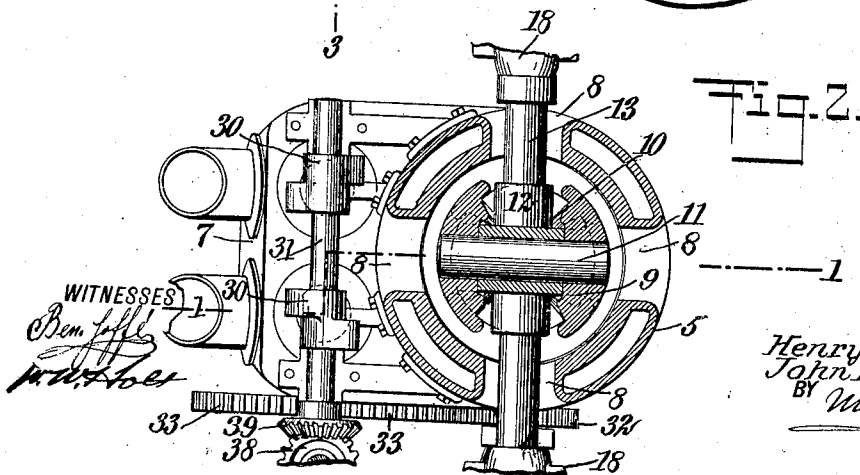
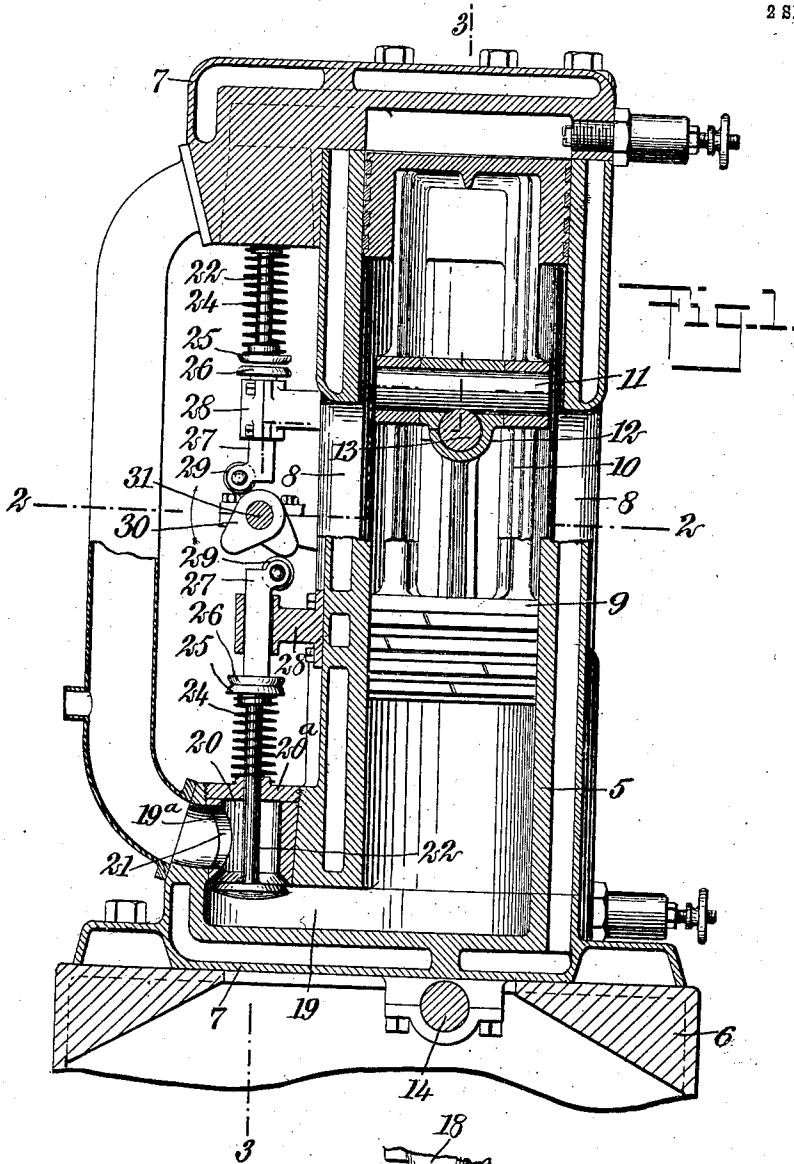


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 APPLICATION FILED JAN. 18, 1909.

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Patented Dec. 14, 1909.  
 2 SHEETS—SHEET 1.



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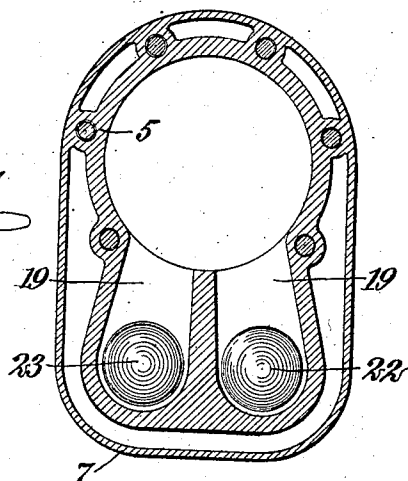
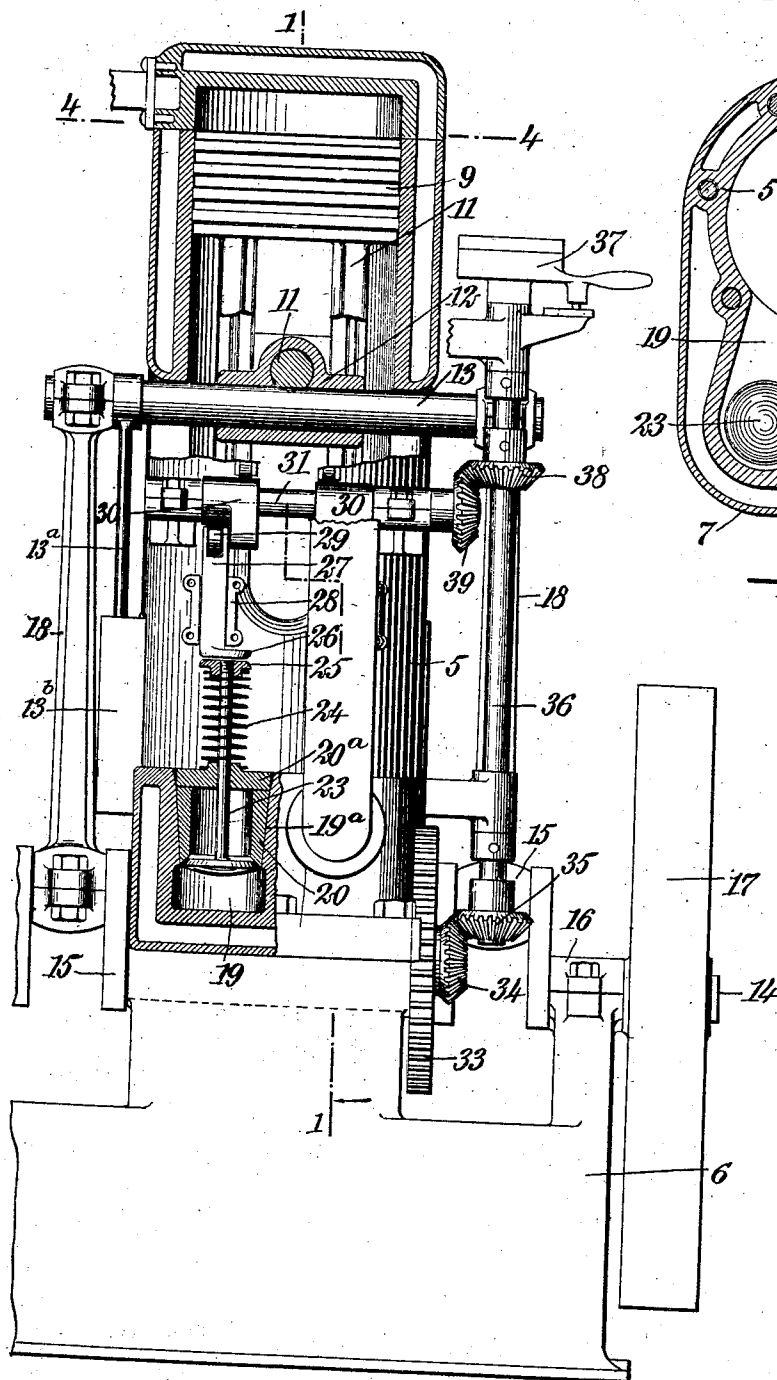


Fig. 4.

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# UNITED STATES PATENT OFFICE.

HENRY O. HORNER AND JOHN P. BOYLAND, OF NEW YORK, N. Y.

DOUBLE-ACTING INTERNAL-COMBUSTION ENGINE.

943,597.

Specification of Letters Patent.

Patented Dec. 14, 1909.

Application filed January 13, 1909. Serial No. 472,947.

To all whom it may concern:

Be it known that we, HENRY O. HORNER and JOHN P. BOYLAND, citizens of the United States, and residents of the city of New York, borough of the Bronx, in the county and State of New York, have invented a new and Improved Double-Acting Internal-Combustion Engine, of which the following is a full, clear, and exact description.

The invention is an improvement in double-acting internal combustion engines and belongs to that class of engines in which the driving-shaft is operatively connected with the piston through slots in opposite sides of the cylinder.

The present invention contemplates the construction of the intermediate portion of the piston of skeleton form, to facilitate the cooling thereof and of the cylinder by air passing thereinto through the slots of the cylinder, also to connect the cross-shaft with the piston in a manner to permit the cross-shaft swinging in a plane with the driving shaft, the center of oscillation being at one side of the cross-shaft, and, further, to provide for the removal of the controlling valve toward the center of the cylinder, whereby the special openings in the outer ends of the cylinder or valve casings, as are usually provided for this purpose, are dispensed with.

Reference is to be had to the accompanying drawings forming a part of this specification, in which similar characters of reference indicate corresponding parts in all the views.

Figure 1 is a central vertical section of an internal combustion engine embodying our invention, the section being taken substantially on the lines 1—1 of Figs. 2 and 3; Fig. 2 is a cross-section of the same on the line 2—2 of Fig. 1; Fig. 3 is a vertical section of the engine on the line 3—3 of Fig. 1; and Fig. 4 is a cross-section of the engine on the line 4—4 of Fig. 3.

In the preferred construction of our improved engine, an upright cylinder 5 is mounted on a suitable base 6, the cylinder having laterally-extending portions 7, 7, at opposite ends, and constructed intermediate its length with longitudinal slots 8, these slots, as best shown in Fig. 2, being arranged diametrically of the cylinder. The cylinder is shown to be provided with the usual water jacket which is extended about

the lateral portions 7; although the water jacket is not essential to the present construction. Within the cylinder is a piston 9 having the usual close-fitting piston-head at each end, with the intermediate portion of the piston of reduced diameter and of skeleton construction, this preferably being effected by providing the two piston-heads with internal longitudinal ribs 10 which are extended to rigidly connect the heads together, and, as shown in Fig. 2, are of approximately T-shape to insure both strength and lightness of construction. Opposite pairs are joined together a short distance intermediate their length, with the joined portions bored out diametrically of the piston to receive a cross-pin 11, and on the intermediate portion of this pin and fitting between the bosses of the piston is journaled a hanger 12, the hanger, as best shown in Figs. 1 and 2, being extended crosswise and below the pin 11 the full thickness of the reduced portion of the piston and bored to receive a cross-shaft 13, the latter passing to the outside of the cylinder through oppositely-arranged openings 8. As shown in Figs. 1 and 3, the bore in the hanger to receive the cross-shaft passes partly through the pin 11, causing the pin to be effectively locked against endwise movement when the cross-shaft is in place. At the outside of the cylinder a piston stem 13<sup>a</sup>, operating within a water pump 13<sup>b</sup>, is operatively connected to the cross-shaft 13.

On the lower end or base of the cylinder a driving-shaft 14 is journaled, and at each side of the cylinder is provided with cranks 15, with the shaft at one side of the cranks journaled in a bearing 16 carried by the base and having an attached fly-wheel 17. The cranks are operatively connected with the outer end portions of the cross-shaft by pitmen 18, and in view of the swinging movement of the cross-shaft in the plane of the driving-shaft on the pin 11, any slight difference in the length of the pitmen is compensated for and the friction greatly lessened.

The laterally-extending portions 7 of the cylinder are provided with admission and exhaust ports 19 of like character, each port having a longitudinal portion 19<sup>a</sup> passing through the inside of the portion 7 of the cylinder. Fitting within the portion 19<sup>a</sup> of each port is a tapered cup bushing 20, the bottom 20<sup>a</sup> of which is threaded to hold the

body portion of the cup in place, which latter is provided with an opening 21 in the side registering with the outer portion of the port, and the inner portion of the port registering with the bore of the cup. The inner edges of the cups have valve seats for admission and exhaust controlling valves 22 and 23 respectively, the stems of these valves passing inwardly and slidable through the bottoms of the cups 20<sup>a</sup>, and are normally forced to their seats by springs 24, the latter bearing between the caps and disks or heads 25 at the ends of the stems. These disks or heads contact with feet 26 formed at the outer ends of slides 27 movably supported in bearings 28 bolted or otherwise secured to the side of the cylinder, each slide having a roller 29 at its inner end arranged in operative relation to one of the cams 30 fixed to a cam-shaft 31.

A gear 32 fixed to the driving-shaft is in mesh with a gear 33 journaled at one side thereof and having an attached bevel pinion 34 in mesh with a similar pinion 35, the latter being secured to a vertical shaft 36 having a timer 37 and carrying a bevel pinion 38 in mesh with a similar bevel pinion 39 attached to the cam-shaft, the cams of the latter being arranged to operate the admission and exhaust valve in proper sequence with the movement of the piston.

During the working of the engine the air is continually passing through the slots 8 in the sides of the cylinder around the annular space between the piston and cylinder and through the piston and into the piston-heads, facilitating the cooling of the working parts, and in practice it is found that the air cooling is carried out to such an extent that the water jacket is of very little consequence. The skeleton construction of the piston also admits of the hanger-bearing being easily accessible for lubricating and other purposes.

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

1. In a double-acting internal combustion engine, a cylinder having slots at opposite sides intermediate its length, a piston in the cylinder, a driving-shaft, a cross-shaft passing through the piston and slots of the cylinder and connected with the piston to swing in a plane passing longitudinally through the driving-shaft, with the center of oscillation arranged at one side of the cross-shaft, and means operatively connecting the cross-shaft with the driving-shaft.

2. In a double-acting internal combustion engine, a cylinder having slots in the sides

thereof, a working piston in the cylinder, a hanger pivotally supported intermediate the ends of the cylinder, a cross-shaft passing through the hanger and the slots of the cylinder below the point of pivotal support of the hanger, a driving-shaft, and means operatively connecting the outer end portions of the cross-shaft with the driving-shaft.

3. In a double-acting internal combustion engine, a cylinder having slots in the sides thereof, a piston having heads fitting the cylinder, a cross-pin in the piston arranged between the heads, a member journaled on the cross-pin, a cross-shaft passing through the member at approximately right-angles to the cross-shaft, a driving-shaft having cranks, and pitmen operatively connecting the outer end portions of the cross-shaft with the cranks of the driving-shaft.

4. In a double-acting internal combustion engine, a cylinder having slots in the sides thereof, a piston having heads fitting the cylinder, a cross-pin carried by the piston between the piston-heads, a hanger journaled on the cross-pin, a cross-shaft passing through the hanger and the slots of the cylinder and locking the cross-pin to the piston, a driving-shaft, and means operatively connecting the cross-shaft to the driving-shaft.

5. In a double-acting internal combustion engine, a cylinder having slots in the side thereof, a driving-shaft, a piston having heads fitting the cylinder, with the heads provided with internal ribs extended to form the intermediate portion of the piston and rigidly connect the heads together, a cross-pin carried by said heads, a hanger journaled on the cross-pin, a cross-shaft passing through the hanger and slots of the cylinder, and means operatively connecting the cross-shaft with the driving-shaft.

6. In an internal combustion engine, a cylinder having a working piston, a driving-shaft, a cross-shaft pivotally connected to the piston and passing to the outside of the cylinder, with the center of the pivotal connection arranged at one side of the cross-shaft, and means operatively connecting the cross-shaft to the driving-shaft.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HENRY O. HORNER.  
JOHN P. BOYLAND.

Witnesses:

W. W. HOLT,  
JOHN P. DAVIS.