two end-plates of the piston-chamber.

It will be seen that the effective piston area exposed to the action of the steam under high pressure is limited to so much of the outer end of the face of the piston-plate G, as is included
 70 in said inclosed space. While steam at high-pressure is being admitted against this reduced area on the outer side of the piston-plate G, communication is established between the space upon the opposite or inner
 75 side of said plate and the exhaust-port P; but, so soon as the piston has completed its instroke under the high pressure, the exhaust, as well as the steam-supply passages, are closed, and communication is established
 80 through the passage m between the port i' on the high pressure side of the piston and the port i on its opposite side, so that the steam which has exerted its force at high pressure against a comparatively small piston surface
 85 in the chamber of reduced area on the outer side of the piston-plate G, is allowed to expand into the chamber of enlarged area and act against a greatly enlarged piston-surface on the opposite side of said plate to drive it
 90 outward. So soon as the high-pressure steam is cut off from the one piston carried by the rock-shaft E, it is admitted to the other piston, so that there is a constant application of the steam-power at high-pressure to produce
 95 a movement of the shaft by the successive instroke of each piston while the steam is allowed to expand and act effectively upon each piston in producing its outstroke. Its force is thereby fully utilized as in a compound engine.

The exhaust and steam-supply passages may be extended entirely through the casing to admit of attaching pipes thereto on either
 100 side of the engine, the opposite end of each passage being closed by a face-plate W, bolted thereon.

The casing A, may be jacketed with a packing V, of asbestos or other non-conducting material.

As a modification of my invention the piston shaft may be mounted to oscillate in suitable bearings in the angle at the intersection
 115 of the two converging walls 10, 10, of a sectoral chamber 11, whose third side describes an arc having said angle at its center. From this shaft two piston-plates 13, 13,—see Fig.
 120 3—project radially to sweep with the edges of their outer ends the inner surface of the curved wall of the chamber 11, these edges being properly packed to form, with said
 125 curved surface, a steam-tight joint. The ends of the piston plates 13, 13, are likewise made to swing in close contact with the sides of the chamber and are packed to maintain a steam-tight joint therewith during their entire movement. The interval between the plates, constituting the thickness of the piston proper,
 130 is so far less than the interval between the two ends of the sectoral chamber in which it works

as to permit of the proper length of stroke of the piston therein. A recess 14 is formed in the outer end of the piston to extend transversely from side to side thereof and from the one plate 13 to the other, by means of a partition plate 15, the area of surface *f* at each end of this recess being about one fourth, more or less, that of the area of the outer surface of the plates 13, 13. A wide offset or abutment 16, is formed centrally upon the inner curved wall of the piston-chamber 11 to extend entirely across it and to project up into contact with the partition-plate 15 with which it is made to form a steam-tight joint by means of a suitable packing strip *a'*. Within this abutment 16, is fitted an oscillating-valve 17 having a longitudinal axial opening therein for the admission of steam thereto, and radial ports 18, 18, extending outwardly therefrom, on opposite sides thereof. Openings 19, 19, are also formed in the abutment 16 adapted to establish communication between the one radial port or the other, and the spaces between the abutment and the respective ends of the recess 14, on each side of the offset. Passages 20, 21, are formed in the wall of the chamber to extend from the two ends thereof to the seat of the valve 17, and an exhaust-port 22 is formed under the valve, and exhaust passages 23, 23, are formed in the valve, to establish alternately in its movements communication between said exhaust-port and the exhaust-passages 20, 21, on each side. The piston-shaft *A'* is connected in the customary manner by means of a radial arm 24, and a connecting-rod 25, with a crank upon a rotating-shaft 26 mounted in the base of the engine, so that the oscillation of the piston shaft will produce a rotation of the latter.

In the operation of this form of my engine, steam, admitted at high pressure into the central port of the valve 17, will be allowed to pass into the space between the abutment 16 and the proximate end of the recess 14, and, by reason of its pressure against said end will force the piston before it to the opposite side of the sectoral-chamber 11, the air or steam within the chamber in advance of the movement of the piston being allowed to exhaust freely through the passages 20, and exhaust-port 22. In the meantime, the steam at high pressure previously admitted in the space formed by the recess 14 on the opposite side of the abutment 16, and which was cut off by the movement of the steam-valve, is allowed to pass freely through the passage 21 into the sectoral-chamber 11 on the opposite side of the piston, and, by the expansion therein upon a piston area four times greater than that on which the steam is acting at high pressure on the surface *f*, will operate as an effective auxiliary in connection with said high pressure in driving the piston over. It is evident that the piston may be made in one casting and with the portion X, between its axis and the partition 15, solid instead of hollow as shown in the drawings.

As a further modification of my invention, the sectoral casing may be divided by a central partition F, in manner as first herein described and as illustrated in Fig. 4 of the drawings, to form two, sectoral piston-chambers 30, 30, in each of which a piston-plate *G'* is fitted to oscillate, each having the rock-shaft *A''*, which is mounted at the apex of the converging upper sides 10, 10, of the casing, as its axis. A curved head or plunger 31, made hollow to render it as light as possible, is made to project from the outer face of the outer end of each piston-plate *G'*. The curved faces of the head or plunger are concentric with the inner peripheral wall of the piston-chamber, and in the movements of the piston the outer face of the head sweeps over said wall with a close joint while the ends of the head form a close joint with the ends of the chamber, the several joints being made steam-tight by suitable packing-strips. The piston-heads or plungers 31, 31, are made each to enter with a steam-tight joint a sectoral chamber 33, produced as an extension of the outer end of each piston-chamber, as is shown in Fig. 4 of the drawings, and so proportioned in length with respect to the piston-head or plunger 31, as that, when the piston has reached the end of its out-stroke so that the outer face of the piston-plate *G'*, is in contact with the top-plate 10, of the main-piston-chamber, the end of the head or plunger 31 will be in contact with the outer end of the auxiliary chamber 33. The outer end of the chamber 33, and the inner end of the piston-chamber next to the partition, are connected by a communicating passage *m*, controlled by a valve N, connecting with a steam-supply pipe, not shown in Fig. 4, and with an exhaust-port 22, said valve N operating, substantially as is hereinbefore described, first, to admit steam, at its initial high-pressure to the chamber 33 of least area to produce an in-stroke of the piston, and second, to allow its exhaust and expansion thence into the piston-chamber on the opposite side of the piston-plate *G'* against its enlarged surface area to produce the outstroke of the piston, the expanded steam being finally allowed to exhaust freely from the engine while a new charge of steam is being admitted to the chamber 33.

In each and all of these forms of the engine, the difference in the area of effective working surface exposed to the direct action of the steam or other expanding gas upon opposite sides of each piston, is preferably made one to four. This difference of four to one, provided for in the difference between the area of piston surface subjected to the low pressure as compared with that exposed to the initial high pressure, operates to avoid back pressure in the engine, and an advantage is obtained in this respect over the engines of this class heretofore constructed in which the difference in piston areas for expansion does not exceed two to one.

The condensation of the steam in the work-

ing-chambers is reduced to a minimum in the forms of the engine shown in Figs. 1, 2 and 3, in view of the fact that the high and low pressure chambers are inclosed between the same walls, so that the expansion against the piston surface of larger area takes place in a chamber already measurably heated by the steam when working at its high-pressure.

I claim as my invention—

1. In a vibrating-piston engine, the combination of a sectoral chamber having parallel side walls, a vibrating piston working therein, and a division plate concentric with the axis of the piston to inclose the inner portion of one face of said piston and reduce the effective area of said face, substantially in the manner and for the purpose herein set forth.

2. The combination, in a vibrating-piston engine, of pressure or working chambers of unequal area, a vibrating-piston interposed between them, a communicating passage connecting them, and valves governing said passage and the steam-supply and exhaust ports of the engine; whereby the steam or motive force admitted at its initial or high pressure into the chamber of least area on one side of the piston is thence exhausted into the chamber of larger area and allowed to expand therein against the opposite side of the same piston before being finally exhausted from the engine, substantially in the manner and for the purpose herein set forth.

3. In a vibrating-engine, a piston constructed of two diverging wings projecting from the same side of its pivotal shaft in combination with connecting-plates inclosing a portion of the angular space included between said wings; whereby the area of the working surface upon one face of the piston is reduced below that upon its opposite face, substantially in the manner and for the purpose herein set forth.

4. The combination in a vibrating-engine with suitable supply and exhaust pipes and a valve or valves controlling the same, of a sectoral casing, a vibrating piston working therein having the effective surface area upon one of its faces reduced by a division plate or wall extending therefrom concentric with its axis to inclose the inner portion of said face, an abutment projecting inwardly from the casing into contact with said division plate, and a valve-controlled passage connecting the spaces on the opposite sides of the piston, substantially in the manner and for the purpose herein set forth.

5. The combination in a vibrating-piston

engine, with suitable supply and exhaust passages and controlling valves substantially as described, of a sectoral-casing, a rock-shaft, a vibrating-piston carried by said rock-shaft and having working or pressure surfaces of unequal area upon its opposite sides, and corresponding, fixed, radial abutments of unequal area against and between which the piston vibrates, substantially in the manner and for the purpose herein set forth.

6. The combination in a vibrating-piston engine with its casing and suitable supply and exhaust passages and controlling valves substantially as described, of a rock-shaft; a sectoral working-chamber left open at one end, closed by a radial abutment at the other and having the rock-shaft at its apex, the outer peripheral wall of said chamber being formed in two sections curved about the axis of the rock-shaft, with the radius of the outer section less than that of the inner and the two connected by an offset serving as the second abutment in the chamber; a piston-plate projecting from the rock-shaft to vibrate between said abutments and traverse with its outer end the inner section of the peripheral wall; and a curved partition-plate, concentric with said peripheral wall and which extends from the outer face of the piston to move therewith and ride over and against the inner face of the outer section of the peripheral wall, all substantially in the manner and for the purpose herein set forth.

7. The combination in a vibrating engine, with its casing, and suitable supply and exhaust valves and passages, substantially as described; of a sectoral working-chamber having its outer peripheral wall divided into two sections describing arcs of unequal radii about a common center; a rock-shaft having its axis coincident with said center; piston-plates of unequal radii projecting from said rock-shaft at divergent angles to sweep severally over said sections; and a curved, plate extending from the end of the shorter piston-plate to intersect the longer piston-plate upon an arc concentric with that of the section of shortest radii which it traverses in the movements of the piston, substantially in the manner and for the purpose herein set forth.

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

WILLIAM E. CRIST.

Witnesses:

A. N. JESBERA,

E. M. WATSON.