(No Model.)

C. C. WORTHINGTON.

MULTIPLE EXPANSION ENGINE.

No. 507,196. Patented Oct. 24, 1893.

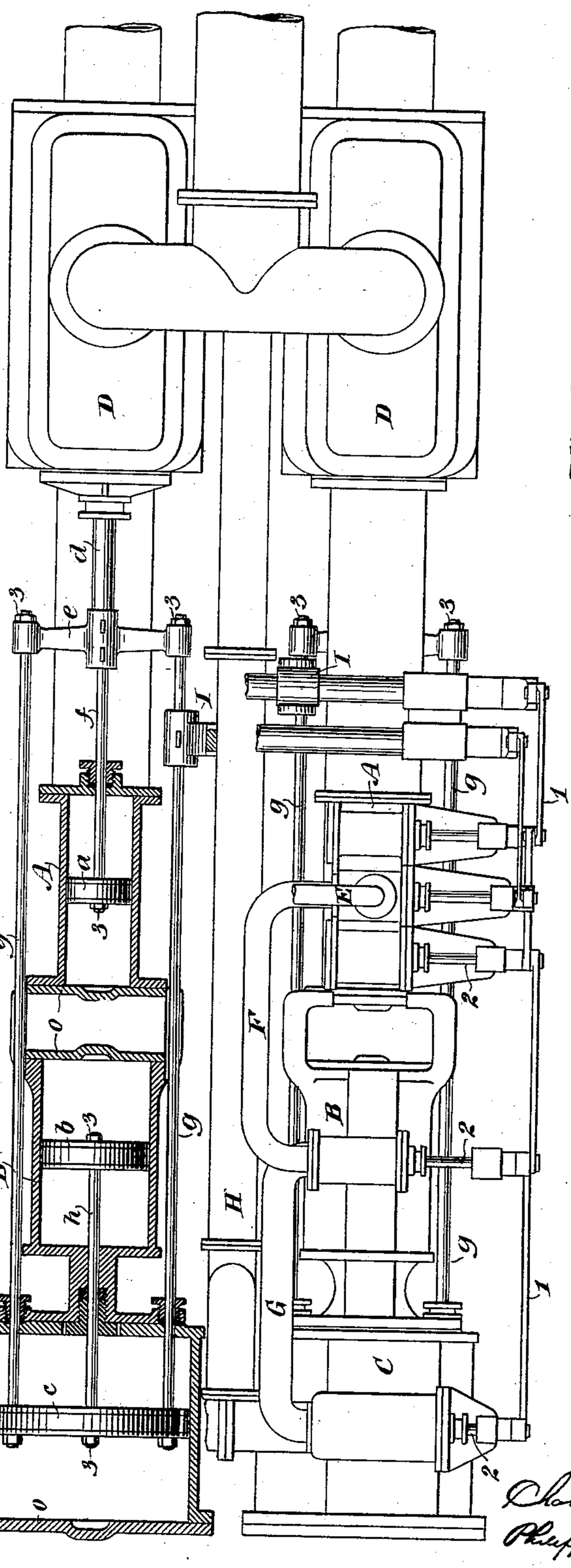

Fig. 1.

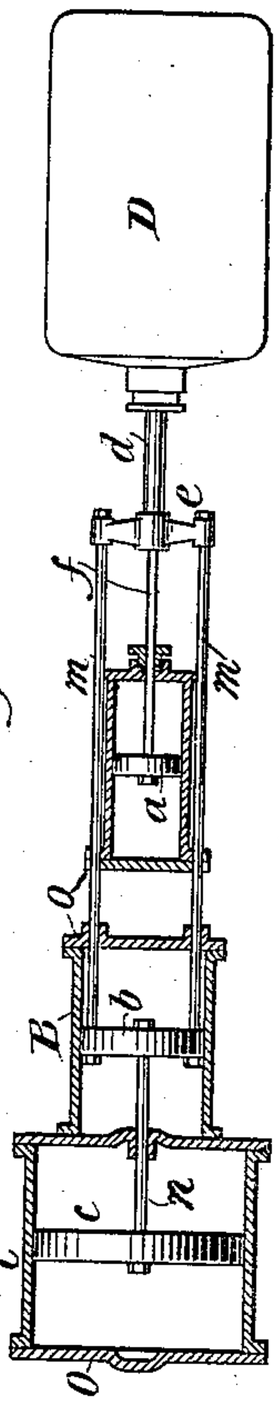

Fig. 2.

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UNITED STATES PATENT OFFICE.

CHARLES C. WORTHINGTON, OF IRVINGTON, NEW YORK.

MULTIPLE-EXPANSION ENGINE.

SPECIFICATION forming part of Letters Patent No. 507,196, dated October 24, 1893.

Application filed February 21, 1893. Serial No. 463,192. (No model.)

To all whom it may concern:

Be it known that I, CHARLES C. WORTHINGTON, a citizen of the United States, residing at Irvington, county of Westchester, and State of New York, have invented certain new and useful Improvements in Multiple-Expansion Engines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

The object of the present invention is to provide an improved construction of triple expansion engine of that class having their cylinders arranged in line, and especially to render the pistons of the respective cylinders more readily accessible and removable than in constructions of this class heretofore in use.

As a full understanding of the invention can best be given by a description of an engine embodying the same, such description will now be given in connection with the accompanying drawings forming a part of this specification, and the features forming the invention specifically pointed out in the claims.

It will be understood that the invention broadly is applicable generally to multiple expansion engines, single or duplex, horizontal or vertical. For the purpose of illustrating the invention, however, I have shown a construction embodying the invention in the preferred form as applied to a duplex horizontal direct acting pumping triple expansion engine of the class known as the Worthington duplex pumping engine, described and shown in many prior Letters Patent, for instance Nos. 299,525, 332,857, 341,534, 401,401 and 451,147, and from the illustration and description of this construction and a modification thereof, the application of the invention in other engines will be readily understood.

In the drawings—Figure 1 is a sectional plan of a pumping engine of the special class referred to embodying my invention in the preferred form, the section being taken centrally through the steam end of one side of the engine. Fig. 2 is a diagrammatic sectional plan of a modified construction, it being understood that the construction shown therein may form a single engine or one side of a duplex engine.

Referring now especially to Fig. 1, A, B, C are respectively the high pressure, intermediate pressure and low pressure steam cylinders, *a*, *b*, *c* the corresponding pistons, and D the water cylinders on each side of the engine. The steam is delivered to the high pressure cylinder A through induction pipe E and exhausted from the high pressure to the intermediate pressure cylinder through pipe F, thence to low pressure cylinder through pipe G, and thence to the condenser or elsewhere through the exhaust H. The steam valves may be of any suitable construction and operated by any suitable valve movement, but cut off valves on only the high pressure cylinder are preferably used, and rotary valves thus arranged as shown, these valves being operated by the lever valve motion I, connecting rods 1, and cranks 2 on the valve stems, as usual in this class of engines and fully described in the patents above referred to, except that a single central main valve is used on each cylinder. It will be understood that the valve motion may be actuated from any suitable moving part of the engine.

Referring now to the arrangement of pistons and piston rods, as shown in section on one side of the engine, *d* is the main piston rod through which the power from the three cylinders is applied, this rod being connected to the pump plunger in any suitable manner, and upon this piston rod *d* is a cross head *e* to which the pistons of the three cylinders are connected, the cross head being secured to the rod by a key, as shown, or in any other suitable manner. The high pressure piston *a* is connected to the cross head *e* centrally by a rod *f*, of sufficient size to carry the high pressure piston load, the piston being secured on the end of the rod *f*, preferably by a nut 3, as shown, and as usual in piston constructions when the piston can be placed upon the end of the rod. The rod *f* is preferably separate from the main piston rod *d* and secured to the cross head *e* in line with the rod *d* by a separate key, as shown, but it will be understood that the piston rod *d* may be extended through the cross head to form the rod *f*, in which case it is preferably reduced in diameter to avoid reducing the effective area of the piston *a*. The cross head *e* is connected to the low pressure piston *c* by rods *g* extending outside the high and intermediate pressure cylinders and connected to the cross

head *e* and piston *c* at their opposite ends, preferably by nuts 3, as shown. The intermediate pressure piston *b* is connected directly to the low pressure piston *c* by its piston rod *h*, secured at its opposite ends to the pistons *b*, *c*, preferably by nuts 3, as shown. Each of the cylinders, therefore, has one head through which the piston rod does not pass, and these heads *o* are made removable in the usual manner, the two inner cylinders A, B being separated sufficiently to afford space for the removal of the respective heads *o* and pistons *a*, *b*. It will be seen that in this construction each of the three pistons is readily accessible by removing the respective cylinder heads *o*, that each of these heads may be removed readily and without interference with any piston rod or stuffing box, and that, as each of the pistons is carried at the end of its rod they may all be removed by simply slacking off the respective nuts 3. In this construction also, the use of keys in the cylinders may be entirely avoided, and the area of the smaller pistons need not be reduced by rods larger than sufficient to carry their respective individual loads. The direct course of steam between the high pressure and intermediate and low pressure cylinders is retained, also, and in case of repairs either the intermediate or the high pressure pistons and valves, or both, could be removed and the engine run with the remaining cylinders or cylinder.

While I prefer the arrangement thus far described as forming the best construction now known to me embodying my invention, and this specific arrangement in itself forms a part of the invention, other arrangements may be used embodying the broad features of the invention, and securing many of the advantages attainable thereby.

Thus in Fig. 2 I have shown a modified construction in which the intermediate and low pressure piston connections are reversed, the low pressure piston rod being connected to the intermediate pressure piston and the latter in turn to the cross head. In this construction the cross-head is placed on the main piston rod *d*, and the high pressure piston *a* secured to the same by rod *f* as before. The intermediate pressure piston *b* is connected to the cross head *e* by rods *m* passing outside the high pressure cylinder A, and the low pressure piston *c* is connected to the intermediate pressure piston *b* by central piston rod *n*. In this modification it will be seen that the pistons *a*, *c* of the high and low pressure cylinders are readily accessible by removing their respective cylinder heads *o*, and may be removed by simply slacking off the nuts 3, as in the construction previously described, but the intermediate pressure piston *b* is not so readily accessible and removable as the rods *m* pass through its removable head *o*. This piston *b* is accessible within the space between the cylinders A, B, by sliding the head *o* of the cylinder B outward upon the rods *m*, and the piston may then be removed by removing the nuts on the opposite sides of the piston by which it is secured on the rods *m* and *n*. In this construction, moreover, if desired, the inner head of the low pressure cylinder C may be constructed to permit the removal of the intermediate pressure piston *b* through the same, so that this piston *b* may be removed by removing the low pressure piston *c*, opening the inner head of the cylinder C, and slacking off the nuts by which the rods *m* are secured to the piston *b*.

In both the constructions shown, it will be seen that the pistons of the two outer cylinders B, C are connected to the main piston rod *d* by connections passing outside the inside cylinder A, one of these pistons being connected directly to the cross head *e*, and the other indirectly. Thus, in Fig. 1 the low pressure piston C is connected directly through the cross head by side rods *g* passing outside the high pressure cylinder A, and the intermediate pressure piston *b* is connected to the cross head by said rods indirectly through the low pressure piston, while in Fig. 2 these connections are reversed and the intermediate pressure piston *b* is connected to the cross head through side rods *m* passing outside the high pressure cylinder A, and the low pressure piston is connected to the cross head by said side rods indirectly through intermediate pressure piston *b*. This connection of the piston of one of the outside cylinders to that of the other is preferred, as only one connection outside the inside cylinder is required, but it will be understood that it is not absolutely essential.

I have shown only the preferable modified arrangement embodying my invention, and it will be understood that the invention is not limited to the arrangements shown but that other arrangements may be made without departing therefrom. It will be understood, also, that my invention is not to be limited to a triple expansion engine or to an engine employing only three cylinders, but that it is applicable generally to multiple expansion engines employing three or more cylinders in line.

What I claim is—

1. A multiple expansion engine having three cylinders arranged in line with an independent piston rod for the inside cylinder passing through the inner head of the cylinder, and with the pistons of the two outer cylinders connected to the main piston rod by connections passing outside the inside cylinder, and constructed to provide space between the two inner cylinders for access to their pistons, substantially as described.

2. A multiple expansion engine having three cylinders arranged in line with the high pressure cylinder placed inside and having an independent piston rod passing through its inner head, and with the low and intermediate pistons connected to the main piston rod by connections passing outside the high

pressure cylinder, and constructed to provide space between the two inner cylinders for access to their pistons, substantially as described.

3. A multiple expansion engine having three cylinders arranged in line in the order of expansion with the high pressure cylinder placed inside and having an independent piston rod passing through its inner head, and with the intermediate pressure piston connected to the low pressure piston by an independent rod and the low pressure piston connected to the main piston rod by connections passing outside the intermediate and high pressure cylinders, the engine being constructed to provide space between the high and intermediate pressure cylinders for access to their pistons, substantially as described.

4. The combination with the cylinders A, B, C, of a multiple expansion engine arranged in line with the high pressure cylinder inside and provided with space between the two inner cylinders for access to their pistons, of the main piston rod *d*, cross head *e* on said rod, high pressure piston rod *f*, connected to said cross head or rod, connections between the intermediate and low pressure pistons, and rods outside the high pressure cylinder connecting the intermediate and low pressure pistons to the cross head, substantially as described.

5. The combination with the cylinders A, B, C, of a multiple expansion engine arranged in line in the order of expansion with the high pressure cylinder inside and provided with space between the high and intermediate pressure cylinders for access to their pistons, of the main piston rod *d*, cross head *e* on said rod, high pressure piston rod *f* connected to said cross head, rods *g* outside the intermediate and high pressure cylinders A, B, connecting the low pressure piston with the cross head *e*, and intermediate piston rod *h* connected to the low pressure piston, substantially as described.

6. A multiple expansion engine having its cylinders arranged in line and having its pistons connected to the main piston rod by connections independent of one head of each cylinder, the inner cylinders being separated to provide space for access to each piston at the end of the cylinder through which the connections do not pass, substantially as described.

7. A multiple expansion engine having its cylinders arranged in line and having two inner cylinders separated to provide space for access to the pistons of said cylinders, and having its pistons connected to the main piston rod by connections independent of the outer head of the inner one of said two inner cylinders, substantially as described.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

CHARLES C. WORTHINGTON.

Witnesses:

LOUIS R. ALBERGER,

H. W. TILLINGHAST.