E. RECTOR.

STEAM MOTOR GENERATOR.

APPLICATION FILED APR. 19, 1916.

1,309,102.

Patented July 8, 1919.

4 SHEETS—SHEET 1.

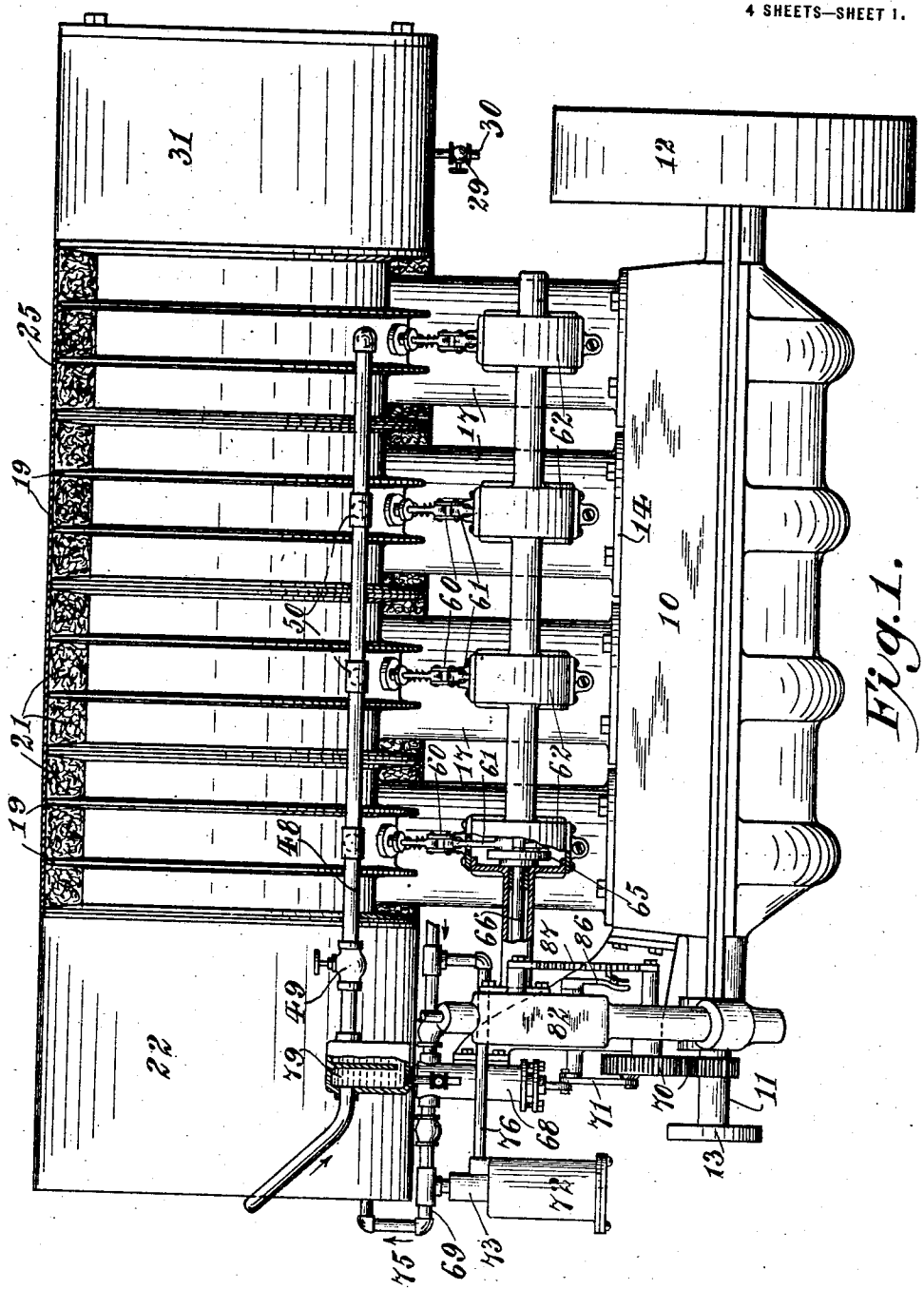


Fig. 1.

INVENTOR

Enoch Rector

BY Johnson & Owen

ATTORNEY

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4 SHEETS—SHEET 2.

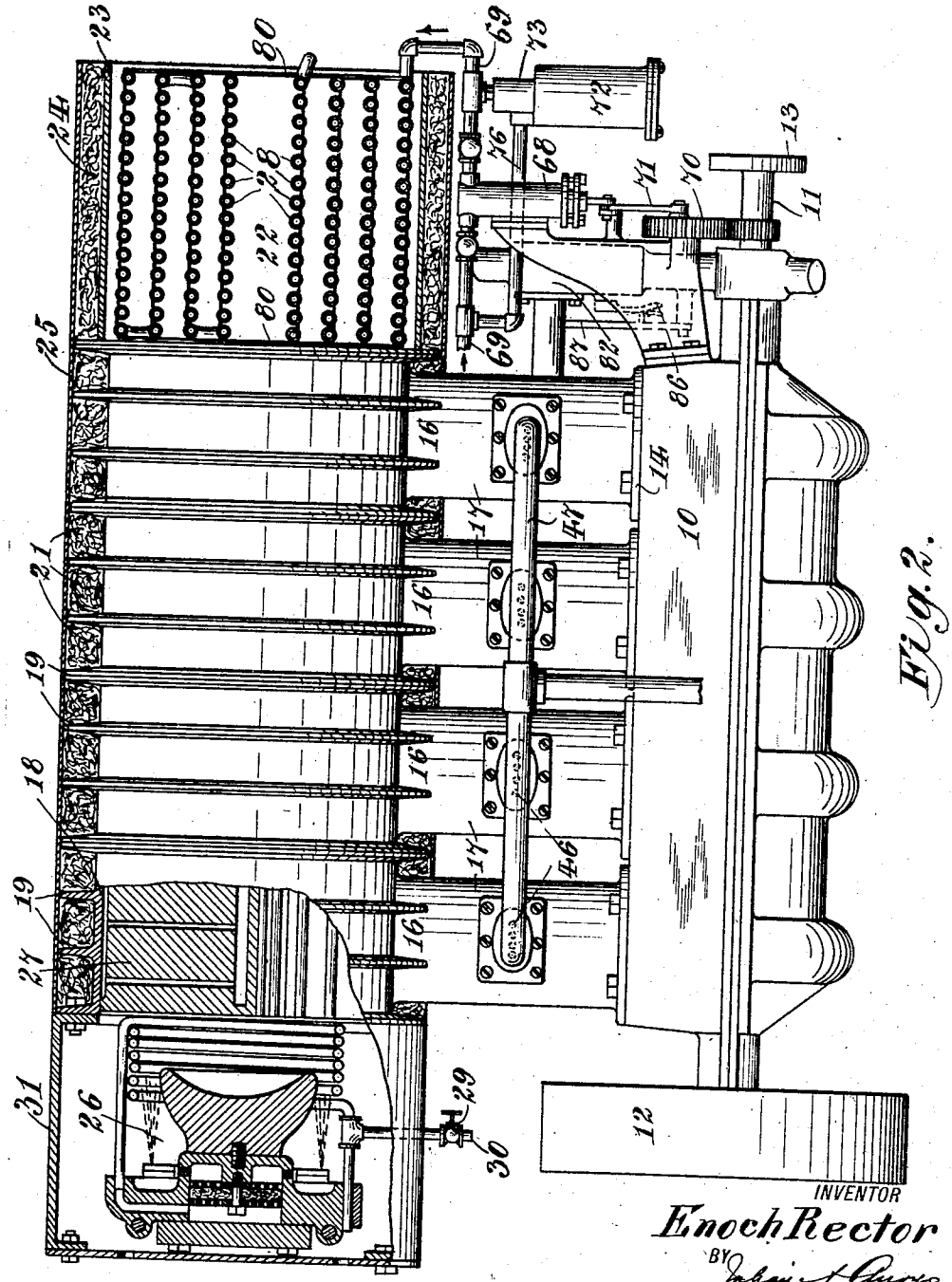


Fig. 2.

INVENTOR

Enoch Rector

BY Johan A. Burgess

ATTORNEY

THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

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4 SHEETS—SHEET 3.

Fig. 3.

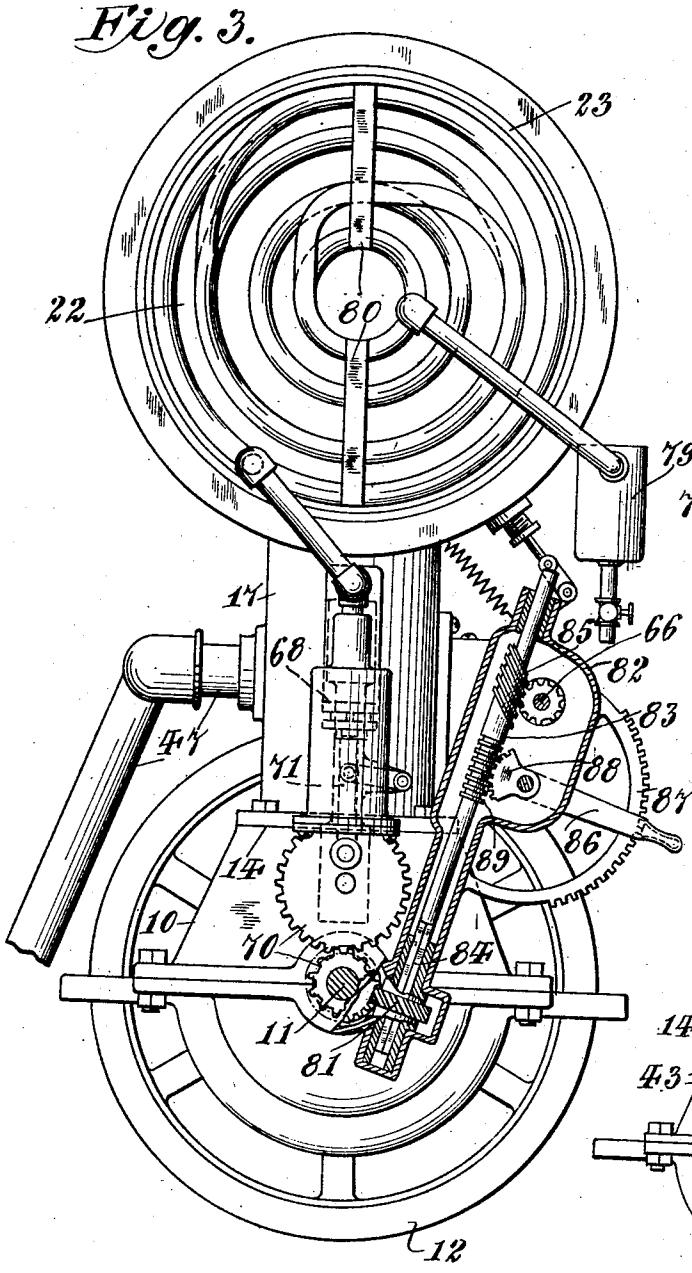


Fig. 6.

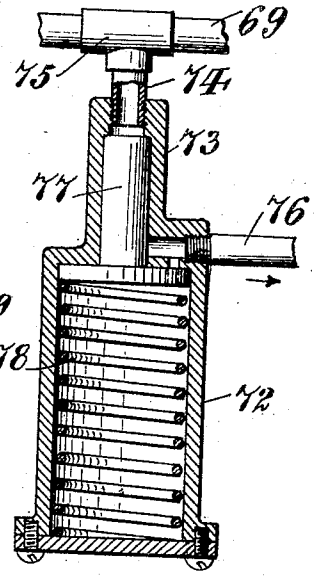
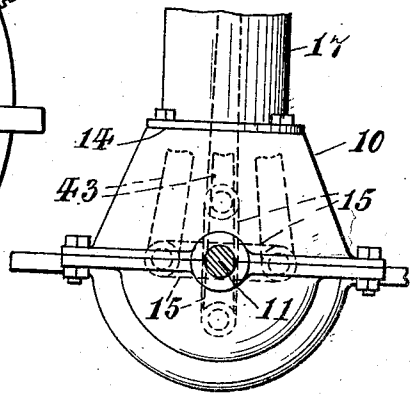


Fig. 7.



INVENTOR.

Enoch Rector

BY Julian A. Mayo

ATTORNEY

THE COLUMBIA PLANOGRAPH CO., WASHINGTON, D. C.

E. RECTOR.

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4 SHEETS—SHEET 4.

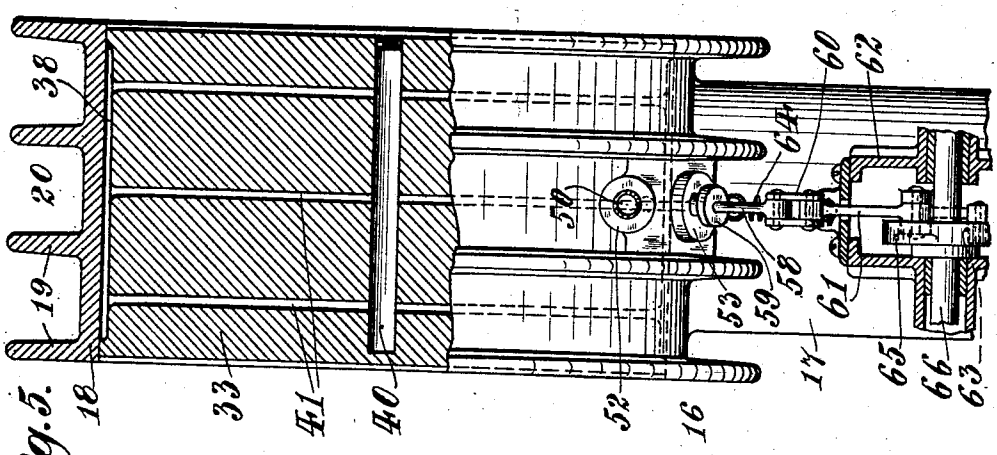


Fig. 5.

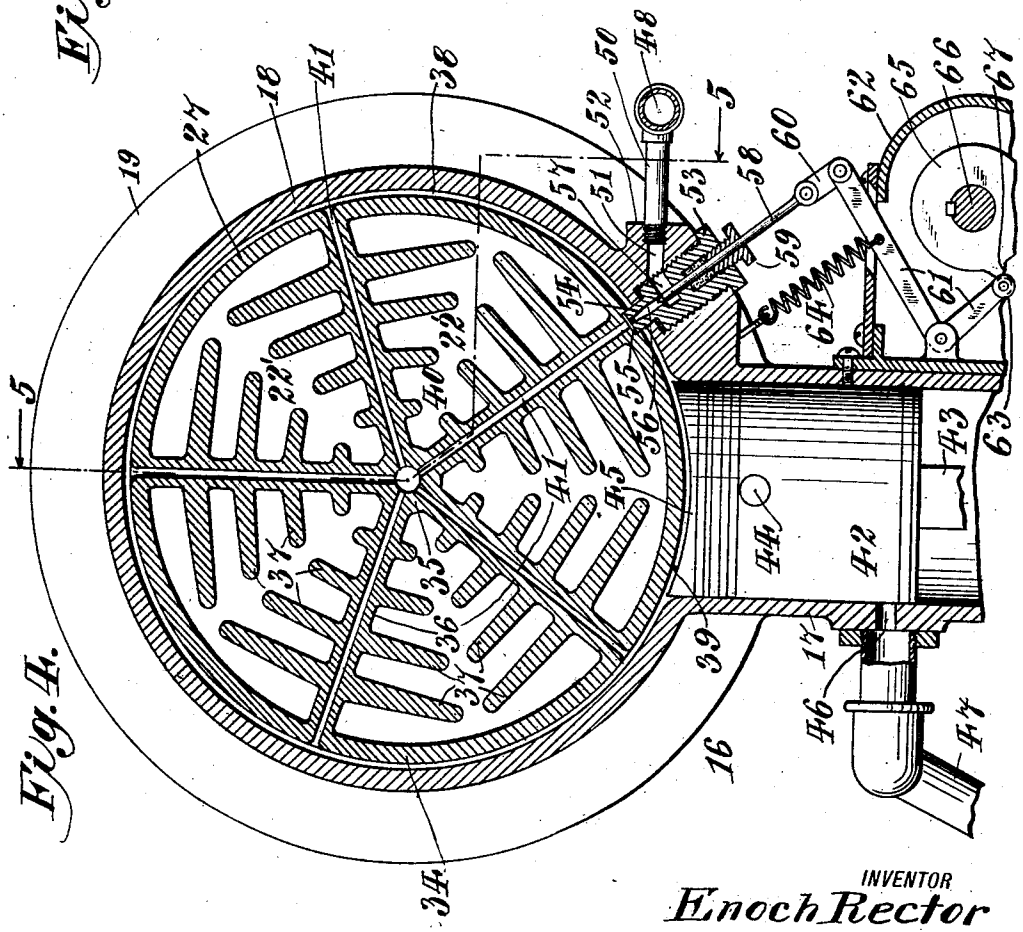


Fig. 4.

INVENTOR

Enoch Rector

BY John A. Clarke

ATTORNEY

UNITED STATES PATENT OFFICE.

ENOCH RECTOR, OF NEW YORK, N. Y.

STEAM-MOTOR GENERATOR.

1,309,102. Specification of Letters Patent. Patented July 8, 1919.

Application filed April 19, 1916. Serial No. 92,114.

To all whom it may concern:

Be it known that I, ENOCH RECTOR, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Steam-Motor Generators, of which the following is a specification.

My invention relates to improvements in that type of steam engines, in which a limited charge of water is fed periodically to the head of the cylinder and there converted into steam of sufficient propelling power to move the piston on its working stroke and for the purpose of this disclosure the device will be identified as a steam motor generator.

One of the objects of my invention is to perfect devices of the above type so as to provide a steam engine of high efficiency compared with such devices now known and which at the same time will be simple in construction and economical in its consumption of water and fuel.

Another object of the invention is to provide a simple form of engine free of any steam controlling valves and promptly responsive to a sensitive control for varying the working capacity of the engine.

As an incident to the economical actuation of the device, the invention contemplates an engine designed to provide a steam clearance of very small volume compared to the area of heating surface facing the small volume space and compared to the massive heat retaining bodies supplying the heating surfaces.

Further it is desired to provide a construction arranged so that the water charge supplied at each actuation of the piston is distributed promptly to all parts of the extensive heating surface present.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form of mechanism embodying my invention, and the invention also consists in certain new and novel features of constructions and combination of parts hereinafter set forth and claimed.

Referring to the accompanying drawings:

Figure 1 is a view in side elevation of a preferred embodiment of my invention with parts broken away to show internal construction;

Fig. 2 is a view similar to Fig. 1 showing the reverse side of the device;

Fig. 3 is an end view of the device taken at the left of Fig. 1 and with the control mechanism casing shown in section;

Fig. 4 is a vertical transverse sectional view taken axially of one of the cylinders;

Fig. 5 is a longitudinal sectional view taken on the irregular line 5—5 of Fig. 4 and looking in the direction indicated by the arrows;

Fig. 6 is a vertical sectional view taken axially through the equalizer; and

Fig. 7 is an end view of the crank casing showing in dash lines the relative positions of the piston rods.

In the following description and in the claim, parts will be identified by specific names for convenience of expression but they are intended to be as generic in their application to similar parts as the art will permit.

For the purpose of this disclosure the invention as shown in connection with the base portion of a standard form of horizontal type, four cylinder, two cycle engine in order to demonstrate the adaptability of the novel features to conventional structures now on the market. This base portion includes a long crank casing 10 in which is journaled the crank shaft 11 which projects beyond opposite ends of the casing. A flywheel 12 is fixed to one end of the shaft and some suitable driving connection 13 is fixed to the other end. The top plate 14 of the casing is provided with four longitudinally spaced openings therethrough, each communicating with the lower end of one of the cylinders hereinafter described. The shaft 11 is provided with four cranks 15, as shown in dash lines in Fig. 7, and each crank extends from the shaft at 90° from the next adjacent crank and is keyed thereto below one of the top openings so that a crank is below each cylinder, all as is usual with known types of steam engines. The superstructure mounted on the base thus described is designed to form an embodiment of my invention particularly adapted for installation in connection with a variable load machine, such as the power plant of a self-propelled vehicle and it is in connection with this particular use that the invention will be described. The central portion of the superstructure includes four combined cylinder and boiler units 16, one for each

crank mounted on the top plate. As these units are similar in construction, a detailed description of one will be sufficient for all. Each unit comprises a single casting, the lower portion of which constitutes a vertically disposed cylinder 17 the lower end of which is flanged and bolted to the casing. The upper portion of each unit is in the form of a cylindrical drum 18 with its axis horizontally disposed and arranged so that the drums are disposed end to end in a battery to form a sectional grid-containing-casing open at opposite ends. The drums are designed so that normally the adjacent ends are spaced apart slightly and thus prevent distortion when subjected to heat expansion. The wall forming the drum is relatively thin, as shown in Figs. 4 and 5, but this is reinforced by longitudinally spaced flanges 19 extending outwardly therefrom and having a mass sufficient to resist distorting internal pressures on the wall of the drum. These flanges serve to provide annular pockets 20, each designed to accommodate a section of an asbestos or similar heat insulating covering 21.

A preheater or economizer 22 for the water supplied to the engine is mounted at one end and forms a continuation of the battery of drums 18. The economizer includes a water coil containing shell 23 encircled by an asbestos jacket 24. The drums, together with their asbestos sections and the economizer jackets are inclosed within a cylindrical inclosing shell 25 preferably of thin sheet metal and not intentionally designed to resist strains.

The end of the drums opposite the economizer is provided with a burner 26 designed to supply the requisite amount of heat to the grids 27 within the drums and to the water coils 28 in the economizer. While any conventional form of burner may be used preferably a gas or oil burner is utilized due to the ease with which such burners are controlled and for this purpose a valve 29 for controlling the fuel supplied to the burner is positioned in the supply line 30 and conveniently accessible to the operator, but for the purpose of this disclosure there is shown a burner such as is described in my co-pending application, Serial No. 58,225, filed Oct. 27, 1915. The burner shown is mounted within a casing 31 demountably affixed to the adjacent drum and opened directly to the heat passageways 22′ in the grids hereinafter described. Each drum is provided with a flat cylindrical cellular and preferably malleable iron casting 33 fitted therein preferably by shrinking the same in position with a frictionally tight fit. This casting constitutes a heat absorbing, retaining and dispensing grid and is designed to provide a relatively large heat absorbing surface compared to the volume of the heating space to which the surface is exposed. The grid is wheel-shaped in form having a wide peripheral band 34 substantially the width of the containing drum, a hub portion 35 and a plurality of radially disposed plates 36 integrally connecting the hub portion with the band, and coacting to form a plurality of longitudinally extending heat conducting passageways 22′ opening from the burner and opening to the water coils 28 in the economizer. Opposite sides of each plate are provided with longitudinally extending flanges 37 projecting into the passageways 22′ and designed to receive the major portion of the heat therefrom as it passes from the burner. Each grid is cast and drilled to form a plurality of small volume spaces open to each other and coactively designed to provide a steam generating chamber of small capacity. The outer periphery of the band 34 is recessed between its end faces to form an inclosed steam collecting passageway 38 between the grid and its correlated drum. As shown in Fig. 4 this passageway increases slightly in cross-section in both directions about the grid from the point most remote from the cylinder to the steam inlet end 39 of the cylinder thereby to provide a steam passageway to the cylinder of gradually increasing space but with the least possible steam clearance necessary to effect the free movement of the formed steam supplied along the length of this collecting passageway.

As shown in Fig. 5 the center of the hub portion 25 is provided with a long cylindrical water receiving chamber 40 of small volume compared with the heating surface formed by the wall outlining the chamber and this chamber is connected to the passageway 38 by means of a plurality of small steam generating spaces and conduits 41 extending centrally through the width of the plates 36. A piston 42 is mounted for reciprocating movement in the cylinder 17 and is connected with the crank therebelow by means of a piston rod 43 pivoted to the piston pin 44. In order to reduce the steam clearance, the working head 45 of the piston is recessed to conform substantially to the configuration of the adjacent face of the grid so that when the piston is at the beginning of its working stroke, the head 45 is close to the grid. The steam containing space in the grid is relatively small compared with the space in the cylinder vacated by the piston when it has completed its moving stroke. In the engine illustrated the steam space is about eight per cent. of the piston-traveled space and this has been found to give the requisite cushioning effect to the piston on its return stroke with the least loss of power. The side of the cylinder is provided with an exhaust port 46 designed to open through the piping system

47 either to the atmosphere, to a condenser or to a low pressure chamber as is usual with devices of this character. The port is controlled directly by the piston and is so proportioned and positioned relative to the final position of the piston on its working stroke that any desired proportion of the expanded steam is free to pass from the cylinder and a definite amount of the steam is trapped by the piston closing the port on its returning stroke. Water is supplied to the steam generating space of each drum at each actuation of the piston thereof in quantities not in excess of the amount, which can be turned into steam by the heat present. The most efficient quantity supplied is usually ascertained by calculation or experiment under the different working conditions of the device and the water controlling valves set to deliver the requisite amount of water at each opening of the valves. For this purpose a main supply pipe 48 extends along the length of the drums and the flow therethrough is controlled by a manually actuated valve 49 positioned convenient to the operator. Branch supply pipes 50 lead from the main pipe to water inlet ports 51 in enlargements 52 projecting from the side of each drum as shown in Fig. 4. An ejecting nozzle 53 in the form of a plug is screwed into each enlargement from the outside and has its outlet nose 54 reduced and positioned in a recess 55 formed in the band 34 in line with one of the radical conduits 41. The nose end of the nozzle has an axially disposed discharge bore 56 reduced to frusto-conical form toward the outlet end positioned in the recess. The receiving end of the discharge bore is connected by a laterally extending passageway 57 with the inlet port 51. A valve in the form of a pointed plunger rod 58 extends through a packing box 59 in the outer end of the plug and is designed to fit in and close the frusto-conical end of the discharge bore and thus intercept the passage of water to the steam generating space in the grid. The outer end of the valve is connected by means of a link 60 with one arm of a bell crank lever 61 pivoted within a cam shaft casing 62 fixed to the side of the engine cylinder as shown in Fig. 1. The other arm of the lever is provided with a roller 63 which is held by means of a spring 64 in engagement with a peripheral cam 65 mounted on a cam shaft 66. Each cam is provided with tripping lugs 67 designed to engage the roller to rock the lever and thus snap open the valve thereby to admit a charge of water to the steam generating space at each complete revolution of the cam shaft.

As the piston on its return stroke compresses the steam remaining in the steam generating space it is necessary to force the water into this space when the valve 58 is opened with a pressure greater than any possible steam pressure present in the space. For this purpose a pump 68 is positioned in the line of pipe 48, preferably in advance of the control valve 49 and preferably in that portion of the pipe which may be identified as the cold water supply pipe 69. The pump is actuated conveniently from the crank shaft through the gearing 70 and crank movement 71.

It is preferred that the pump have a capacity to supply the steam generating spaces under all conditions of service and to return any surplus water to the system. This is attained automatically in the device illustrated by means of an equalizer 72 (see Fig. 6) positioned in the pipe line 69 in advance of the pump. The equalizer is in the form of a cylinder having a reduced head 73 opening through the lateral bell 74 of a T 75, constituting part of the cold water supply pipe 69. A by-pass pipe 76 leads from the side of the equalizer back to the pipe 69 and around the pump. Communication between the pipes 69 and 76 is normally intercepted by a plunger valve 77 held in close position by a high tension spring 78 contained within the equalizer.

A trap 79 is positioned in the line of pipe 48 preferably between the pump and valve 49 so as to remove sediment from the water before it is ejected into the several steam generating spaces.

While it is obvious that cold or merely hot water may be fed to the generating space the most efficient operation of the device illustrated depends upon the use of heated water possibly at a temperature of four or five hundred degrees Fahrenheit so that in this disclosure the term water may be understood to mean the saturated water vapor usually present under the heavy pressure conditions at these high temperatures. The water is heated conveniently from the heat supplied by the burners and which is not absorbed by the grids. For this purpose the pipe 48 includes the heating coil 28 contained in the line between the equalizer and the trap. This coil is conveniently arranged in concentric spaced layers and is mounted in a frame 80 positioned within the shell 23 and coacting to form the economizer 22.

The cam shaft is actuated from the crank shaft in a manner to provide a simple means for advancing the time at which the valve 58 opens relative to the position of the piston in the cylinder and thus reverse the engine. As shown in Fig. 3 one of the gears 70 constantly meshes with a helical gear 81 rotatably mounted in a reversing mechanism containing casing 82. A connecting shaft 83 is mounted for both rotary and longitudinal movement in the casing and a portion 84 thereof is squared so as to slide in the gear 81 while driven by the same. The shaft 83

is connected to the cam shaft through a helical pinion driving connection 85. The shaft is shifted longitudinally by means of a lever 86 pivoted to the casing and designed to be locked temporarily on a notched wheel 87. The end of the lever opposite the handle end is in the form of a toothed segment 88 forming a rack and pinion connection between the connecting shaft and the lever 86.

In operation, and with the burner active, the grids quickly becomes heated even to incandescence. The heat passing about the coil 28 raises the temperature of the water thereon to any desired or safe degree and with such devices a pressure of 1000 lbs. has been found to be quite efficient for general working conditions. By regulating the fuel control valve 29, the activity of the burner may be varied and the heat not absorbed by the grids passes into the superheater, so that the valve 29 controls the temperature of the water passed from the coil 28. The pressure thus formed in the coil reacts on the equalizer, tends to compress the spring 78 thus placing the water system under tension. The equalizer also acts as a safety valve, opening the superheated water back to the cold water supply through the by-pass pipe 76 when the pressure in the coil becomes excessive for any reason.

The control valve 49 is then opened slightly admitting a charge of this superheated water to whichever one of the cylinders should happen to have its valve 57 in open position. Should the engine have stopped in a "dead" position with all the valves 57 closed, then the operator shifts the lever 84 in one or the other of its directions of movement depending on whether a direct or reverse driving of the engine is desired. This will have the effect of rotating the cam shaft and thus manually open one of the valves 57.

The charge of water will be shot along the conduit in line with the open nozzle, into the chamber 40 and into the conduits leading therefrom to the collecting passageway 38. This small volume of water, coming in contact with the high temperature and large-heat-capacity grid will be quickly turned into steam if not already in this state and in each case will cause the charge to intensify its expansive force. As the clearance in the device illustrated is but eleven or twelve cubic inches in contact with over eight square feet of heating surface it will be apparent that the hot grids will deliver a large amount of heat to each unit of water present. This high power steam moves out of the conduits into the passageway 38 which increases in clearance to the piston. The steam acts on the piston to move the same on its working stroke as is usual with devices of this character except that with this device it is possible to time the working of the piston so that the charge is admitted as the piston reaches the end of its compression stroke. The formation of the steam and its delivery to the piston head is so rapid that the device will turn over even without a fly-wheel. In this device the piston has a five inch head and a four and one-half inch stroke so that there is an expansion of about 10 volumes permitted to the mass of high pressure steam present before the exhaust port is opened.

This movement of one of the pistons rotates the crank shaft and through the connecting shaft 85, the cam shaft is rotated to open the valve to the next cylinder in order. This action is continued, a charge of water being ejected into each cylinder as its piston has about reached the end of its compression stroke. As the engine begins to actuate, the pump 68 acts on the water supply to force the water through the coils and to sustain the water under a tension sufficient to cause it to fill promptly any free space in the steam generating space. After the engine has started the lever 88 is moved back to its initial position, when displaced therefrom so as to insure the introduction of the water charge to the grid at the proper position of the piston. The device works most efficiently when a steam under high temperature is supplied to the piston.

Should the work required of the engine increase it is merely necessary to open the valve 49 a little more thereby to admit a greater volume of water in each charge. A greater mass of water is converted into steam under these conditions with perhaps not as high temperature but as the burner is usually supplying heat in quantities sufficient to convert any amount of water present into steam, there is effected a variable control promptly responsive to any sudden demand for more power. The relatively large volumes of water supplied under these conditions may tend to consume some of the reserve heat in the grids and the active steam may gradually become "cold". In this case it is merely necessary to open up the burner and cause a more active generation of heat to supply the grids and maintain the high temperature desired about the heating coils. When the necessity for this excessive power has passed both the burner and water supply may be reset to their normal efficient working conditions.

As the piston reaches the end of its working stroke it uncovers the exhaust port 46 permitting the steam present back of the piston to exhaust through the port and reduce to whatever may be the pressure conditions in the piping system 47. On its return stroke the piston closes the port and acts on the trapped steam to compress the

same. As the clearance is small compared with the space in the cylinder passed over by the piston, there is a material compression of the steam possibly to about one-tenth of its expanded volume, which action generates heat in the grid thus tending to compensate for the cooling effect of the expanding steam on the grid. Maintaining the grid continually in a hot condition substantially prevents any reduction in temperature of the water supplied to the grid and thus uses the heat supplied directly from the burner solely to raise the temperature of this steam-water. Should it be desired to reverse the direction of movement of the crank shaft and thus reverse the engine, the lever 86 is shifted so as to change the lead of the valve opening movements relative to the positions of the pistons in their cylinders.

By means of a device of this character it is possible to provide a flash boiler type of engine which will not only turn over the piston but which will actually run the engine economically. In order to operate an engine of this character I have found it essential to have a powerful charge of steam generated almost instantaneously and promptly utilized to do its mechanical work. Accordingly, such a device must be able to supply a large amount of heat suddenly to the water charge but the steam generating and receiving space must be small otherwise a part of the steam generated would be utilized merely to fill dead space without doing work. Further the generated steam must have a clear passageway to the piston head even at the beginning of its working stroke and should be subjected to an intense heating even up to the place where it passes into the piston cylinder otherwise some cooling effect will be introduced.

Another problem solved in the device disclosed is to design the steam clearance so that there is provided not only a steam cushion for the piston on its compression stroke but an arrangement for concentrating the heat of compression into a small volume of trapped steam from the previous charge and thus maintain a high normal temperature to the steam generating chamber.

Again, with the object in view of supplying economically the highest possible temperature of steam to the piston head, the feed water is heated and even vaporized before it is passed onto the hot plates in the boiler so that the boiler heat is used not entirely for generating steam but rather to give the superheated mixture of steam-charged-water a final, sudden and intense heating just before it is delivered to the piston cylinder and thus supply heat energy at the point where it is most capable of performing mechanical work. In other words the coil preheater 22 may supply the necessary heat to the water therein so that when the water or combined steam and water in this preheater is open to the grid device there will be sufficient heat present to flash the water into steam if it is not already in this condition. In this case the grid devices must be considered as superheaters and their function under these conditions is entirely that of highly superheating the steam in its passage to the engine cylinders.

It is not to be assumed that the water is pumped directly into the steam generating space for it is apparent that no known type of reciprocating pump would be capable of forcing a small amount of water into the space under some condition of service, as where the feed water from the heater is at a temperature of as high as 500° F. Rather it is to be assumed that the water is shot under its own resiliency to flood the free space in the chamber.

While I have shown and described, and have pointed out in the annexed claim, certain novel features of my invention, it will be understood that various omissions, substitutions and changes in the form and details of the device illustrated and contained within the scope of the claim and in its operation may be made by those skilled in the art without departing from the spirit of the invention.

Having thus described my invention, I claim:

In a device of the class described, a flash boiler including a grid, wheel shaped in form, having a wide peripheral band, a hub portion and a plurality of radially disposed plates connecting the hub portions with the band, said plates and rim coacting to form a plurality of heat conducting passageways therethrough and said grid provided with a steam generating chamber designed to be supplied with heat from said passageways, a cylinder opening directly from the band of said grid and supplied from said chamber, a piston mounted for reciprocatory movement in said cylinder, the end of said piston adjacent the grid being shaped to conform to the configuration of the adjacent face of the grid thereby tending to reduce the clearance between the piston and grid when the piston is at the beginning of its working stroke.

Signed at New York city, in the county of New York, and State of New York, this 17" day of April, A. D. 1916.

ENOCH RECTOR.

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