

L. E. WARREN.
APPARATUS FOR GENERATING AND TRANSMITTING POWER.
APPLICATION FILED APR. 1, 1912.

Patented Aug. 5, 1913.

4 SHEETS—SHEET 1.

1,069,361.

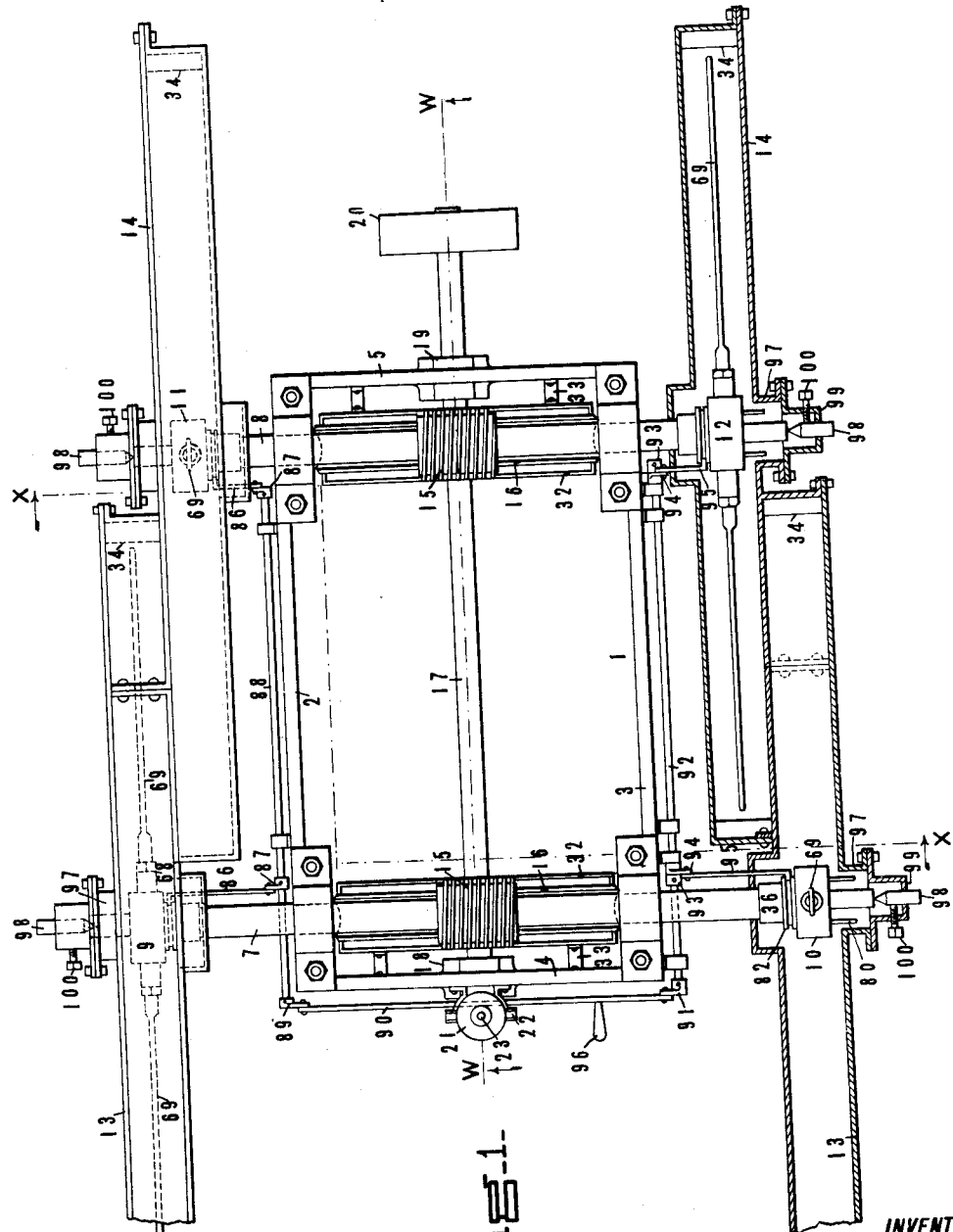


FIG. 1.

WITNESSES
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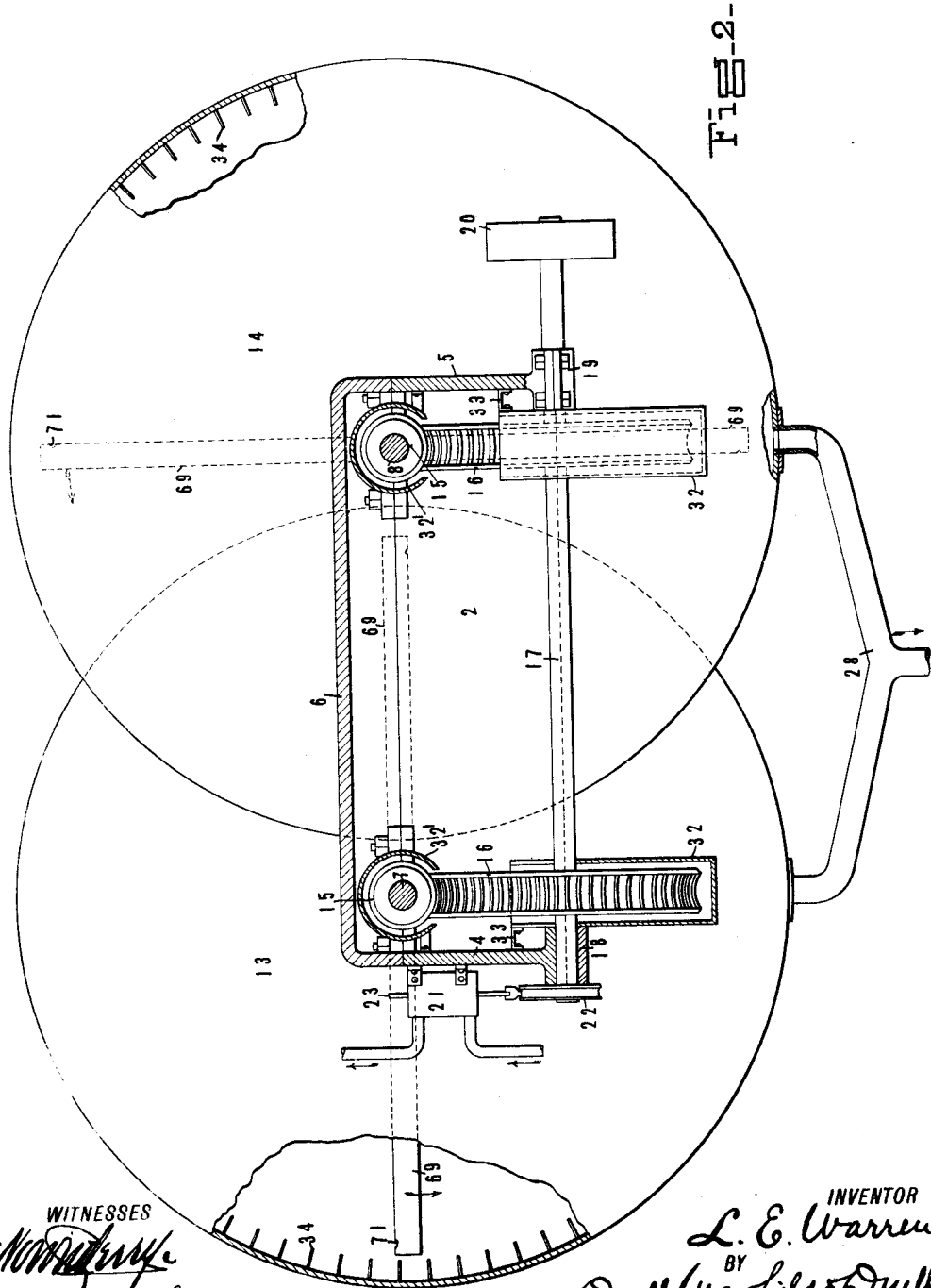


FIG-2-

WITNESSES
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4 SHEETS—SHEET 3.

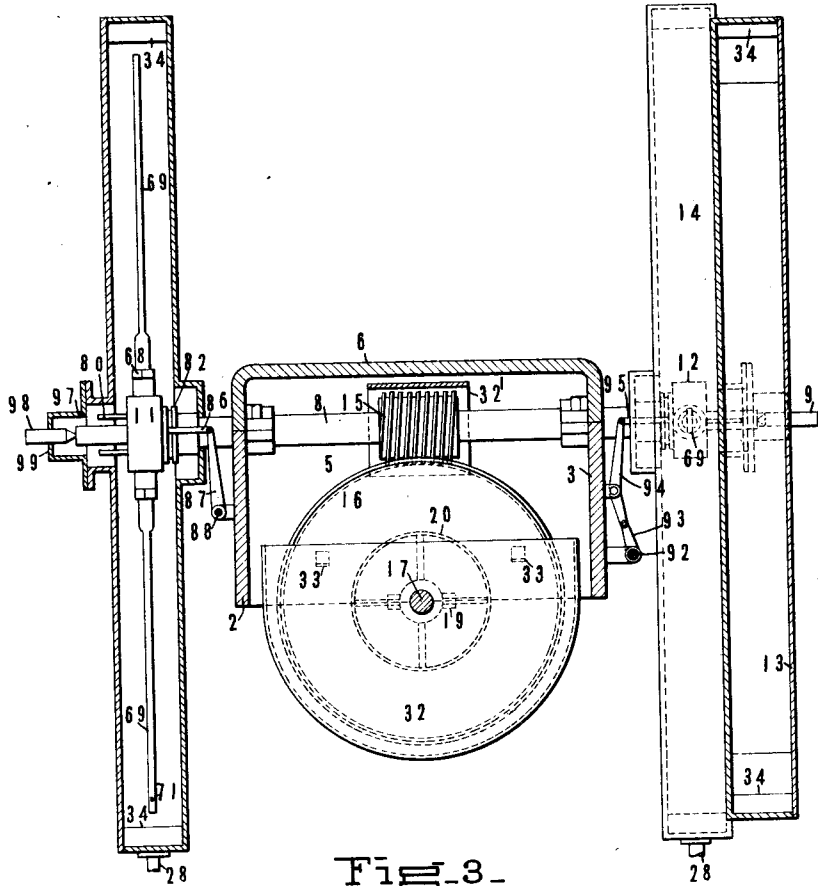


Fig. 3.

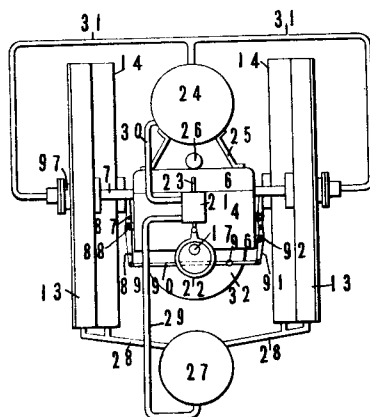


Fig. 4.

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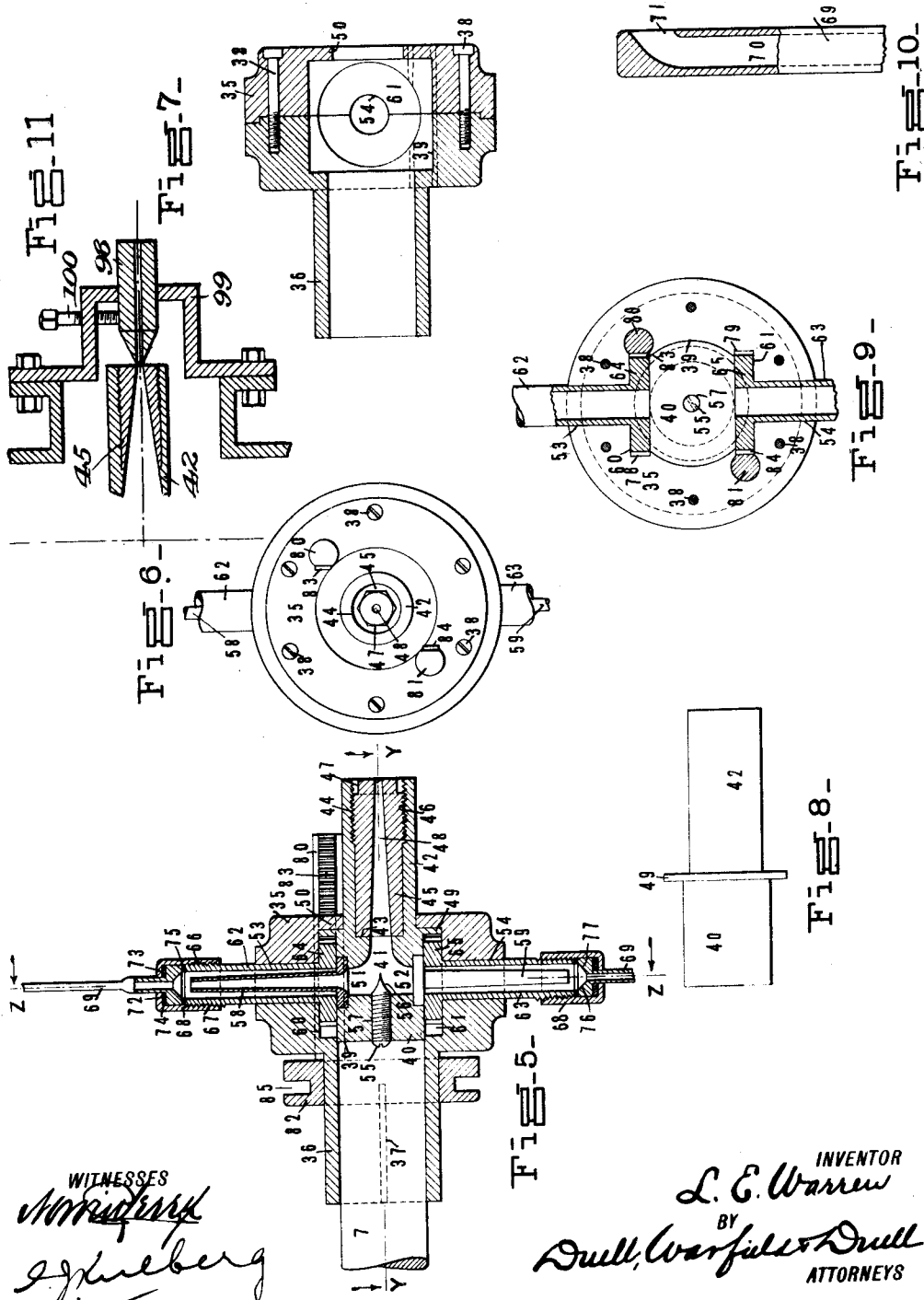
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4 SHEETS—SHEET 4.



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APPARATUS FOR GENERATING AND TRANSMITTING POWER.

1,069,361.

Specification of Letters Patent.

Patented Aug. 5, 1913.

Application filed April 1, 1912. Serial No. 687,567.

To all whom it may concern:

Be it known that I, LYMAN E. WARREN, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Apparatus for Generating and Transmitting Power, of which the following is a full, clear, and exact description, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to a fluid operated power unit and with respect to its more specific features, to a machine assemblage of the type described, comprising a rotary reaction engine.

One of the objects of the invention is to provide a device of the class described which will be compact and may be mounted in a small space.

Another object is to provide a device of the kind described whose moving parts shall be substantially balanced.

Another object of the invention is to provide a practical and efficient device of the class described which shall have a maximum efficiency and ease of operation.

Another object is to provide a device of the class described which shall be simple and cheap in construction and inexpensive to operate.

Another object is to provide a practical and efficient engine whose parts may be readily assembled and disassembled.

Other objects will be in part obvious and in part hereinafter pointed out.

The invention accordingly consists in the features of construction, combinations of elements and arrangement of parts which will be exemplified in the construction hereinafter set forth, and the scope of the application of which will be indicated in the following claims.

In the drawing wherein is shown one of the various possible embodiments of the invention, Figure 1 shows a plan view thereof, certain parts being omitted for the sake of clearness; Fig. 2 represents a cross section on the line $w-w$ of Fig. 1 showing a portion of the casing broken away and revealing the buckets therein; Fig. 3 is a cross section on the line $x-x$ of Fig. 1, omitting certain parts for the sake of clearness; Fig. 4 is a diagrammatic end elevation of the machine showing the relation of the various parts. Fig. 5 is a detailed longitudinal cross sec-

tional view of the engine; Fig. 6 is a detailed view of the engine viewed from the right of Fig. 5; Fig. 7 is a cross section on the line $y-y$ of Fig. 5, with certain parts removed; Fig. 8 is a detailed view of the removable plug; Fig. 9 is a cross section on the line $z-z$ of Fig. 5, with certain parts removed; and Fig. 10 is a detailed view of one of the conduits or arms; Fig. 11 is a sectional detail of a portion of the device showing the relative arrangement of the steam supplying nozzle and the engine nozzle.

Similar reference numerals indicate similar parts throughout the various views of the drawings.

Referring now more specifically to the drawings, we find in Figs. 1 to 4, a generally oblong rectangular frame-work 1, provided with side walls 2 and 3, end walls 4 and 5, and a top 6. Supported at either end thereof in bearings in the side walls 2 and 3 are transverse shafts 7 and 8. The transverse shafts are substantially parallel to one another. The rectangular cover not only serves to provide rigidity to the frame-work but also serves to prevent the dropping of articles into the gear mechanism and ports from above and also keeps out the dust. The shafts 7 and 8 support two sets of reaction engines. The shaft 7 supports at either end thereof at a point outside the walls of the frame-work 1, reaction engines 9 and 10. The shaft 8 supports at either end thereof at a point beyond the wall of the frame-work, reaction engines 11 and 12. Each of the reaction engines is provided with a plurality of conduits or arms, which will be described more fully hereinafter. The shaft 8 is shorter than the shaft 7 in the embodiment shown, whereby the conduits or arms of engine 11 mounted on the end of shaft 8 will clear the conduits or arms of engine 9 mounted on the end of shaft 7. The same provision is made in connection with engines 12 and 10. The engines 9 and 10 are provided with an exhaust casing 13, and engines 11 and 12 with exhaust casing 14, and it will be noted that the casing 14 about the engine 11 lies between the casing 13 about engine 9 and the adjacent side of the frame-work 1. The same may be said respectively of the casings about engines 12 and 10. According to the construction outlined, it will be noted that the supporting frame-work 1 is interposed between the engines and not

only supports the shafts 7 and 8 and engines thereon, but also suspends the casings surrounding them, as more clearly shown in Fig. 3. Upon each of the shafts 7 and 8, and intermediate the engines mounted on either end thereof, is a worm wheel 15 which is adapted to rotate with the shaft and to coact with a worm gear 16 below the shaft to transmit power from the engines. The worm gears are mounted on the main shaft 17 which passes through each of the gears and which is supported in bearings 18 and 19 which are situated on ends 4 and 5, respectively, of the supporting frame-work 1. At one end of the shaft, pulleys 20 may be conveniently arranged for transmission of power. It is to be noted that any other power transmission means might be used in this connection. At the end of the shaft opposite the pulleys is arranged a pump 21 which is adapted to be operated from the main shaft by means of an eccentric strap 22 which passes there-around and is adapted to be connected to the pumping cylinder by means of a rod 23. It will be noted that the worm gear mechanism and the transmission members in general are supported by the frame-work 1.

As shown more clearly in Fig. 4, the engines are adapted to be supplied with steam from a flash-boiler 24 which is mounted longitudinally of the frame-work 1 upon suitable supports 25, being held in position between the exhaust casings of the four engines shown and generally below the uppermost part of the casings. Beneath the boiler is provided a suitable torch 26 which is also mounted upon the frame-work. At a point below the lowermost point of the gear mechanism and generally below the casings 14 is a reservoir 27 which is connected with piping 28 adapted to transmit the products of condensation from the casings thereto, and also piping 29 leading to the pump. The reservoir 27 acts as a supply reservoir for the boiler and the water pumped therethrough is forced through the pipe 30 by the pump 21 into the boiler. Suitable pipes 31 connect the boiler with the reaction engines. It will thus be seen that the frame-work 1 interposed between the engines and casings supports all the parts of the machine, and it is to be noted that the structure thus produced is very compact in form and may be placed in various positions, upon, for instance, automobiles and other vehicles, or in cramped places in motor boats and the like with great facility; at the same time the parts may be readily inspected, and gotten at for repairs with great convenience. It will be noted particularly, that with this construction providing reaction engines which project beyond the sides of the casing and are situated on opposite ends of a common shaft, a balanced mechanism is pro-

vided, which not only insures little wear of the parts but makes possible a smooth-running, quiet and effective machine. Each of the gears 16 is provided with a receptacle or trough 32 in which oil may be held for lubricating the parts. Each trough is attached to its adjacent end wall by means of suitable bars 33. It will be noted that the frame-work 1 incases the gears and each trough 32. Each wheel 15 is provided with an oil-shield 32' which partially surrounds it and permits oil to drip back into trough 32. The exhaust casing for each engine is provided with radially arranged steps 34 which are attached to the curved sides of the substantially cylindrical casing.

Referring now more particularly to Figs. 5 to 10, there is found one of the reaction engines as shown in detail. Each reaction engine comprises a substantially cylindrical casing 35 which is provided with an elongated tubular portion 36 providing a recess adapted to receive an end of either of the shafts 7 or 8 mounted on the frame-work 1. The end of each shaft is provided with a key-way corresponding to a similar key-way in the casing and upon insertion of the key 37 therein the shaft and casing may be held in engagement. At the same time this mode of construction permits the ready removal of the engine from the shaft for repairs or otherwise. The casing, as is shown more clearly in Fig. 7 is divided into two substantially equal halves which may be suitably bolted together by bolts 38 passing from the front face of the casing through the rear half thereof. Suitable means may be interposed between the halves to prevent leakage. The casing provides a substantially cylindrical chamber 39 in which is mounted a substantially cylindrical plug 40 which fits said chamber and is held in such manner therein that it is removable. The plug is provided with a longitudinal passageway 41 of which the walls 42 are elongated and project beyond the front face of the casing 35. Near the rear end of this passageway, a shoulder portion 43 is provided and near the front end of the passageway an internally screw-threaded portion 44 is provided. A generally cylindrical nozzle 45 is adapted to be inserted in the elongated longitudinal passageway of the plug, the nozzle being somewhat elongated to correspond to the plug, and the rear end of this nozzle abuts the shoulder 43 and forms a tight joint therewith. The front end of the nozzle is provided with an external screw-threaded portion 46 which is adapted to coact with the screw-threads 44 of the plug to thereby hold the nozzle in position. The front end of the nozzle is provided with a hexagonal or other angular surface 47 which may be engaged by a wrench or other means for removal

of the nozzle. This nozzle is provided with a longitudinal passageway 48 which gradually widens in area from the front end to the rear end thereof. The cylindrical
 5 plug is of greater diameter at its rear end than at its front end, forming a shoulder thereby, and about the shoulder is arranged a flange 49 which is adapted to abut the inner part of the casing about the
 10 orifice 50 through which the elongated walls 42 of the plug project.

Joining the longitudinal passageway and communicating therewith at a point near the rear end of the plug are two transverse
 15 passageways 51 and 52 which are aligned and which are coaxially disposed with respect to two diametrically opposite discharge orifices 53 and 54 respectively in the walls of the engine casing 35. The discharge orifices 53 and 54 communicate with the interior of the casing. In the rear wall of the plug and substantially in line with the axis of the longitudinal passageway of the plug is a screw 55 which projects into
 20 the space formed at the juncture of the two transverse passageways and the longitudinal passageway. This screw is provided with a tapered face 56 which is adapted to deflect steam or other fluid from the passage-
 25 way 41 into the transverse passageways 52 and 51 respectively. Screw 55 fits in passage 57.

Passing through the outer orifices or discharge outlets 53 and 54 of the casing, and forming coaxial extensions of the passage-
 35 ways 51 and 52, are respectively placed spur tubes 58 and 59, which are attached to the plug 40 in the passageways mentioned and serve to lead the steam therefrom to a point
 40 exterior of the cylindrical plug and into detachable discharge conduits hereinafter described. Situated in counter-sunk recesses 60 and 61 which are preferably diametrically disposed with respect to one another
 45 on the interior of the casing, are pipes 62 and 63 forming part of the conduits above mentioned. These pipes 62 and 63 are adapted to be detached from the casing and are provided respectively at their inner
 50 ends with flanged portions 64 and 65 which are adapted to abut and surround the orifices 53 and 54 in the casing. These pipes project through the orifices 53 and 54 and are adapted to surround and to communi-
 55 cate with the conduits or tubes 58 and 59 and to thereby receive steam therefrom; thereby pipes 62 and 63 communicate respectively with the transverse passageways 51 and 52. At the end opposite the flanged
 60 end of each of the pipes 62 and 63 is provided a screw-threaded portion 66. Each pipe is adapted to engage the screw-threaded portion 67 of a recess in a substantially cylindrical collar 68 which surrounds the
 65 lower portion of a flattened conduit or

reaction arm 69. It will be noted that the removable plug 40 abuts the lower faces of the flanged portions 64 and 65 and thereby aids in retaining the pipes 62 and 63 in
 70 position. Further, according to the above, the discharge conduits comprise separable sections 62, 63 and 69.

As indicated each of the conduits or arms 69 is detachable and is provided with a flattened channel 70, extending coaxially of
 75 the passageways in pipes 62 and 63, which terminates at the extremity of the conduit or arm in a substantially tangential outlet 71, having a curved wall adapted to direct the steam or other fluid used in the conduit
 80 or arm against the buckets 34 in each of the casings whereby a reaction will be provided tending to rotate the conduit or arm. The lower portion of each of the flattened con-
 85 duits or arms 69 is substantially cylindrical and fits into the upper threaded portion of the collar 68. Between the upper face 72 of the cylindrical base portion of each conduit or arm and the inner periphery 73 of the upper wall of the collar, 68 is inclosed a
 90 suitable packing 74 providing a tight joint between the conduit or arm and collar. Suitable packing 75 forms a tight joint between the upper end of the pipes and the lower face of the cylindrical base of the con-
 95 duct or arm. This lower face is recessed, the recess being provided with converging walls 76 and 77 which lead to the narrowed channel 70 running longitudinally of the conduit or arm. It will be seen by the construction
 100 as above outlined that the conduits or arms 69 will be held securely in place and that leakage will be practically prevented.

In order to provide a suitable means for reversing the direction of rotation of the
 105 conduits or arms, means are provided for rotating the conduits or arms through an angle of 180°. This is accomplished by providing the substantially cylindrical flanged portions 64 and 65 of the pipes 62 and 63
 110 with teeth 78 and 79 extending about the respective peripheries of the flanged portions. It is to be understood that these pipes are so mounted on the interior of the casing that they are permitted to turn about
 115 their longitudinal axes through the aforementioned teeth coacting with racks as hereinafter described. In turning, their motion is of course imparted to the conduits or
 120 arms attached to each, and the conduit or arm being thus turned, as the direction of flow of steam from the outlet 71 reverses, the conduit or arm thereby rotates in a di-
 125 rection reverse to that in which it would have operated prior to turning. The teeth 78 and 79 are adapted to coact with rods 80 and 81, respectively, which as shown more clearly in Fig. 9, are situated substantially
 130 diametrically opposite one another, being attached to an annular collar 82 which is

adapted to fit and reciprocate upon the extension 36 of the engine casing. The rods 80 and 81 project through the casing lying in suitable channels provided therefor. On the inner face of the rods are provided rows of teeth 83 and 84 respectively, which constitute racks and which coact respectively with the teeth 78 and 79 on the flanged portions 64 and 65 and upon movement of these racks the pipes and conduits or arms will be turned through 180° or any intermediate angle desired.

Each collar 82 is provided with a circular groove 85. Coacting with the groove 85 on each of the engines mounted on the left in Fig. 3 is a depending finger of an arm 86. The arm is pivotally connected at its opposite end with one end of a lever 87. Joining the lower end of lever 87 of each engine is a longitudinal rod 88 pivotally attached to the side 2 of the frame. This rod 88 is extended somewhat beyond the end 4 of the casing and to it is attached a lever 89. To the other end of lever 89 is pivotally attached a transverse rod 90. To the opposite end of rod 90 is attached a lever 91, which in turn is connected to a longitudinal rod 92 extending along and pivoted to the side 3. This rod has mounted thereon near either extremity and positioned to coact with each engine on the right in Fig. 3 a lever 93. The other end of lever 93 is attached to one end of a bell crank lever 94, the other end of which is connected to an arm 95 whose free end has a depending finger coacting with the groove 85 in each collar of the engines on the right. A handle 96 is attached to rod 90 and it will be seen that by moving the handle to the left or right the arms 86 and 95 will be correspondingly simultaneously swung to the right and left, thus through movement of racks 80 and 81 controlling the direction of rotation of the conduits or arms. It is to be understood that the handle or other means for swinging the levers may be placed in any position for convenience in an automobile, boat or other structure.

Each of the exhaust casings 13 and 14 is provided with a recessed portion 97 shown more clearly in Fig. 1, in which the racks 80 and 81 may reciprocate without striking the sides of the casing. The elongated portion 42 of the removable plug containing the nozzle also projects into this recess to such a distance that it communicates with the steam supply nozzle 98 which projects through the outer face 99 of the recessed portion of the casing. This steam supply nozzle may be adjusted toward and from the steam nozzle of the engine and is adjustably held in place by means of a set-screw 100 which passes through the wall of the recess 97 and contacts with the side of the steam supply nozzle.

The operation of the device which should be largely obvious from the foregoing description is as follows: Steam is generated in the boiler 24 passes through the pipes 31 to the steam supply nozzles 98 which are so adjusted that they are held in close contact with the engine nozzle in the removable plug 42. The steam passes into the graduated nozzle 45 gradually expanding during its passage, strikes the rear wall of the removable plug 40 by which and the faces 56 and 57 it is guided into the spur tubes 58 and 59, passing thence through the channels 70 and out through the channels 71. The reaction in the conduits or arms caused by the steam forces each conduit or arm to rotate. The speed of rotation will vary according to the steam pressure, but it has been found in practice that with a pressure of approximately 600 pounds to the square inch, 7000 revolutions per minute has been obtained. Of course the machine may be operated on various pressures above and below 600 pounds. The steam after passing from the conduits or arms into the casing passes from this casing through the pipes 28 into the reservoir 27. During the passage through the casing the steam will be largely condensed due to the large area of exposure therein. Further condensation will of course take place in the reservoir 27. From reservoir 27 the products of condensation are pumped up by means of the pump and steam again generated in the boiler, following once more the cycle of operations already outlined.

It is to be noted that there is comprised in the engine very little material which will be affected by steam at high temperatures and which is liable to consequently burn out and permit leakage thereby impairing the efficiency of the device. On the contrary there are substantially no joints on the interior of the casing requiring packing, so that the passage of the steam is throughout substantially guided by metallic connections. By providing the parts of such metals that contraction and expansion are substantially uniform throughout, no chance for leakage is provided.

Some of the advantages of the device are as follows: The device is light and compact. High horse-power may be obtained efficiently with a device that is much lighter than engines of other types given a similar rating. The machine occupies little room, requires only a small foundation or base for support and consequently is admirably adapted for use in structures which require such conditions in a power machine of this type. By providing a removable plug and removable conduits in each engine, they may be readily taken apart for repairs and if necessary new parts or parts having varying structural features may be substituted. For

example, by providing a removable nozzle in the removable plug of the engine, a nozzle having a passageway of certain proportions and taper may be substituted by one having substantially different details in this respect to correspond with the steam pressure and other variance in the operation of the device. By making the conduits or arms removable similar opportunity is provided for change or reinstalment. It is further to be noted that any given engine may be removed from its shaft in case it becomes necessary to replace the casing or some other part of the engine requiring this removal. The machine can then be either operated on three engines, or else if a spare engine be handy this may be inserted and the efficiency of the device may remain unaltered. It will thus be seen that with the advantages noted and those brought out in connection with the detailed description, a highly practical and efficient device is provided and one which achieves among others, the objects previously enumerated, completely and conclusively.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense. It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an apparatus of the character described, in combination, a frame, a horizontal shaft supported thereby intermediate its ends, a reaction engine on each end of said shaft, and means mounted on the said frame adapted to generate a fluid operating medium for said engine.

2. In an apparatus of the character described, in combination, a plurality of reaction engines, a shaft member supporting said engines, a support interposed between said engines adapted to support said member, a pump mounted to be operated from said shaft, a boiler, mounted on said support, and a reservoir adapted to apply water to said boiler and to receive products of condensation from said engines.

3. In an apparatus of the character described, in combination, a generally rectangular supporting frame, transverse shafts mounted at either end of said frame, reaction engines mounted on the ends of said

shafts, exhaust casings surrounding said reaction engines, and a boiler mounted on said frame, said boiler lying between said casings and generally below the uppermost portion of said casings.

4. In an apparatus of the character described, in combination, a generally rectangular frame, a shaft mounted at either end of said frame, a reaction engine on either end of each shaft, an exhaust casing about each reaction engine, and a boiler mounted on said framework between the reaction engines and lying generally below the uppermost part of each of said casings.

5. In an apparatus of the character described, in combination, a frame-work, a parallel shaft at either end of said frame-work projecting beyond the sides thereof, and two sets of reaction engines mounted on said shafts beyond the sides of said frame-work, each comprising a reaction arm, one of said shafts being shorter than the other of said shafts, whereby the vanes of the set of engines on the shorter shaft may rotate without contacting with the vanes of the set of engines on the longer shaft.

6. In an apparatus of the character described, in combination, a generally oblong rectangular frame-work, transverse shafts projecting beyond said frame-work and held in bearings in the side walls of said frame-work adjacent the ends thereof, reaction engines supported on said shafts outside of said frame-work, one of said shafts being of less length than the other of said shafts, whereby said engines may operate without mutual interference, and a plurality of exhaust casings about said engines, one of said casings lying between another of said casings and the adjacent side walls.

7. In an apparatus of the character described, in combination, a frame-work for support, reaction engines mounted thereon, exhaust casings mounted about said engines extending above and below said frame-work, a boiler mounted above said frame-work and between said casings, a reservoir mounted below said frame-work and between said casings, a pump mounted on said frame-work, piping leading from said boiler to said engines, piping leading from said casings to said reservoir, piping leading from said reservoir to said pump, and piping leading from said pump to said boiler.

8. A reaction engine comprising a casing providing inlet and discharge ports, a conduit situated within one of said discharge ports, said conduit being provided with screw-threads, and a reaction conduit provided with screw-threads and attached thereby to said first mentioned conduit.

9. A reaction engine comprising a casing provided with an inlet and discharge port, a pipe member having a flanged end abutting the interior of the casing about one of

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said ports, said pipe being provided on one end with a screw-threaded portion, and a reaction arm provided at its lower portion with an enlarged base having a screw-threaded portion adapted to coact with said screw-threaded portion on said pipe member to thereby hold said reaction arm in position.

10 A reaction engine comprising a casing provided with an orifice, a pipe having a flanged portion abutting the orifice, and a reaction arm providing a discharge port extending coaxially of said pipe, said reaction arm having a retaining member adapted to engage a corresponding retaining member on said pipe to hold said reaction arm in position.

11. A reaction engine comprising a casing provided with inlet and outlet orifices, a pipe having a flange on one end and a screw-threaded portion on the other end abutting the casing about the outlet orifice, and a reaction arm extending co-axially of the pipe, said reaction arm having a screw-threaded portion adapted to engage said screw-threaded portion on said pipe to hold said reaction arm in position.

12. A reaction engine comprising a casing having a substantially cylindrical chamber therein provided with inlet and discharge ports, a pipe having a flanged end abutting the interior of the casing about the discharge port, said pipe being provided on the end opposite the flanged end with a screw-threaded portion, and a reaction arm having a channel extending co-axially with the passageway formed by said pipe, said reaction arm being provided at its lower portion with a substantially cylindrical base provided with an internally screw-threaded recessed portion adapted to coact with the threaded portion of said pipe to thereby hold said reaction arm in position.

13. A reaction engine comprising a casing having inlet and discharge ports, a reaction member connected with one of said ports, and a removable nozzle seated in one of said ports.

14. A reaction engine comprising a casing provided with inlet and discharge ports, reaction members situated in said discharge ports, and a removable nozzle situated in said inlet port, said nozzle being provided with means on the periphery thereof co-acting with said casing to hold said nozzle in operative position with respect to said casing.

15. A reaction engine comprising a rotatable casing having inlet and discharge ports a substantially cylindrical plug in one of said ports provided with a passageway for fluid therein, said plug having an internally screw-threaded portion, and a nozzle having an externally screw-threaded portion adapted to coact with said internally

screw-threaded portion to hold said nozzle in position in said plug.

16. A reaction engine comprising a casing provided with an inlet port and two diametrically disposed discharge outlets, pipes provided with flanges at one end adapted to project through said discharge outlets to a point exteriorly of said casing and held in place by the abutment of their flange portions with the interior of the casing, and reaction arms attached to said pipes.

17. A reaction engine comprising a substantially cylindrical plug provided with a longitudinal passageway and a plurality of communicating transverse passageways, a casing providing a substantially cylindrical chamber adapted to receive and hold said plug, discharge outlets in said casing, and conduits projecting through said discharge outlets and communicating with the transverse passageways in said plug, said conduits being removable from said casing.

18. A reaction engine comprising a substantially cylindrical plug provided with a longitudinal passageway and a plurality of communicating transverse passageways, said casing providing a substantially cylindrical chamber adapted to receive and hold said plug, discharge outlets in said casing, and pipes having a flanged portion on one end and a screw-threaded portion on the opposite end projecting through said discharge outlets and communicating with the transverse passageways in said plug, said pipes being removable from said casing, and flattened reaction arms each provided with a substantially cylindrical collar having an internally screw-threaded recess, said recess being adapted to coact with the screw-threaded portion of one of said pipes to thereby hold said reaction arms in position.

19. A reaction engine comprising a casing having two separable sections, providing a substantially cylindrical inner chamber and inlet and discharge ports leading thereinto, reaction members in said discharge ports, a removable plug member fitting said chamber and held therein, said plug being provided with a longitudinal passageway, a nozzle member occupying said passageway, said plug being provided with screw-threads adapted to engage screw-threads on said nozzle, said nozzle being provided with a tapered longitudinal passageway, and means on said nozzle to permit engagement thereof for removal, said plug member being provided with a shoulder adapted to abut the casing about said orifice to hold said plug member in position.

20. A fluid operated reaction engine comprising a casing, discharge orifices in said casing, spur-tubes projecting through said orifices from the interior of said casing, recesses in said casing, pipes having flanged ends seated in said recesses, said pipes pro-

jecting through said discharge orifices and inclosing said spur-tubes, reaction arms having discharge orifices, attached to said pipes, and a cylindrical plug having passageways adapted to provide communication with the exterior of said casing to admit a fluid operating medium and to guide said operating medium to said spur-tubes, said spur-tubes being adapted to guide said medium to said pipes and reaction arms, and said vanes being adapted to discharge said medium.

21. A reaction engine comprising a casing providing a substantially cylindrical chamber having inlet and discharge ports, a detachable conduit held within said chamber, and a removable plug provided with a nozzle, said plug being adapted to aid the retention of said conduit in position.

22. A reaction engine comprising a casing having inlet and discharge ports, a rotatable reaction arm in one of said ports adapted to reverse the direction of said engine upon rotation, and a removable plug in another of said ports provided with a nozzle portion providing a seat for said reaction arm.

23. In an apparatus of the character described, in combination, a reaction engine comprising a casing, said casing being provided with inlet and discharge outlets, a plurality of pipes projecting through said discharge outlets, said pipes being provided with an enlarged portion at one end, said enlarged portion being provided with teeth, reaction arms attached to said pipes, and racks projecting into said casing adapted to coact with said teeth to thereby rotate said reaction arms.

24. A reaction engine comprising a casing having inlet and discharge ports, a removable plug in one of said ports, said removable plug being provided with an elongated portion, and a nozzle situated in said elongated portion.

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

LYMAN E. WARREN.

Witnesses:

AUGUST ANDERSON,
J. HARRY CONDON.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."