No. 756,210. PATENTED APR. 5, 1904.

T. P. BUTLER.

ROTARY ENGINE.

APPLICATION FILED JULY 23, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

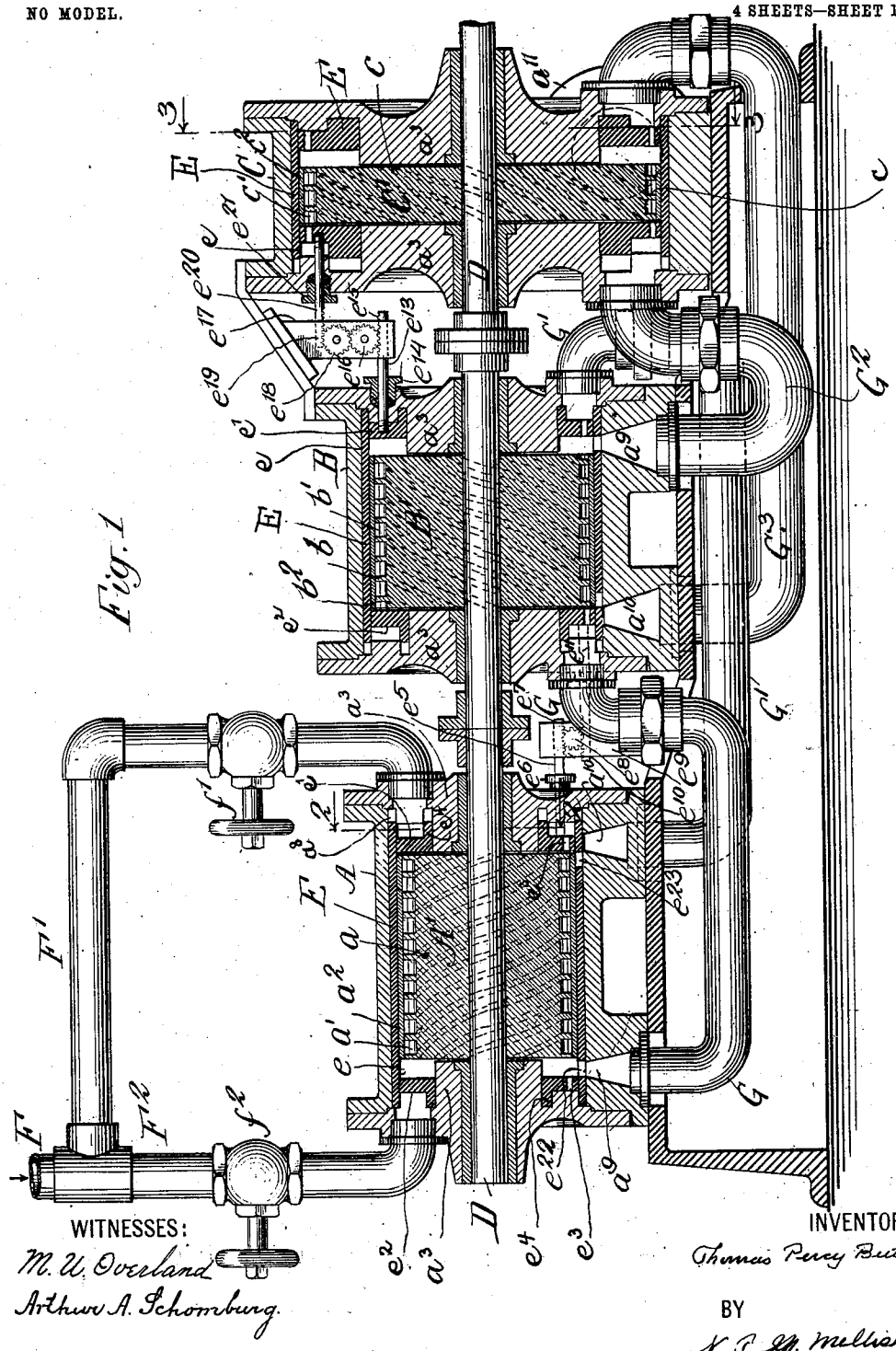


Fig. 1.

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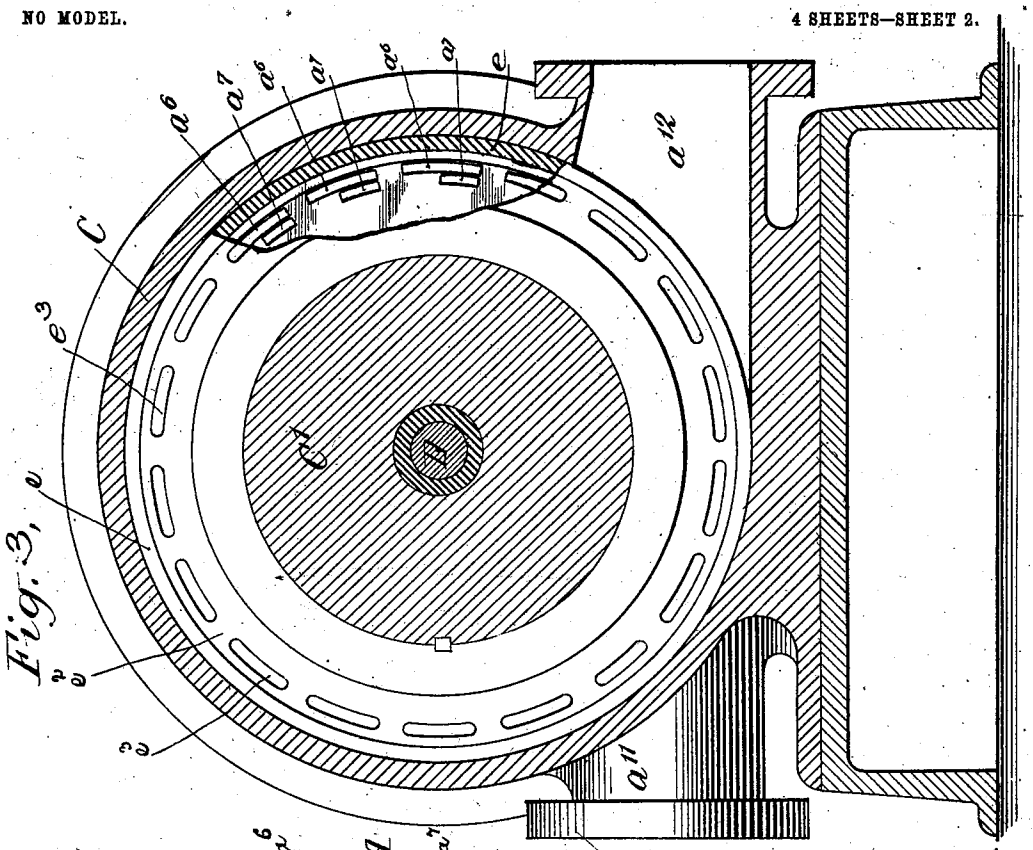
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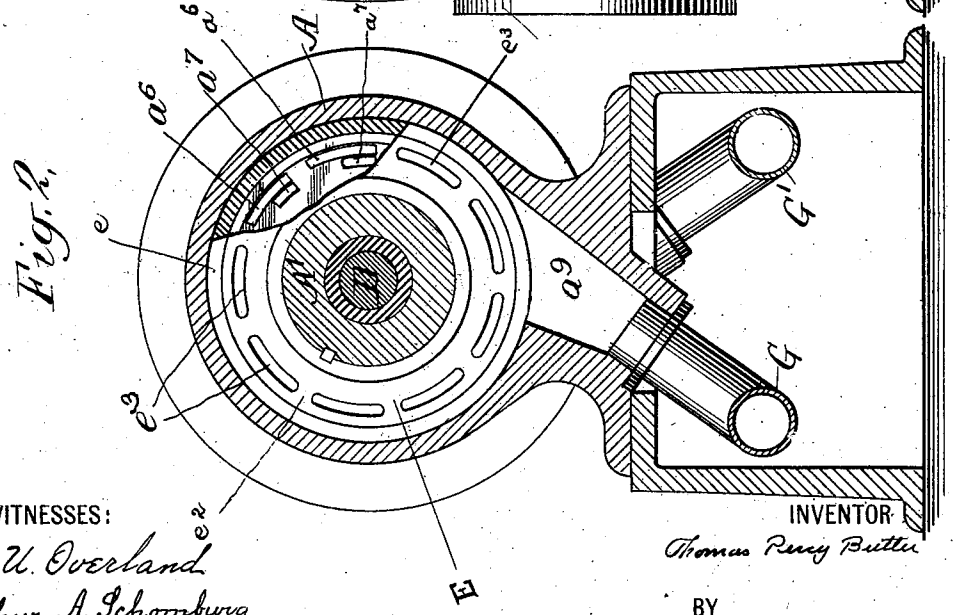
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NO MODEL. 4 SHEETS—SHEET 2.





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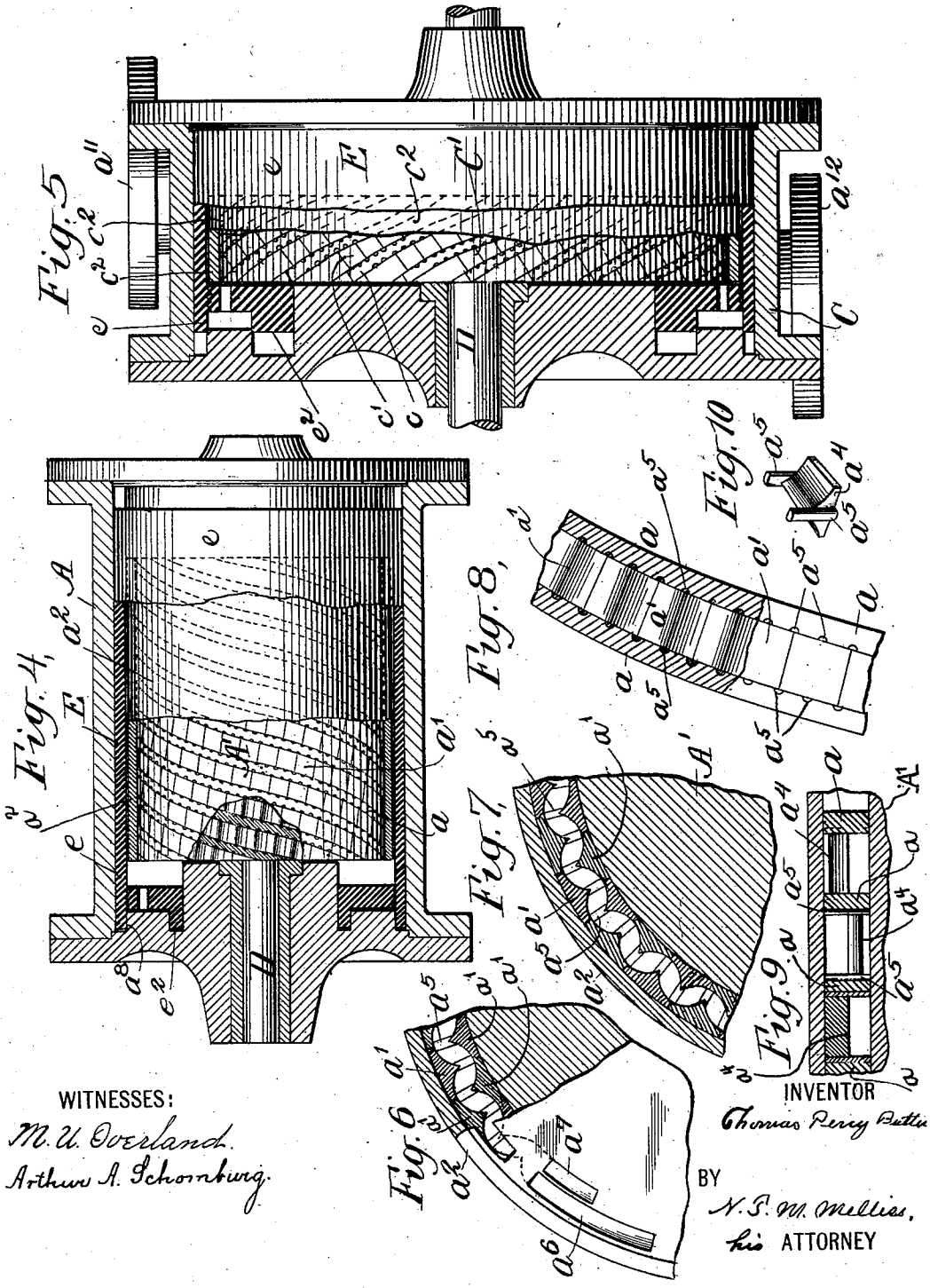
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NO MODEL. 4 SHEETS—SHEET 3.



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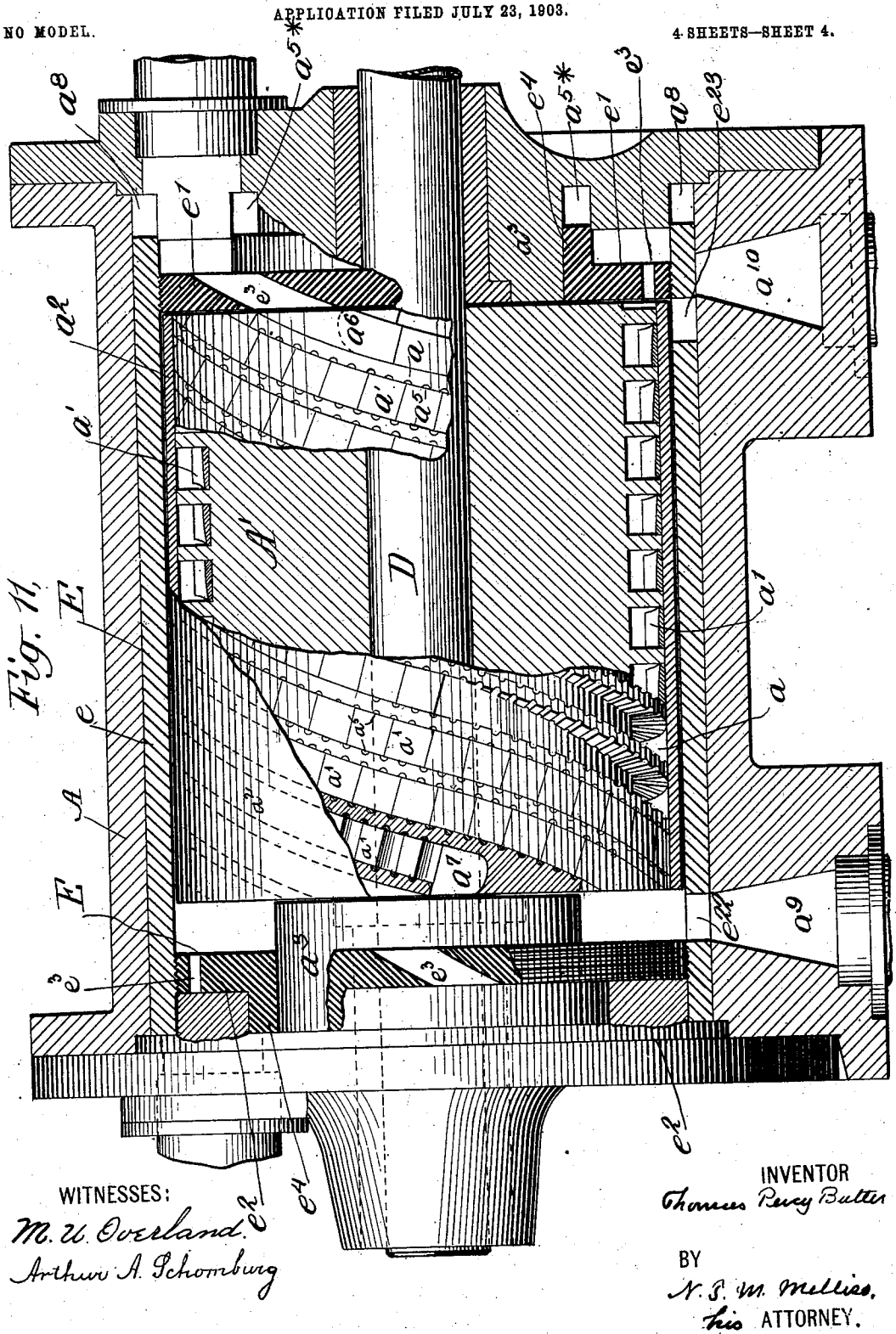
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Fig. 11.



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No. 756,210. Patented April 5, 1904.

UNITED STATES PATENT OFFICE.

THOMAS PERCY BUTLER, OF WANTAGH, NEW YORK.

ROTARY ENGINE.

SPECIFICATION forming part of Letters Patent No. 756,210, dated April 5, 1904.

Application filed July 23, 1903. Serial No. 166,736. (No model.)

To all whom it may concern:

Be it known that I, THOMAS PERCY BUTLER, of the town of Wantagh, county of Nassau, State of New York, have invented a new and useful Improvement in Rotary Engines, of which the following is a specification.

I will describe a rotary engine embodying my improvement and then point out the novel features in claims.

In the accompanying drawings, Figure 1 is partly a central longitudinal section and partly an elevation of an engine embodying my improvement. Fig. 2 is a transverse section of the same, taken in two different planes close to one end of the smallest of three cylinders which are comprised in the engine. Fig. 3 is a similar view of the largest of said cylinders. Fig. 4 is partly a longitudinal section and partly an elevation of the smallest cylinder. Fig. 5 is a similar view of the largest cylinder. Fig. 6 shows a segment of the piston of the smallest cylinder, being partly an end view and partly a transverse section in a spiral line about the axis. Fig. 7 is a transverse section of the piston of the smallest cylinder, taken spirally around the same. Fig. 8 is a view of the top or circumference and a section taken parallel to the top or circumference of two rib-coils and intermediate abutments comprised in the piston of the smallest cylinder. Fig. 9 is a longitudinal section of a portion of said piston, showing adjacent rib-coils and intermediate abutments. Fig. 10 is a perspective view of one of the abutments. Fig. 11 is another view of the smallest cylinder and its concomitants, some parts being shown in elevation, others in section at various planes, and certain abutments being removed.

Similar letters of reference designate corresponding parts of all the figures.

The three cylinders of the illustrated engine are marked A B C in the drawings. As shown, cylinder A is the smallest, cylinder C the largest, and cylinder B of intermediate size. These cylinders are fitted with pistons A′ B′ C′. The cylinders and pistons may be of the same general characteristics and are so represented in the drawings. Obviously there may be less or more than three cylinders and pistons. Preferably the pistons of the three cylinders are affixed to a common shaft D, and when this feature of construction is adopted the three cylinders and pistons will of course be in line. This arrangement is characteristic of some of the features of my improvement, but is not essential to others.

The shaft D may be supported in any suitable bearings provided in the heads of the cylinders and made in any number of sections coupled together.

With the described arrangement of cylinders live steam will be used in the smallest cylinder and exhausted thence into the second cylinder and finally into the third cylinder.

The pistons A′ B′ C′ have circular and preferably cylindric bodies provided externally with spiral rib-coils a b c, having between them abutments a' b' c'. The detailed description of one of these pistons will be applicable to each of the others; but whenever the machine or device to be driven by the engine will not counteract end thrust of the pistons it will be advantageous to make the direction of the spirals of the rib-coils different in the several pistons to minimize end thrust of the shaft D. The pitch of the spirals of the several pistons will generally, if not always, be different. I have shown the spirals of the rib-coils belonging to the piston A′ as left-hand spirals and those of the pistons B′ and C′ as right-hand spirals. Outside the rib-coils and abutments of the pistons are shells a^2 b^2 c^2, which form integral parts of the pistons.

The smallest cylinder A and its concomitants will be selected for a detailed description, because of being most fully illustrated in the drawings.

The cylinder A is of ordinary form, provided at the ends with flanges, and, generally speaking, the heads of the cylinder are also of ordinary form, and they may be secured to the flanges of the cylinder by bolts. Each of the cylinder-heads is provided with an inwardly-extending hub a^3, preferably circular in form. These hubs a^3 extend close to the ends of the piston A′. Intermediate of the piston A′ and the cylinder A is a reversible valve and steam-distributer E. This will presently be described in detail. It will be suffi-

cient to say now that it is incapable of rotary movement, but is capable of a longitudinal movement relatively both to the cylinder and the piston. As already stated, the rib-coils extend in spiral lines around the body of the piston. The abutments, which are arranged between them, may best be understood by reference to Fig. 10, where one is shown in perspective, for although they are of two kinds, which are arranged in alternation, yet the general structure is always the same and consists of a block a^4, provided with guide-pieces a^5 for securing the block in place. A set of blocks a^4 are arranged with their edges in contact, as shown best in Figs. 6 and 7. The bases of one set bear upon the body of the piston. The bases of the other set bear against the inner surface of the cylindric shell a^2 of the piston. It is of course advantageous to shape the bases of the abutments so that they will conform to and have a firm bearing upon the surfaces by which they are supported. The operative surfaces of each abutment are made in the form of reverse arcs extending from the ends of the abutment toward each other until they meet and form ridges parallel with the ends of the abutments, but projecting considerably beyond the plane of those edges. The abutments in two sets are so arranged that they form salient ridges, each set of which have their ridges opposite the longitudinal end edges of the abutments comprised in the other set. The abutments are held in position by the engagement of their guide-pieces a^5 with grooves formed in the opposite faces of the rib-coils, between which the abutments are arranged.

It will be seen by reference to Figs. 6 and 7 that the construction and arrangement of the abutments which I have described form sinuous passages between adjacent rib-coils. Steam entering the spaces between the rib-coils and acting upon these abutments will fulfil its duty without any detrimental eddy-currents, and this is due to the character of the passages which have been provided by the new construction and arrangement of abutments. Where the passages formed between the abutments terminate at the ends of the piston, they are of somewhat different construction. This difference may be best understood by reference to Fig. 6, where not only the end, but also the middle or main portion, of a passage is represented, owing to the fact that this figure is partly an end elevation and partly a spiral section of a segment of a piston. At the end of the piston each passage is destitute of abutments. It is divided into two arc-shaped ports or openings a^6 and a^7, arranged concentrically to each other and to the axis of the piston. This construction is the same at both ends of the piston, because the piston is intended to be reversible. The outer arc-shaped ports or openings a^6 will be the inlets for steam, and the inner arc-shaped ports or openings a^7 will be always the outlets for steam. Of course at any time when the arc-shaped ports or openings a^6 serve as the inlets for one end of the piston the arc-shaped ports or openings a^7 at the same end will be inoperative, and those at the other end will constitute the exhaust ports or openings.

The reversing-valve and steam-distributer E coöperates with the arc-shaped ports or openings a^6 a^7. When steam is admitted into one end of the cylinder A, the device E slides away from that end of the cylinder and into close proximity with the adjacent end of the piston A′. Then the arc-shaped ports or openings a^7 in that end of the piston will be closed by the adjacent end piece of the device E; but the arc-shaped ports or openings a^6 at said end of the piston will receive steam through the arc-shaped ports or openings e^3, with which the said end piece of the device E is provided. The other end piece of the device E will then have been moved wholly away from the adjacent end of the piston, and hence steam may escape through the arc-shaped ports or openings a^7 in the last-mentioned end of the piston. Each of the ports or openings e^3 should be of a length and its end walls of such an angle as to cause the steam to enter a passage between adjacent rib-coils in the most effective manner.

To avoid any misunderstanding, it may be added that each of the end pieces e' e^2 of the device E is provided with uniformly-distributed arc-shaped ports or openings e^3, which coincide with the arc-shaped ports or openings a^6 of the piston. It is because of these ports or openings e^3 that the device E has the function of a steam-distributer. It has the function of a reversing-valve, because upon the introduction of steam into either end of the cylinder it will be moved into a position to cut off the arc-shaped exhaust ports or openings a^7 at that end of the piston which is adjacent to the cylinder and where steam is admitted and open the arc-shaped ports or openings a^7 at the other end of the piston.

The construction of the arc-shaped exhaust ports or openings a^7 is believed to be important, and so they have been formed at their extremities with a turn or deflection different from the main course of the rib spirals, this being for the purpose of utilizing the reaction of the steam during its escape.

It may be added in explanation of the device E that it may be made with a cylindric shell e and two separately-made end pieces e' e^2, all rigidly secured together. As shown, the cylindric shell e has a sliding fit between the piston A′ and the body of the cylinder A and projects beyond the heads e' e^2, so that its ends may work within circular recesses a^8, formed between the body of said cylinder and its heads. The end pieces e' e^2 have been shown as provided with circular rims e^4, fitting

the hubs a^3 of the cylinder-heads and working within recesses a^{5*}, which are formed in the heads of the cylinder. The rims e^4 may advantageously be formed integral with the end pieces e' e^2, and the latter may be fixedly united with the shell e by means of screw-threads, as shown in Fig. 11.

It may be advantageous to connect the valve E of one cylinder with that of another. The valves of all three cylinders have been shown so connected. The connections between the valves E of the cylinders A B is shown as consisting of a stem or rod e^5, passing through a stuffing-box e^6 and provided with a toothed rack e^7, which engages with a toothed pinion e^8, mounted on a standard e^9 and engaging also with a toothed rack e^{10}, arranged upon a stem or rod e^{11}, which is secured to the valve E of the cylinder B and passes through a suitable stuffing-box. A similar connection is provided between the valves E of the cylinders B and C, consisting of a stem or rod e^{13}, extending from the valve E of the cylinder B through a stuffing-box e^{14} and provided with a toothed rack e^{15}, engaging with a toothed pinion e^{16}, mounted in a bracket e^{17} and engaging with a toothed pinion e^{18}, which is also mounted in said bracket and which engages with a toothed rack e^{19}, arranged upon a stem e^{20}, working through a stuffing-box e^{21} and connected with the valve E of the cylinder C. Even if the valves E are not connected it may be desirable to provide them with stems such as the stems e^5, e^{11}, e^{13}, and e^{20} for the purpose of enabling the attendant to observe the workings of the valves E from outside of the cylinders.

Obviously all the valves E may have their stems connected with a common lever outside of the cylinders A B C to enable the attendant to shift the valves together in order to effect the reversal of the engine.

As here shown, steam is supplied through a pipe F to branch pipes F' F^2, controlled by throttle-valves f' f^2. By opening one of these throttle-valves and closing the other steam may be permitted to enter either end of the cylinder A. In Fig. 1 it is supposed to be passing through the pipe F into the right-hand end of the cylinder A. At whichever end it enters it will act upon the valve E to shift it longitudinally within the cylinder in the manner and with the result already described.

The cylinder A is provided with two exhaust-ports a^9 a^{10}, which are arranged in its circumference one near each end. The shell e of the device E is provided with similar exhaust-ports e^{22} e^{23}; but these are not so far apart as are the exhaust-ports a^9 a^{10}. Hence when one of them coincides with the exhaust-ports a^9 a^{10} the other will fail to do so. When the valve E is moved in one direction—as, for instance, to the left, as shown in Fig. 1—its port e^{22} will coincide with the exhaust-port a^9 of the cylinder A and permit the escape of steam through the latter; but at this time the port e^{23} of the valve E will be out of line with the port a^{10} of the cylinder A, and hence the latter port will be closed. The reverse movement of the valve E will close the cylinder-port a^9 and open the cylinder-port a^{10}.

From the outlet-port a^9 of the cylinder A a pipe G extends to one end of the cylinder B, and from the outlet-port a^{10} of the cylinder A a pipe G' extends to the other end of the cylinder B. From the outlet-port a^9 of the cylinder B a pipe G^2 extends to one end of the cylinder C, and from the outlet-port a^{10} of the cylinder B a pipe G^3 extends to the other end of the cylinder C. The ends of the cylinder C are provided with outlets a^{11} a^{12}.

Steam entering the cylinder A—as, for instance, at its right-hand end on Fig. 1—will cause the valve E to be shifted toward the other end, so that it will close the arc-shaped ports or openings a^7 at the adjacent end of the piston A' and open the arc-shaped ports or openings a^7 at the other end of the piston. Thus the steam will be permitted to flow into the passages between the various rib-coils and between the sets of abutments in spiral directions about the axis of the piston, but in a sinuous course toward and from the axis of the pistons without eddy-currents until it escapes into the space between the farther end of the piston and the opposite end piece of the valve E. Thence it will flow through the pipe G into the cylinder B and there operate in the same manner, escaping into the pipe G^2 and flowing into the cylinder C to operate there again and eventually pass to the atmosphere or to a condenser.

It must, of course, be understood that at the ingress of the steam into the cylinders B and C their valves E will be appropriately shifted to cause a flow of steam in the proper direction.

Although reference has been made only to steam, all equivalent motive fluids may be used without departing from my invention.

What I claim as new, and desire to secure by Letters Patent, is—

1. The combination with an internally-circular casing of a rotary piston, comprising a shell, a body or shaft, rib-coils extending spirally between said body or shaft and shell, and abutments extending across the space between adjacent rib-coils, some from the interior of the shell and some from the piston-body, and constructed so as to provide a passage running sinuously toward and from the axis of the body or shaft.

2. The combination with an internally-circular casing of a rotary piston, comprising a body or shaft, rib-coils extending spirally around said body or shaft, and abutments extending across the space between adjacent rib-coils, and arranged in two sets, having re-

versely-curved arc-shaped opposite surfaces, so disposed as to produce a continuous passage, extending sinuously toward and from the axis of the body or shaft.

3. The combination with an internally-circular casing of a rotary piston, comprising a body or shaft, rib-coils extending spirally around said body or shaft, abutments extending across the space between adjacent rib-coils, and severally having reverse, arc-shaped surfaces, meeting to form ridges, and the ridges of opposite abutments being arranged out of line, so as to form a continuous passage, and extending sinuously toward and from the axis of the body or shaft.

4. The combination with an internally-circular casing, of a rotary piston, comprising a body or shaft, rib-coils extending spirally around said body or shaft, and two sets of abutments arranged one set outward of the other, and extending across the space between adjacent rib-coils, the several abutments being made separately, and fitted to slideways in the rib-coils.

5. The combination with an internally-circular casing, of a rotary piston, comprising a body or shaft, rib-coils extending spirally around said body or shaft, and two sets of abutments arranged one set outward of the other, and extending across the space between adjacent rib-coils, and each formed with two arc-shaped surfaces, meeting to form a ridge, and provided with guide-pieces, for engaging slideways in the rib-coils.

6. The combination with an internally-circular casing, of a rotary piston, comprising a body or shaft, rib-coils extending spirally around said body or shaft, abutments extending across the space between adjacent rib-coils, and outward of said body or shaft, and exhaust-passages at the ends of the spaces between adjacent rib-coils, having a turn or deflection different from the main course of said space, so that the reaction of escaping motive fluid may be utilized, to contribute to the desired rotation of the piston.

7. The combination with an internally-circular casing, and a rotary piston adapted to receive a motive fluid at either end, means for conducting motive fluid to either end of the cylinder, and a valve arranged between the casing and piston for opening and closing the proper ports of the piston for causing its rotation in the desired direction.

8. The combination with an internally-circular casing, and a rotary piston adapted to receive a motive fluid at either end, means for conducting motive fluid to either end of the cylinder, and a valve, operated by the inflowing motive fluid, to open and close the proper ports of the piston for causing its rotation in the desired direction.

9. The combination with an internally-circular casing, and a rotary piston adapted to receive a motive fluid at either end, means for conducting motive fluid to either end of the cylinder, and a valve fitting within a cylinder and surrounding the circumference and ends of the piston, and movable lengthwise of the cylinder, and piston to open and close the proper ports of the piston, to secure the rotation of the piston in the desired direction.

10. The combination with an internally-circular casing, and a rotary piston adapted to receive a motive fluid at either end, means for conducting motive fluid to either end of the cylinder, and a valve fitting within a cylinder and surrounding the circumference and ends of the piston, and movable under the influence of the motive fluid, lengthwise of the cylinder and piston, to open and close the proper ports of the piston, to secure the rotation of the piston in the desired direction.

11. The combination of a plurality of cylinders, a corresponding number of rotary pistons, connections between the cylinders so that exhaust motive fluid from either end of one cylinder may pass into one end of another cylinder, and a valve between the first-mentioned cylinder and its piston, for reversing its inlet and outlet.

12. The combination of a plurality of cylinders, a corresponding number of rotary pistons, connections between the cylinders, so that exhaust motive fluid from either end of one cylinder may pass into one end of another cylinder, and a valve, operated by the inflowing motive fluid, in the first-mentioned cylinder, for reversing its inlet and outlet.

13. The combination of a plurality of cylinders, a corresponding number of rotary pistons, connections between the cylinders, so that exhaust motive fluid from either end of one cylinder may pass into one end of another cylinder, and a valve between the cylinder and piston of each engine, which discharges into the cylinder of another engine, said valves being for the purpose of reversing the pistons, and connections between said valves in the different cylinders.

14. The combination of a plurality of cylinders, and a corresponding number of rotary pistons, comprising spiral rib-coils, running in reverse directions upon different pistons, to minimize end thrust upon the piston-shaft.

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