(No Model.) 3 Sheets—Sheet 1.

G. F. & C. L. SWAIN & W. O. & J. D. WORTH.

STEAM ENGINE.

No. 419,378. Patented Jan. 14, 1890.

Fig. 1.

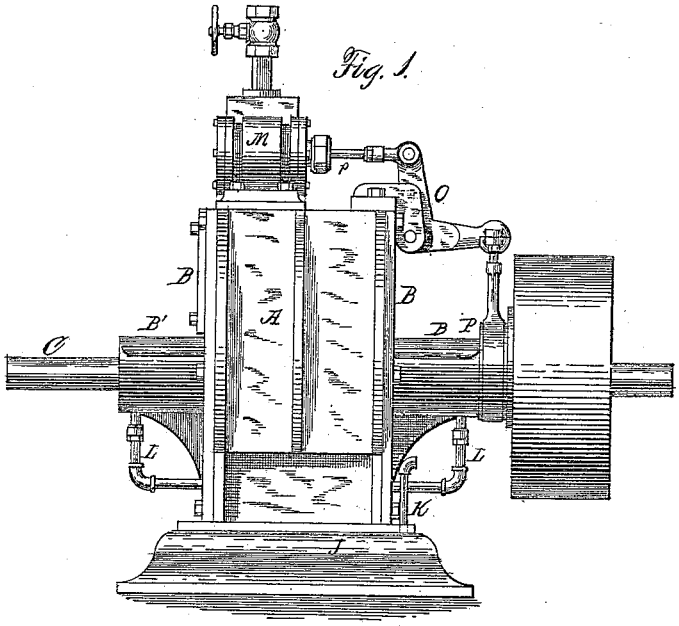
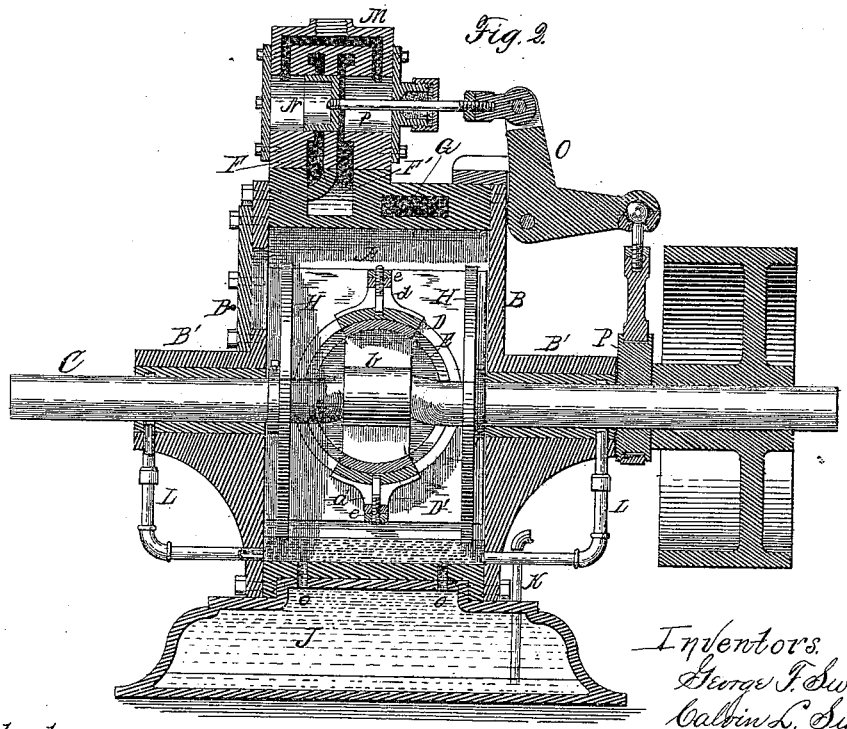


Fig. 2.



Attest
D. W. Leeson
Henry Frantz

Inventors.
George F. Swain,
Calvin L. Swain
William O. Worth
John D. Worth.
By J. M. St. John,
Atty.

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G. F. & C. L. SWAIN & W. O. & J. D. WORTH.

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Fig. 3.

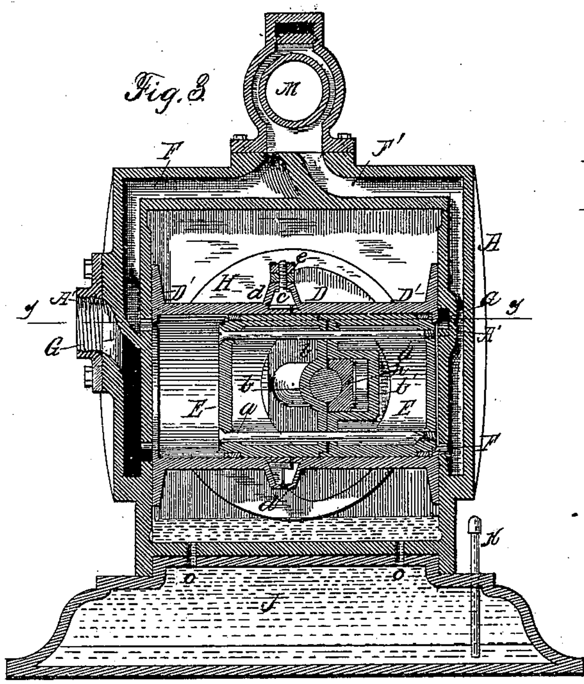


Fig. 4.

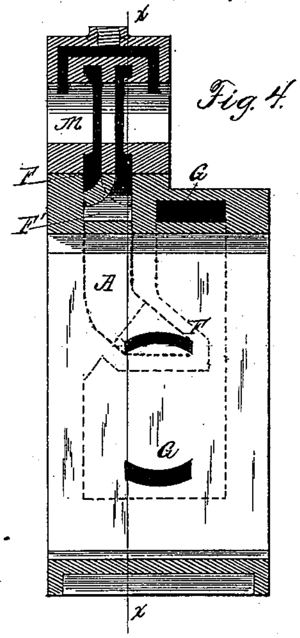


Fig. 6.

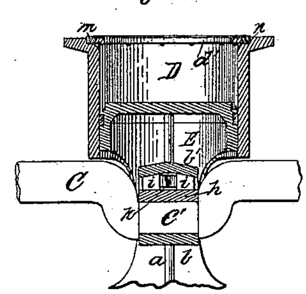


Fig. 5.

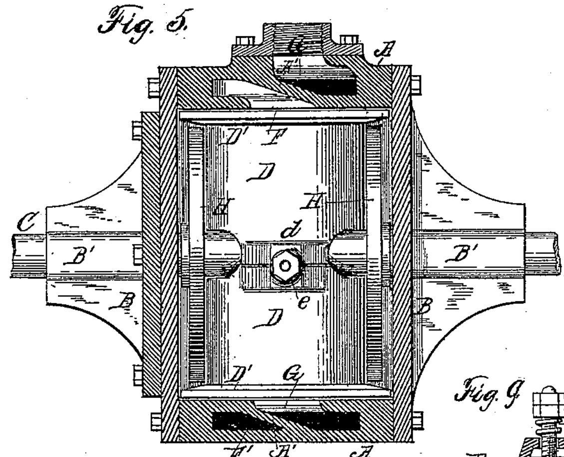


Fig. 7.

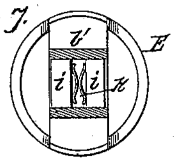


Fig. 9.

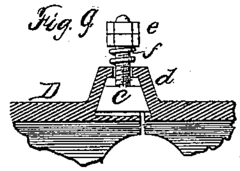
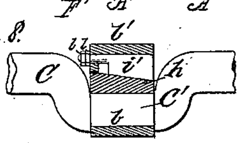


Fig. 8.



Attest.
D. W. Kearn
Henry Frantz

Inventors.
George F. Swain,
Calvin L. Swain,
William O. Worth,
John D. Worth.
By J. M. St. John,
Atty.

(No Model.) 3 Sheets—Sheet 3.

G. F. & C. L. SWAIN & W. O. & J. D. WORTH.

STEAM ENGINE.

No. 419,378. Patented Jan. 14, 1890.

Fig. 10.

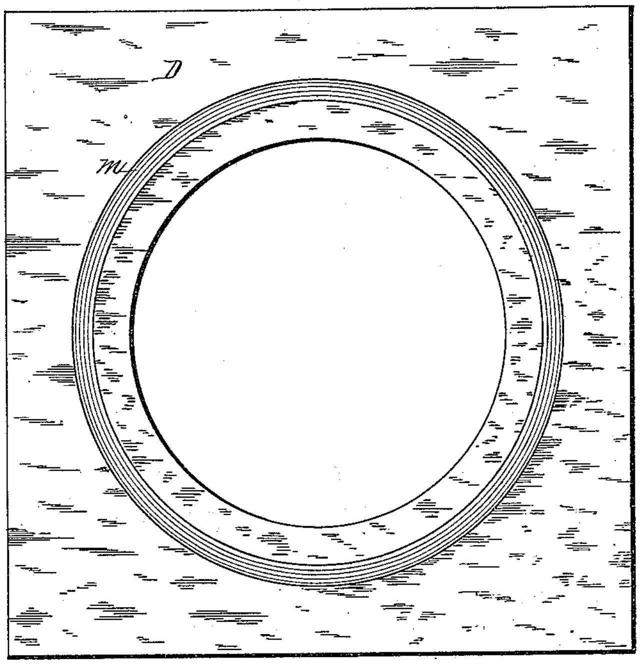


Fig. 11.

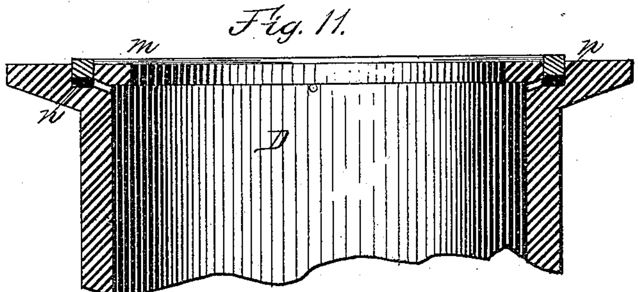
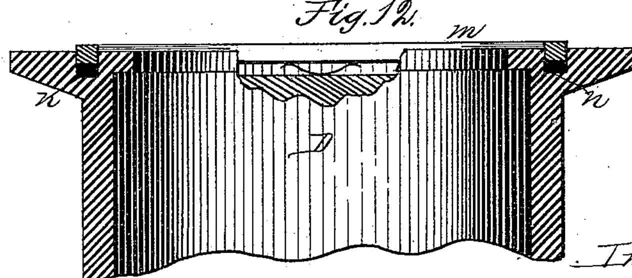


Fig. 12.



Attest.
William Brainerd.
Frank G. Clark

Inventors.
George F. Swain,
Calvin L. Swain,
William O. Worth,
John D. Worth,
By J. M. St. John
Atty.

UNITED STATES PATENT OFFICE.

GEORGE F. SWAIN, CALVIN L. SWAIN, AND WILLIAM O. WORTH, OF CEDAR RAPIDS, AND JOHN DANIEL WORTH, OF MASON CITY, IOWA.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 419,378, dated January 14, 1890.

Application filed November 21, 1887. Renewed February 1, 1889. Serial No. 298,380. (No model.)

To all whom it may concern:

Be it known that we, GEORGE F. SWAIN, CALVIN L. SWAIN, and WILLIAM O. WORTH, citizens of the United States, residing at Cedar Rapids, in the county of Linn and State of Iowa, and JOHN DANIEL WORTH, a citizen of the United States, residing at Mason City, in the county of Cerro Gordo and State of Iowa, have invented certain new and useful Improvements in Steam-Engines, of which the following is a specification.

This invention relates to engines in which the working parts are inclosed in a rectangular shell, the cylinders having open ends sliding on the smooth inner surface of said shell, and the pistons being connected rigidly to each other and being on opposite sides of the crank-pin of the crank-shaft mounted centrally in said shell, whereby the pistons and cylinders have reciprocal movements perpendicular to each other.

The object of our invention is to improve this class of engines by such a construction as will decrease friction, facilitate the adjustment and lubrication of parts, and provide for the better and more economical use of steam than hitherto.

The invention consists in the construction, combination, and arrangement of parts, as more fully hereinafter set forth and claimed.

In the accompanying drawings, forming a part of this specification, Figure 1 represents a front elevation of an engine embodying our invention; Fig. 2, a longitudinal section of the same in the line of the center of the main shaft; Fig. 3, a transverse section of the same, central as to the cylinders and their immediate connections and on the line $x\ x$ as to the shell; Fig. 4, a central vertical section of the shell, showing the arrangement of the steam-passages; Fig. 5, a horizontal section of the shell in the line $y\ y$ of Fig. 3, showing also the internal parts in their proper position; Fig. 6, a horizontal section of one of the cylinders and pistons, showing the adjustment of the box on the crank-pin; Fig. 7, a front sectional view of the same; Fig. 8, a fragmentary view showing a modification in the device for adjusting the box on the crank-pin; Fig. 9, a modification of the device for adjusting the cylinders endwise; Fig. 10, Sheet 3, an end view of one of the cylinders, showing the arrangement of the packing-ring; Fig. 11, a fragmentary view showing the same in longitudinal section with a provision for forcing the ring outwardly by steam-pressure, and Fig. 12 a similar view showing the application of a spring for the same purpose.

Similar letters of reference indicate corresponding parts.

The operative parts of the engine are inclosed in a rectangular shell A, which, with its heads B B, forms a nearly cubical box. Suitable boxes B′ B′ are formed on these heads and serve as bearings for the crank-shaft C. The two opposite ends of the shell inside are made perfectly plain and smooth, and on these surfaces slide the flanged ends of the cylinders D D, which are open at both ends. Pistons E E, which, when connected, constitute practically one piston, are fitted to the inside of these cylinders and journaled on the crank-pin in the middle. The top and ends of the shell are chambered to form steam-ports F F′ and exhaust-ports G, which communicate with the interiors of the cylinders through openings in the inner face of the shell upon which the cylinders reciprocate. These constitute the essential features of the engine, to which the following improvements more specially relate.

In the operation of this engine, as has already been explained and as the drawings indicate, the cylinders, as well as the pistons, have a reciprocal movement, and this is of course perpendicular to that of the pistons. When arranged, as in the drawings, with two horizontal cylinders, their motion will of course be vertical and that of the pistons horizontal. The effect of this is naturally to produce an unequal strain on the crank-pin C′ at different points in its revolution, owing to the weight and friction of the cylinders. To counterbalance this weight we mount a counterbalance-wheel H on each side of the cylinders and inside the shell, which is made wide enough for that purpose. The counterbalances need not for the counter-weight alone be necessarily a complete circle on the periphery; but in practice we make them so, the better to aid in the lubrication of the engine, as will be hereinafter explained. It will

be observed that the flanges D′ of the cylinders project laterally as well as vertically, and the counter-balances occupy the space between these flanges, as shown in Fig. 5. They are thus entirely concealed from observation, and, being two in number, help to balance the shaft laterally, and may be accurately adjusted to the counter-weight of the cylinders.

In this style of an engine it is evident that the longer the distance between the ends of the cylinders which bear on the inner face of the shell the greater will be the relative friction to be borne by the crank. It is desirable, therefore, to make the cylinders as short as they can be made and at the same time allow for the stroke of the pistons. This we accomplish by coupling the pistons on the crank-pin very closely together and correspondingly reducing the length of the cylinders. By referring to the drawings it will be seen that the box for the crank-pin forms a part of the piston, being in the nature of a bridge across the ends of said pistons. The two are connected by suitable bolts *a a*, which in practice we make to extend the whole length of the two pistons and through the central bridges *b b′*, whereby the connection is stronger than if the bolts simply passed through the bridges alone. To allow for the passage of the sides of the crank in its revolution the sides of the piston are cut away for some distance back from the boxes, as shown in Figs. 3 and 6.

The greatest amount of wear on the piston is of course on the top and bottom, and to equalize this wear as much as possible, as well as to prevent excessive friction at the extremes of the piston, a portion of the upper and lower face of the pistons (which unite to form the piston proper) is carried flush with said face to the meeting-point in the middle. The piston thus has on its upper and lower sides a continuous bearing-face its entire length, as will be seen by reference to Fig. 3. For the same reasons the corresponding portion of the cylinders are made continuous to their meeting ends, and thus, as to the upper and lower sides, where there is the greatest friction, form practically one cylinder, in which the whole contiguous surface of the piston may play. Between these points the cylinders are cut away to allow for movement across the crank-shaft. In practice we match the ends of these parts, the pistons and the cylinders, by counterboring one part and forming a shoulder on the other, as shown in Fig. 3. This might be dispensed with in the case of the piston-connection, but is quite essential in the case of the cylinders which have no other lateral connection. The cylinders are adjusted to the wear on their ends by means of a bolt *c*, having a wedge-shaped head set in a suitable socket formed in projections of the cylinders *d d* on the upper and lower sides thereof. The adjustment may be made positive by nuts *e* on the bolt, or, by interposing a spring *f* between the nuts and the socket portion, the cylinders may be automatically adjusted to the wear or expansion of the parts.

The box for the crank-pin *c′* has an adjustment on the pin as follows: One portion of the bridge *b′* has a recess formed therein, and in this recess is placed the movable half of the box *h*. The adjustment may be effected in a variety of ways; but that shown in Fig. 6 is preferred, as it is simple and automatic. In this the inner part of the back side of the recess is doubly beveled, as shown in Fig. 6. Between this bevel and the back of the half-box *h* are placed two wedges *i i*, which are forced apart by a spring *k*. Instead of this automatic adjustment the same may be positive, a simple device for that purpose being shown in Fig. 8, in which a wedge-bolt *i′* is interposed between the box and the bridge, and is adjusted and set by suitable jam-nuts *l l*.

In addition to the means already described for adjusting the cylinders endwise, we provide said cylinders with means whereby the pressure of the steam tends to seat them against the plane surface of the shell on which they slide. This construction is shown in Figs. 3 and 6, and consists in an internal annular flange *d′*, made by counterboring the cylinders. The back-pressure of the steam against this flange tends of course to force the cylinder against its seat, and thus prevent any chattering or leakage at this point.

To compensate for any slight irregularity in the surface of the back ends of these cylinders, and to provide for the most perfect seating of them, we further supply them with an adjustable ring *m*, which is let into the back face of the cylinders in an annular groove formed therein. The fitting is sufficiently loose to allow the ring to slip in and out in the groove, and for automatic adjustment springs may be placed under the ring in a common and well-known way, or holes may be made in the flange *d′*, leading back to the groove *n*, and the back-pressure of the steam will then serve for adjustment.

The shell A is mounted on a hollow base J with a water-tight joint. Through the bottom of the shell and the top of the base we put a number of holes *o o*—in practice six or eight—and preferably toward the outside, as indicated. In this base we place a quantity of oil or oil and water, the surface of which should be high enough in the shell so that some part of the internal mechanism comes in contact therewith. This is preferably the periphery of the counter-balances H H, which, being continuous and uniform, carry the oil in a steady stream and throw it over the other working parts.

It is important that the bottom of the shell should be closed with the exception of the perforations, since a medium is thus interposed between the upper stratum of oil and the lower strata of oil and water, and this medium prevents that undue agitation of the

oil and water which is common where the chamber is quite open, and which tends to intimately mix the two liquids. By this arrangement there is little or no agitation of the liquid below the top of the base, and the water is therefore free to settle to the bottom and entirely separate from the oil. The oil is kept at a uniform level in the shell by means of an overflow-pipe K, communicating with the lower part of the base and with the water alone and having its upper opening at the proper level.

In practice we first fill the base with oil up to the proper level, and this supply serves continuously for several weeks, since there is comparatively little waste, and what there is is compensated by the condensation of the leakage steam inside the shell, which, settling to the bottom, keeps the oil at a uniform level. Any excess of condensation is of course carried off by the overflow-pipe. Provision is also made for returning to the interior of the shell any excess of oil in the boxes of the crank-shaft B′ B′. This consists in pipes L L, communicating with the insides of the boxes and of the shell, respectively.

The sides and top of the shell are provided with chambers, which serve as the steam-ports F F′ and the exhaust-port G. The exhaust-port is made continuous from one side of the shell to the other; but the steam-ports are separated at the upper part of the shell and communicate with separate steam-passages in the steam-chest M, as represented in Figs. 3 and 4. The steam-chest is provided with a suitable valve N, the stem *p* of which connects with a bell-crank O, and this by a ball-and-socket joint with the connecting-rod of the eccentric P. This eccentric may be connected directly with the governor, and the action of the valve be thus automatically regulated.

It will be observed that the steam-chest has but two ports, and these are the steam-ports, the exhaust being isolated from the steam-chest and not controlled by the valve therein. In practice we arrange these ports in the manner indicated—the steam-ports on one side and at opposite ends of the shell and the exhaust-port on the other side and extending through the ends and top of the shell; but the opening of both the steam and exhaust ports to the interior of the shell should be central therewith, and is preferably a portion of the circle forming the bore of the cylinders. The effect of this construction is of course to give the quickest possible admission and exit of steam to and from the cylinders. In so arranging the openings of the steam-passages it is necessary that the ports should partly cross each other, and this may be done by interposing a diagonal diaphragm A′ at the place of crossing, as shown in Fig. 5. As the steam-valve operates entirely independent of the exhaust, the admission of steam to the cylinders may be regulated to suit the requirements of the engine without in the least affecting the said exhaust, which is controlled entirely by the passage of the cylinder past the port at the speed of the crank-pin. This quick opening of the port, of course, insures a very free exhaust. By a proper adjustment of the steam-valve it may be made to cut off at any desired point in the stroke of the piston. Thus the ports may be filled with steam at the boiler-pressure and then cut off on the opening of the ports below, or the opening may be simultaneous therewith or otherwise, as desired. In this way the quick opening of the lower ports may be taken advantage of without waste of steam, or the steam may be admitted to the cylinder during the whole time that the lower steam-port remains open by a simple adjustment of the eccentric on the crank-shaft.

Having thus described our invention, what we claim as new, and desire to secure by Letters Patent, is—

1. In a steam-engine the cylinders and pistons of which have a reciprocating motion perpendicular to each other within a rectangular shell, the combination of an exhaust-port wholly within said shell and adapted to be opened and closed by the movement of the cylinders, steam-ports similarly adapted to be opened and closed at their lower extremities and at their upper ends terminating in separate steam-passages in a steam-chest, and adapted to be opened and closed at this end by the independent action of a valve having a reciprocal motion through suitable mechanism, substantially as and for the purpose set forth.

2. In an engine of the class specified, the combination of the shell A, having the exhaust-port G isolated from the steam-chest, and the separate steam-ports opening at the lower ends in opposite sides of the shell and at the upper ends into separate passages in a steam-chest, the steam-chest M, provided with the valve N, and means, substantially as specified, for imparting independent reciprocating motion to said valve, substantially as and for the purpose set forth.

3. In a steam-engine of the class specified, the combination of the outer rectangular shell within which the cylinders reciprocate perpendicularly to the motion of the piston, cylinders joined closely together in the middle at the top and bottom, with an opening in the side for the crank-shaft, and provided with a socket at the top and bottom, a wedge-shaped plug in said socket, and a spring adapted to force said plug toward the narrower part of the socket, whereby said cylinders are forced apart and automatically adjusted endwise, substantially as set forth.

4. In an engine of the class specified, the combination of the pistons E E, having the bridges *b b′*, one of said bridges forming one half of the box for the crank-pin and the other with a recess adapted to receive the other half of the box *h*, wedges in said recess between the half-box and the bridge, and means,

substantially as specified, for setting up said wedges for the adjustment of said box.

5. The combination of the pistons E E, having the bridge portions b b', with a recess in one of them to receive an adjustable half of the box for the crank-pin, the wedges i i between said half-box h and the back of the recess, and a spring k, adapted to set up said wedges and automatically adjust said box to the crank-pin, substantially as set forth.

6. In an engine of the class specified, the combination of the shell inclosing the working parts of the engine, a hollow base therefor adapted to hold oil and water, and a separating medium between the interior of the shell and of the base to prevent agitation of the contents of the base, but perforated to allow the oil to flow up into the shell as raised by the water in the base, substantially as specified.

In testimony whereof we affix our signatures in presence of two witnesses.

GEO. F. SWAIN.
CALVIN L. SWAIN.
WILLIAM O. WORTH.

Witnesses:
HENRY RICKEL,
E. H. CROCKER.

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

JOHN DANIEL WORTH.

Witnesses:
W. H. COTTERELL,
GEO. VERMILYA.