No. 864,183. PATENTED AUG. 27, 1907.

E. P. NOYES.

CONTINUOUS COMBUSTION APPARATUS.

APPLICATION FILED OCT. 9, 1905.

4 SHEETS—SHEET 1.

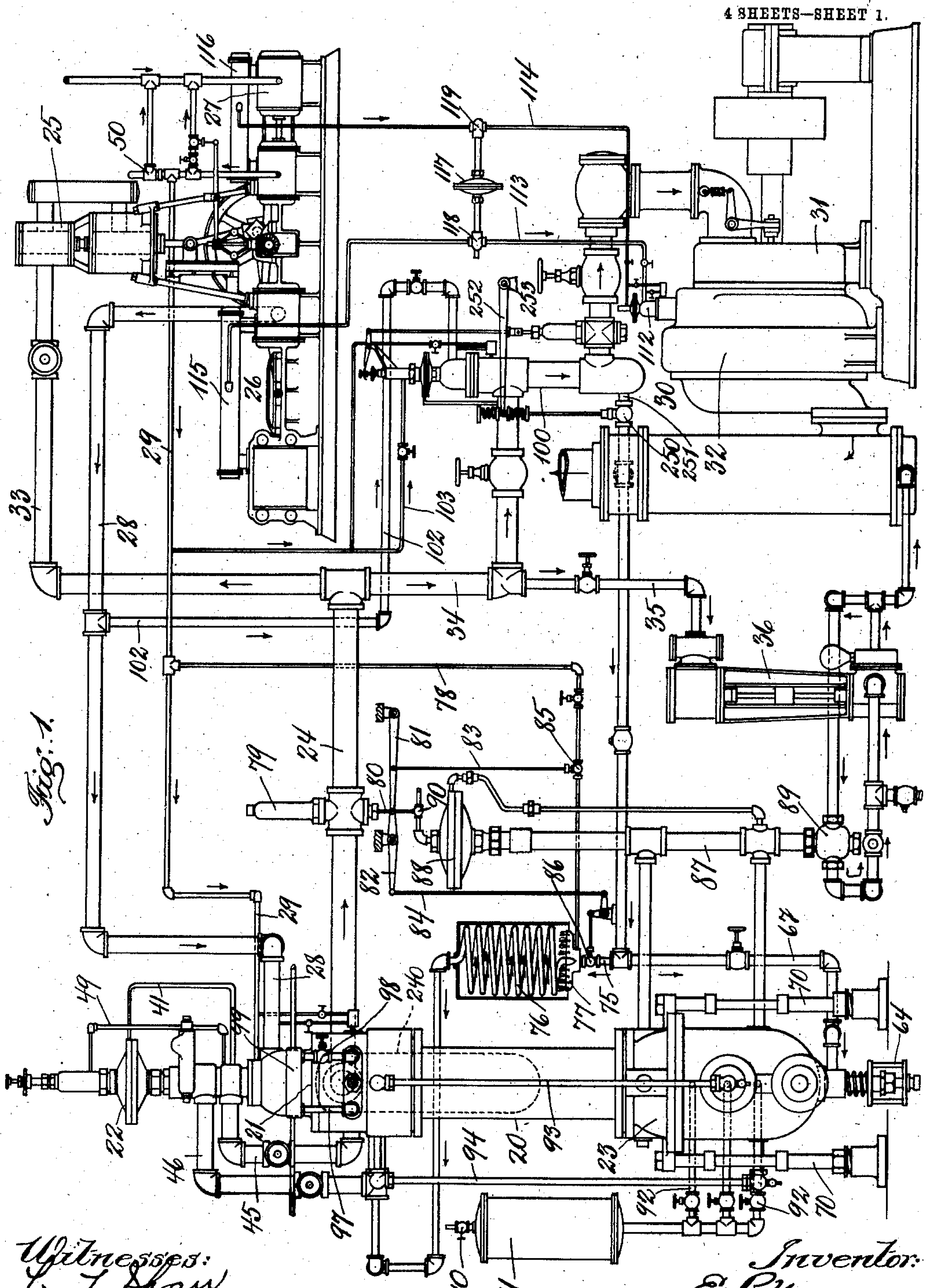

Fig. 1.

Witnesses:
L. T. Shaw
M. A. Moder

Inventor:
Ed. P. Noyes
by Bentley & Pierson
Att'ys.

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4 SHEETS—SHEET 2.

Fig. 2.

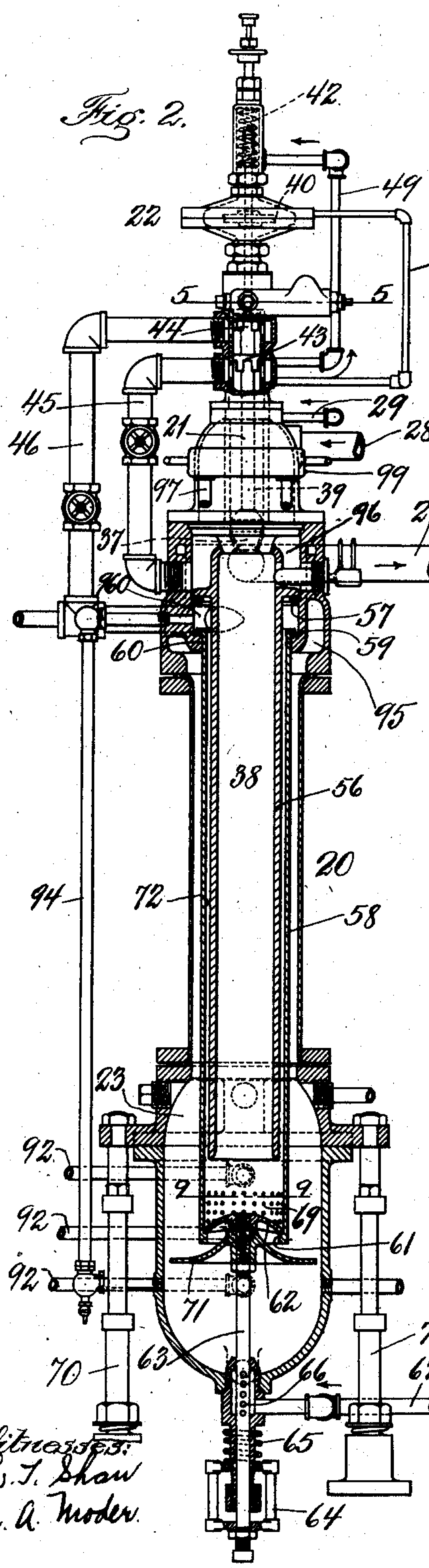
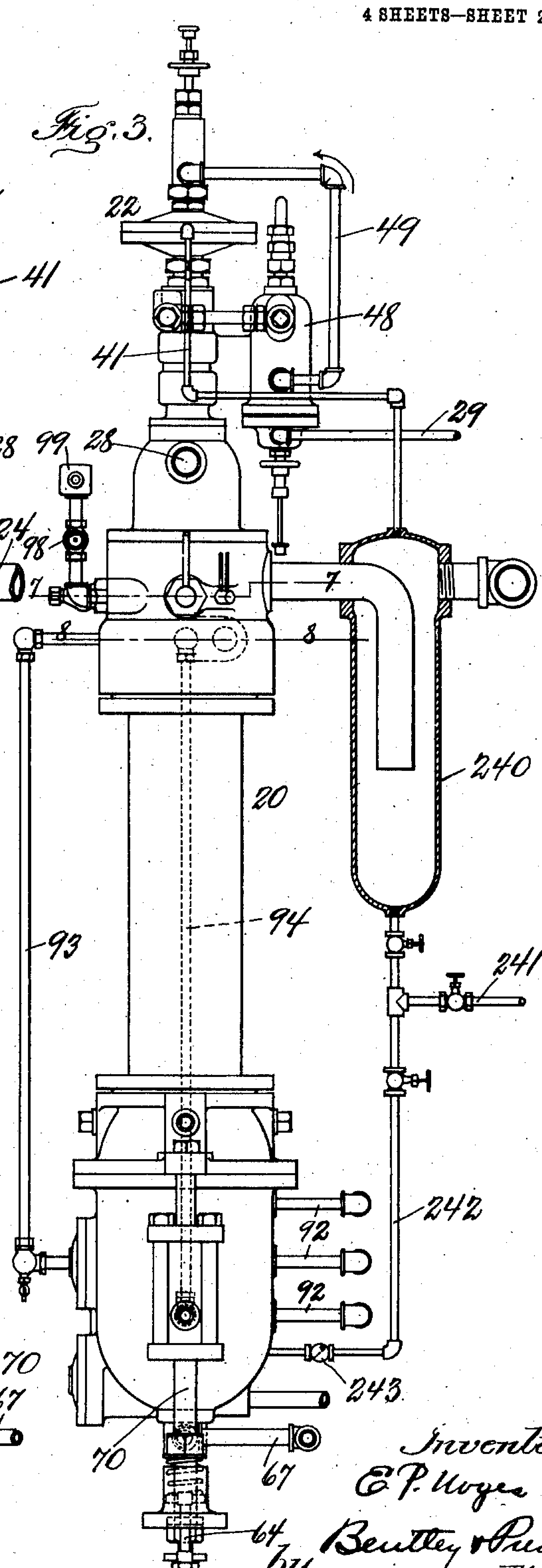



Fig. 3.

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L. T. Shaw
M. A. Moder

Inventor:
E. P. Noyes
by Bentley & Prim
Atty's.

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4 SHEETS—SHEET 3.

Fig. 13.

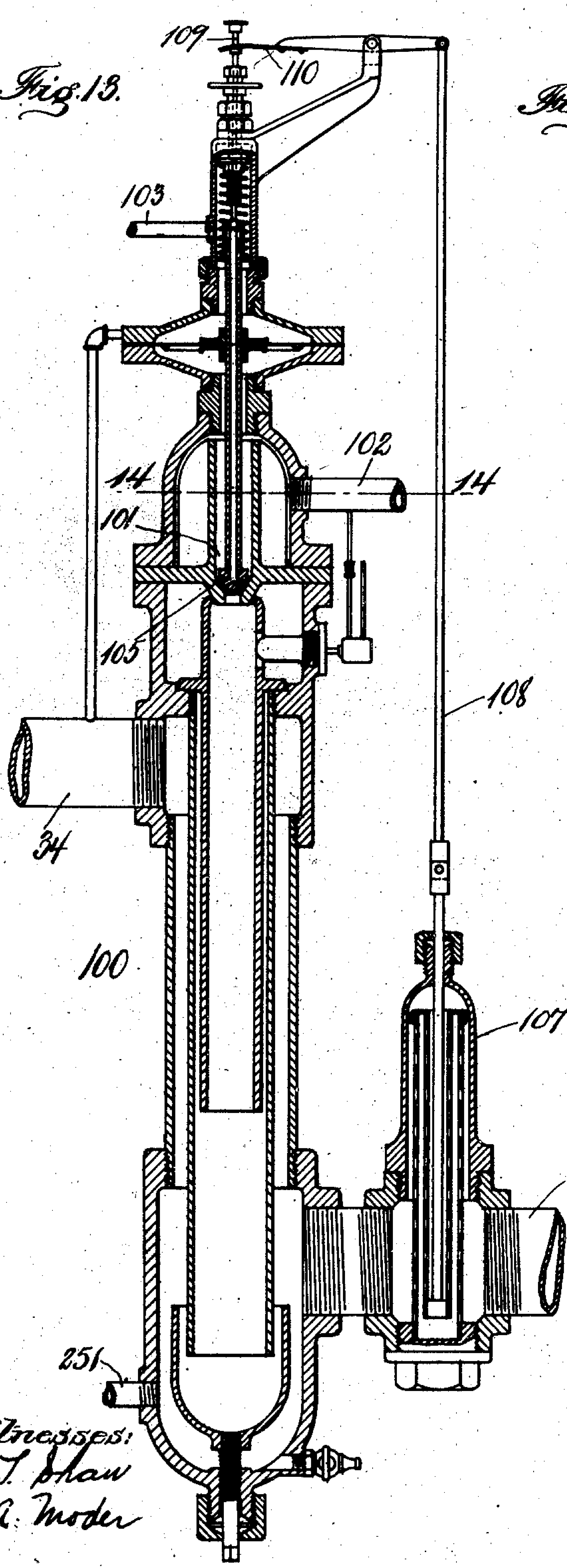



Fig. 14.

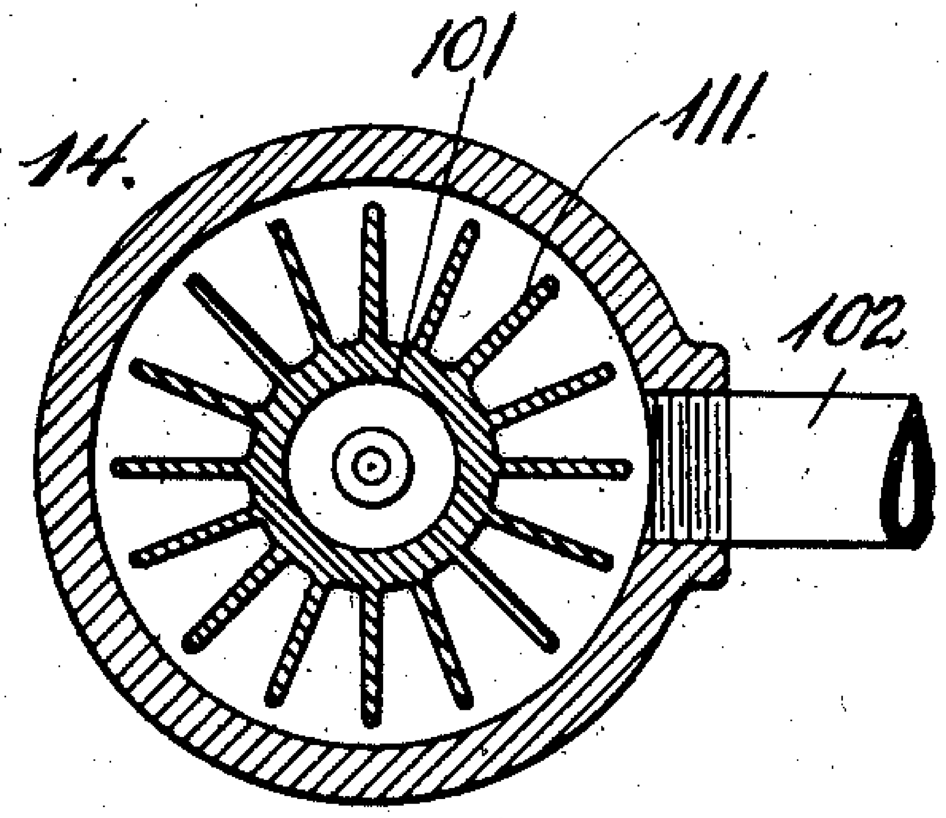



Fig. 15.

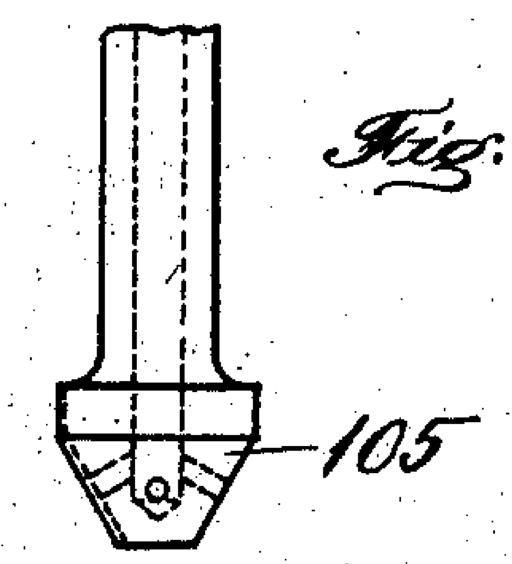



Fig. 16.

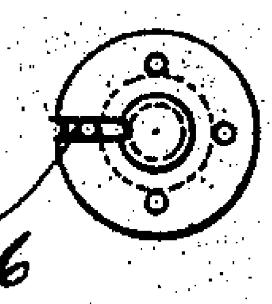
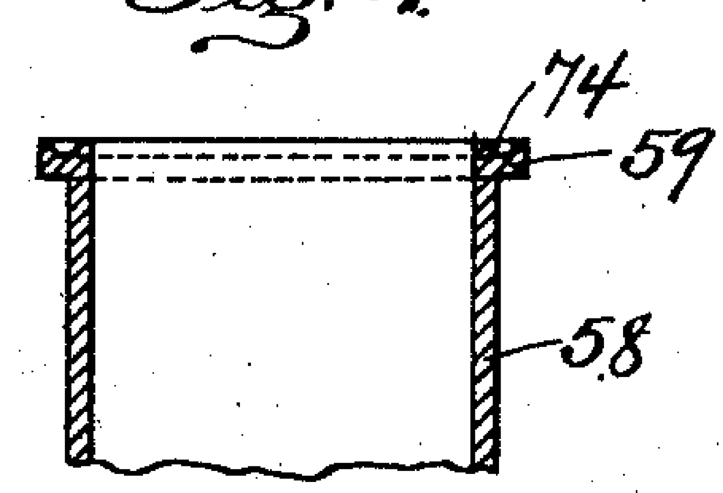



Fig. 4.

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M. A. Moder

Inventor:
E. P. Noyes
by Bentley & Pierson
Att'ys.

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4 SHEETS—SHEET 4.

Fig. 5.

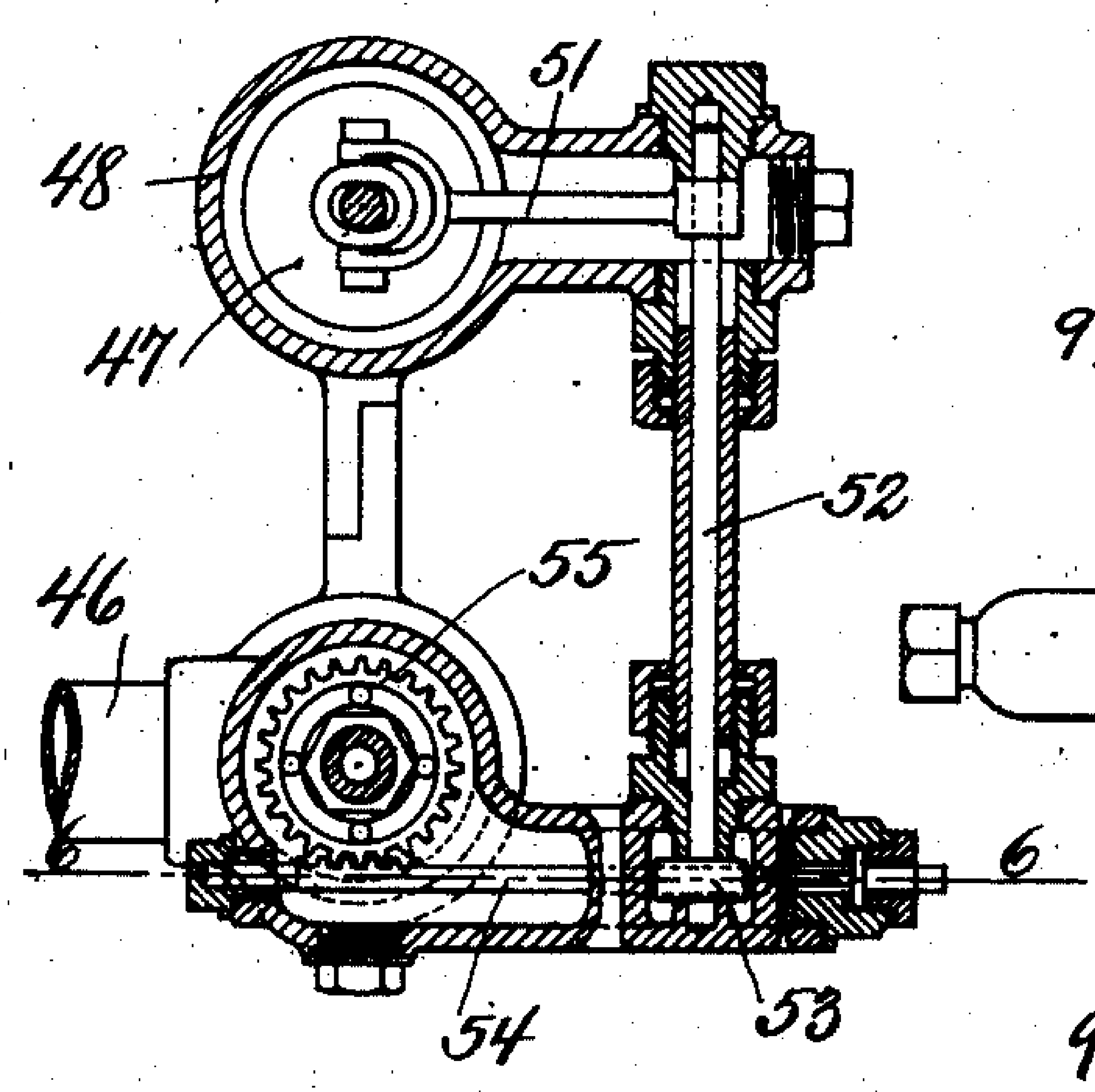



Fig. 7.

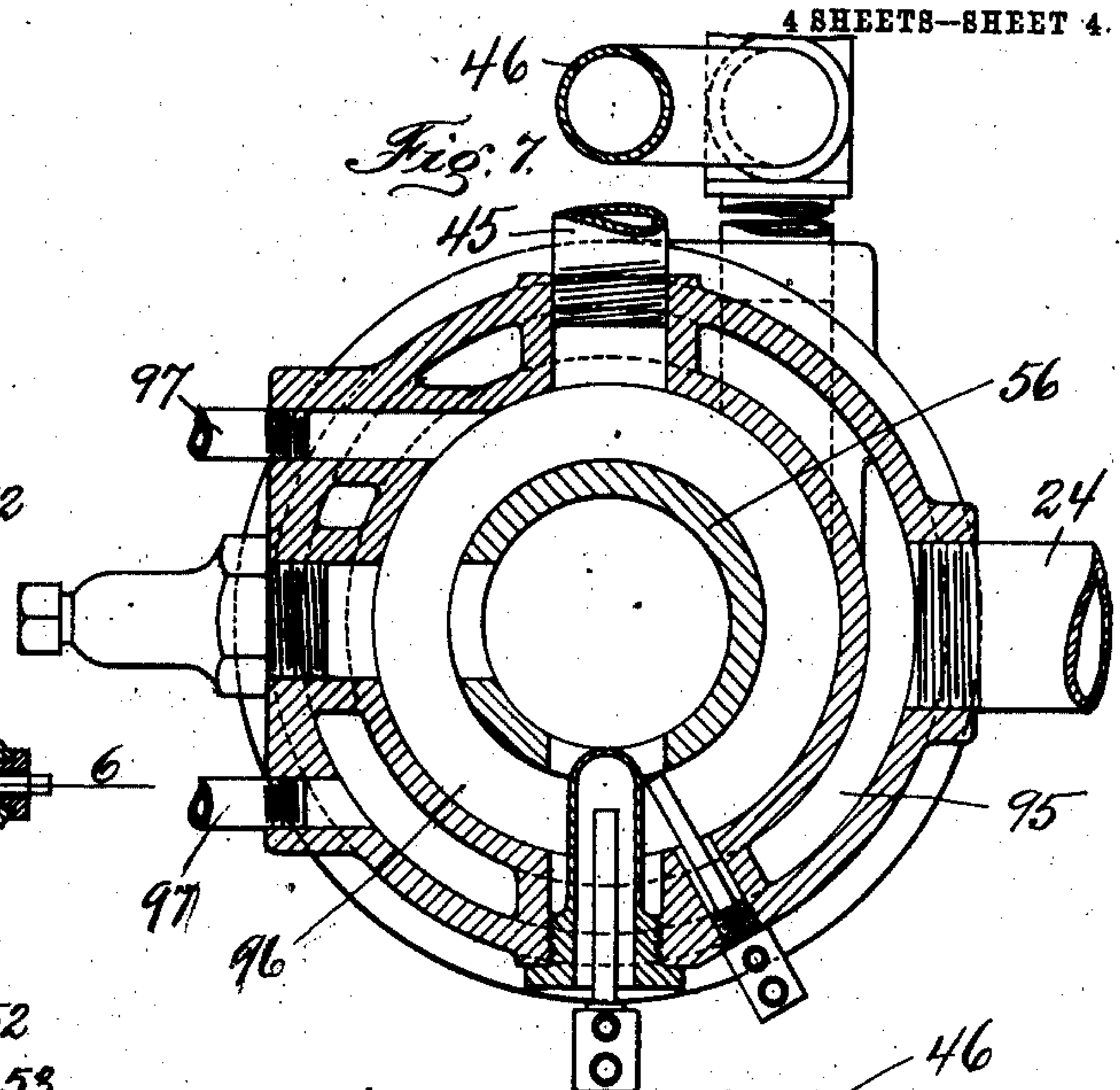



Fig. 6.

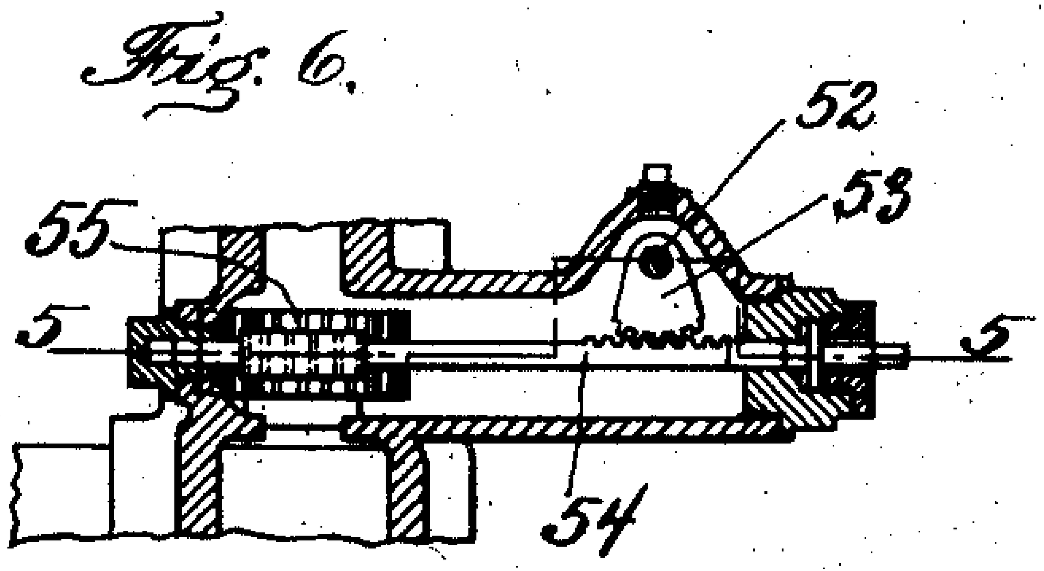



Fig. 8.

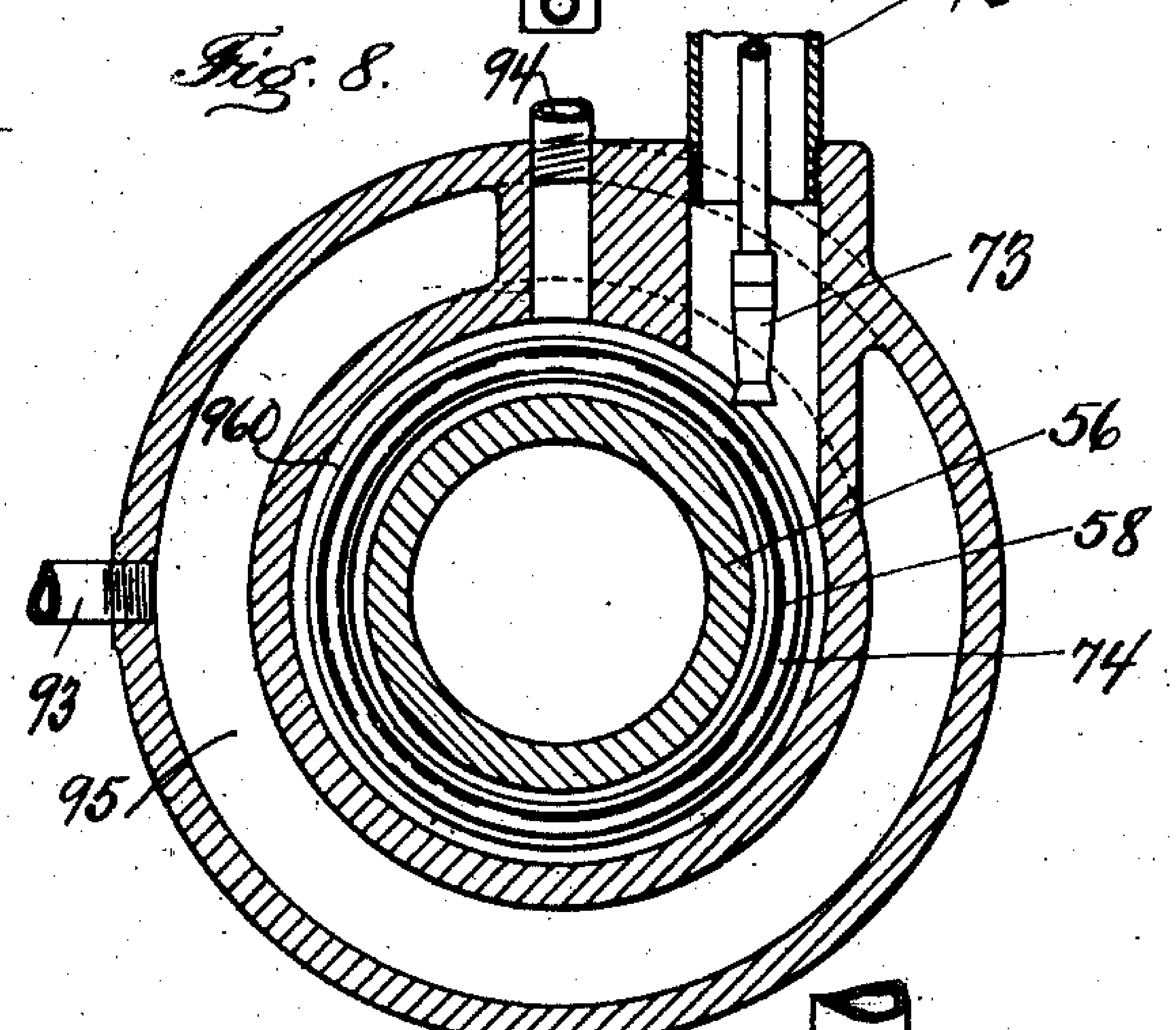



Fig. 9.

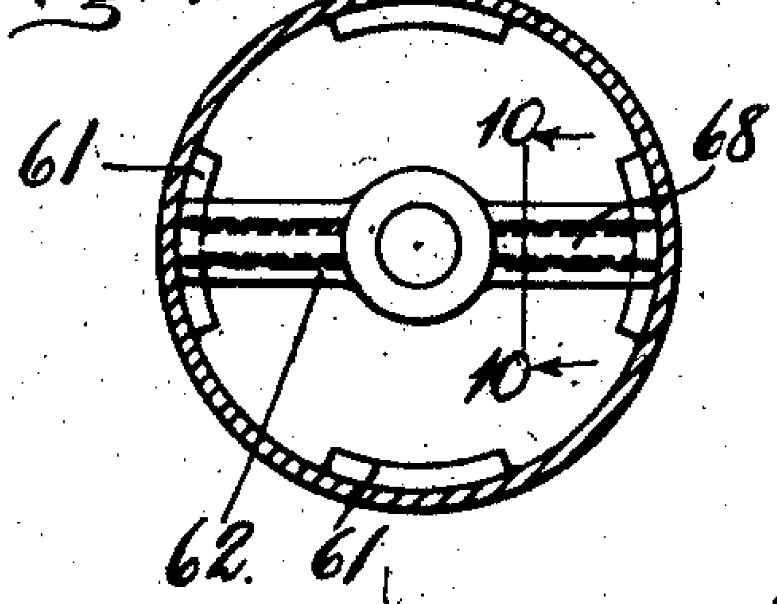



Fig. 12.

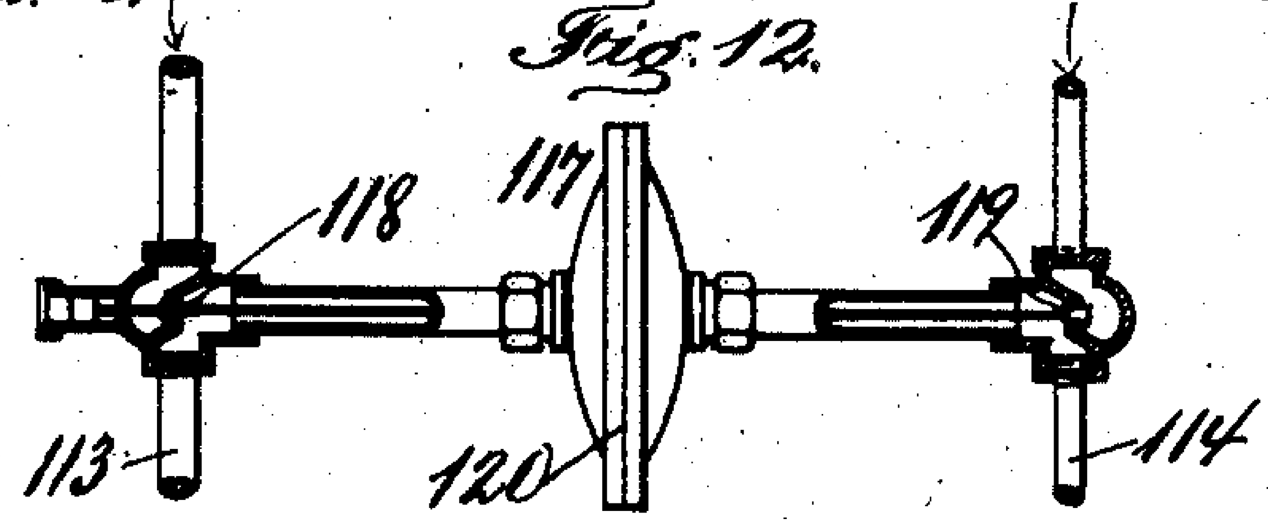
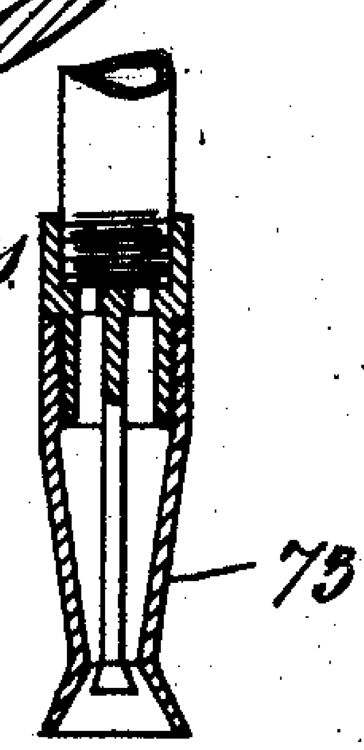



Fig. 11.



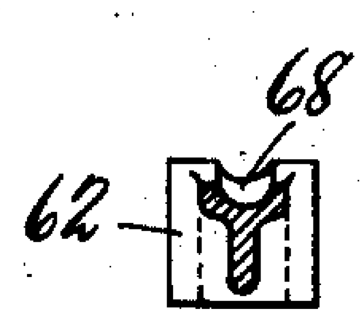




Fig. 10.

Witnesses:
L. S. Shaw
M. A. Moder

Inventor:
E. P. Noyes
by Bentley & Pierson
Atty's.

# UNITED STATES PATENT OFFICE.

EDWARD P. NOYES, OF WINCHESTER, MASSACHUSETTS.

## CONTINUOUS COMBUSTION APPARATUS.

**No. 864,183.** **Specification of Letters Patent.** **Patented Aug. 27, 1907.**

Application filed October 9, 1905. Serial No. 281,934.

*To all whom it may concern:*

Be it known that I, EDWARD P. NOYES, a citizen of the United States, residing at Winchester, in the county of Middlesex and State of Massachusetts, have invented certain new and useful Improvements in Continuous Combustion Generating and Controlling Apparatus, of which the following specification and accompanying drawings illustrate the invention in a form which I now regard as the best out of the various forms in which it may be embodied.

This invention relates to apparatus for driving a motor by continuous combustion under constant pressure with an internal-combustion burner located at a suitable point anterior to the motor.

In Patents Numbers 588,178 and 588,293 granted to Sidney A. Reeve, and in various joint and several applications of said Reeve and myself, including copending applications filed by me Serial Nos. 736,588 and 275,861, is described a system of this general character including an internal continuous-combustion constant-pressure generator having a pool of water vaporized by the products of combustion to create a body of mixed steam and gases which passes to the engine and operates the latter.

The present invention deals especially with the construction of a novel form of generator for such systems and with the novel regulation and control of combustion and superheating both within the generator and at a distant point nearer to the motor, or in the course of the fluid passing through the motor.

Referring to the drawings, Figure 1 represents a diagrammatic elevation of continuous-combustion apparatus embodying my invention, Fig. 2 represents a vertical section of the generator, Fig. 3 represents a side elevation thereof, partly in section, looking at right-angles to Fig. 2, Fig. 4 represents a section of the upper end of the combustion-tube, Fig. 5 represents a section on the line 5—5 of Fig. 2, Fig. 6 represents a section on the line 6—6 of Fig. 5, Figs. 7 and 8 represent sections on the lines 7—7 and 8—8 of Fig. 3, Fig. 9 represents a section on the line 9—9 of Fig. 2, Fig. 10 represents a section on the line 10—10 of Fig. 9, Fig. 11 represents an axial section of the water-spray nozzle in the generator, Fig. 12 represents a view partly in section of the pressure-balance mechanism for the reheating burner, Fig. 13 represents a vertical section of the distant superheating burner, Fig. 14 represents a section on the line 14—14 of Fig. 13, Figs. 15 and 16 represent details of the cone-valve in said superheater.

The same reference characters indicate the same parts in all the views.

In the drawings 20 indicates a constant-pressure generator having a burner 21 and regulating valve-mechanism 22 at the upper end and a water-pot or cooling chamber 23 at the lower end. The engine or motor receives a motive fluid composed of steam and products of combustion through a trunk-pipe 24. The motor is shown in two forms, viz: First, a compound reciprocating engine 25 driving a two-stage reciprocating air-compressor 26 and a two-stage reciprocating gas-compressor 27 which supply compressed air and gas to the generator 20 through an air-pipe 28 and a gas-pipe 29, and secondly, a compound turbine 30 having a high-pressure department 31 and a low-pressure department 32, the two engines being supplied in parallel through the branch pipes 33 34. A branch 35 also leads to the motor-cylinder of a pump 36 for supplying feed-water under pressure to the generator 20.

The burner-head 21 has a cone-valve 37 which controls the flow of compressed gas and primary compressed air into the combustion-chamber 38 of generator 20 and is attached at the lower end of a valve-stem 39 connected with a diaphragm 40. On its upper side this diaphragm receives the final or terminal pressure of the generator through a pipe 41, and the pressure of a spring 42 in aid of said terminal pressure, and on its lower side said diaphragm receives the initial pressure of the compressed air from pipe 28. On the valve-stem 39 are also located valves 43 44, the former of which controls a supply of secondary air going to the outside of the flame through a pipe 45 and the latter of which controls a supply of by-pass air which obtains entrance into the combustion-tube as hereinafter described by way of a pipe 46.

The structure 22, including diaphragm 40 and its attached valves, and termed the "initial-terminal" or I-T valve, is more fully described in my aforesaid applications Serial Nos. 736,588 and 275,861.

The vertical movement of the valve-stem 39 produces a variation in the orifices for the flow of air and gas which maintains the resistance at a substantially constant point during variations in the volume of flow of said fluids. Valves 43 44 are also adapted for rotatory movement upon the stem 39, which changes the relation between the primary and by-pass orifices to correspond with a variation in the flow of gas to the burner but does not change the total air-orifice. Before reaching the burner the gas-supply passes a floating meter piston 47 (Fig. 5) in a casing 48 and reaches the interior of valve-stem 39 through a pipe 49. Gas above a predetermined pressure is released back to the gas-compressor suction through a loaded valve 50. The piston 47 connects with the two valves 43 44 through an arm 51, rock-shaft 52, pinion-segment 53 and rack 54 engaging a gear 55 formed on the valve-sleeve. According as more gas is released past valve 50 and less burner-gas is measured by piston 47, the by-pass valve 44 opens and the burner valve 43 closes, sending a proportionately less quantity of air to the burner, the total resistance, however, being unvaried by rotation of valves 43 44. This action is described more in detail in my application Serial No. 275,861, and the present mechanism just described differs therefrom principally in the improved means shown in Figs. 5 and 6 for transmitting motion from the meter piston to the rotary air valves. The combustion space 38 is immediately inclosed by a removable and renewable liner 56 into whose upper end the nose of the burner-head projects. This liner is supported upon a ledge 57 in the upper chamber of the main generator body, and it extends downwardly through the major part of the length of the combustion-tube 58, the lower end of the latter being within the cooling chamber 23 and normally immersed by the water therein.

It has in practice been a matter of difficulty to make a proper and durable joint between the combustion-tube 58 and the upper body of the generator casing. In the present instance I provide a very simple and efficient joint at this point which will prevent leakage between the interior of the combustion-chamber and the slightly lower pressure outside of said chamber and will at the same time permit renewals of the combustion-tube, by forming a flange 59 on the upper end of said tube, resting this flange on a ledge 60 on the upper casting, and attaching the lower end of the combustion-tube to the lower wall of the water-pot 23 with a yielding connection which allows for the unequal expansion of the combustion-tube and the outer wall of the generator. Tube 58 is formed with lugs 61 (seen clearly in Fig. 9) engaged by the head 62 of a key-bolt or stay 63 which passes through the bottom of the water-pot. On the outside is an adjustable head or yoke 64 engaged by a downwardly-pressing spring 65. The bolt stem is hollow and perforated at 66 to form a continuation of the feed-water conduit 67 which supplies the cooling chamber. The upper face of the key-bolt head is grooved at 68 (Figs. 9 and 10) to guide the overflow and insure the cooling of said head when the water-level is below it and also to distribute the water in a film over the unimmersed interior surfaces in order to promote evaporation during the downward hot flow. The lower end of the tube 58 is formed with perforations 69 for the exit of products of combustion and any steam into the cooling chamber.

71 is a conical baffle attached to the stem of key-bolt 63 for directing the water circulation and forming a quiescent space in the lower part of the water-pot.

Spring standards 70 support the intermediate portion of the generator casing, and the water-pot 23 is bolted to said intermediate portion independently of said standards in order that the water-pot may be removed without disturbing the upper part of the generator.

Between the combustion-tube 58 and its liner 56 is an annular space 72 into which the by-pass air from pipe 46 enters and passing downwardly joins the main flow of products of combustion just above the surface of the water. It is important to note that this by-pass air may aid in completing combustion or it may be an excess supply which becomes heated and expanded by the hot products of the completed main combustion, according to the height of the lower end of 56, distribution of flows, etc. In passing through the annular passage 72 this air absorbs heat from the surface of liner 56 and serves to protect the latter and also the combustion-tube 58. The steam in the motive mixture passing upwardly from the cooling chamber 23 becomes more or less superheated by contact with the outside of the combustion-tube and by by-passing unquenched through the upper row of perforations, and the amount of superheat may be adjusted by varying the water-level in the cooling chamber.

A further aid to the protection of burner parts and the suppression of excessive temperatures is by a water-spray (in which term I also include a jet or spray of steam or mixed water and steam) delivered through a nozzle 73 (Figs. 8 and 11) against the outside of the liner 56 at about the hottest part thereof. Just below said nozzle the upper edge of the combustion-tube 58 is grooved at 74 to catch any drip from said nozzle and distribute it uniformly around the edge of the tube for overflow into the interior of said tube. This jet is supplied by a branch 75 from the feed-pipe 67 and passes through a heating coil 76 heated by an atmospheric gas-burner 77 which is fed under throttle through a pipe 78 from the gas-conduit 29. A preheating of the jet-water is thus afforded and if desired the water may be vaporized before introduction to the by-pass air-space. A thermostat 79 in the generator delivery-pipe 24 is connected through rod 80, levers 81 82, and rods 83 84 with valves 85 86 in the gas-line and the water-line respectively of the heater 76, so that as engine-flow becomes hotter the water-flow to nozzle 73 will become cooler. By maintaining the water delivered by said nozzle alternately above and below the vaporizing point a very powerful influence is provided for the control of temperatures and superheat in the generator. I may if desired control temperatures entirely by means of this water flow and dispense with a pool in the water-pot 23.

Water-level is automatically controlled within the cooling chamber 23 by a level-controller 87 having a diaphragm 88 acting on a pump by-pass valve 89. Normal generator pressure is constantly on the lower side of said diaphragm, and on the upper side thereof the pressure is varied by the covering or uncovering of the inlet to the upper diaphragm-chamber by the rising and falling water. When said inlet is covered a minute leakage past a valve 90 reduces the pressure in said upper diaphragm-chamber and enables the diaphragm 88 to rise and open the by-pass 89. Should leakage-valve 90 be wholly closed it is evident that the water-level will rise within the generator, resulting in the evaporation of more water and the diminution of superheat. Hence by attaching the stem of valve 90 to the stem 80 of the thermostat 79 I am enabled to control the water-level and vary the superheat automatically in accordance with the temperature of the generator output. The valve 90 is placed as high as any part of the release pipe approaching it, so that neither water of condensation nor uplifted water can lodge back of it. Hence when the valve is opened by the thermostat, it begins to perform its office immediately.

For emergencies there is provided a reservoir 91 of water which opens through alternative inlets 92 into the cooling-chamber 23 and is provided with a vent 910 whereby any trapped air or gases may be released or piped off to some lower pressure chamber at will. So long as the inlet is covered the water stays in the reservoir 91, and when uncovered the reservoir is vented and its contents discharged into the cooling chamber.

The downward passage of combustion gases around the lower end of the combustion-tube 58 and through its perforations causes the water-level to be depressed in the said tube and raised on the outside thereof. I provide for observing the two different levels by means of two gage-glasses 93 94 (Figs. 1, 2, 3 and 8) both of whose lower ends connect with the cooling chamber 23 while their upper ends connect respectively with the chamber 95 outside the combustion-tube and the chamber 960 within said tube. Should there be no substantial leaks in the combustion-tube or through its joint with the ledge 60 the two gage-glasses will show different water-levels inside and outside the tube. For the purpose of detecting leaks and for judging as to the volume of combustion-flow, I connect together chamber 95 outside the combustion-tube and chamber 96 communicating with its interior, by means of a loop 97 in which is placed a by-pass valve 98. When a leak is suspected the generator may be shut down, the water-level therein raised as high as desired and the pressures within and without the combustion tube equalized by opening valve 98. The latter is then closed and a gentle air-pressure admitted to the space within said tube. This will depress the water in the tube, and if a leak is encountered the water will cease to fall and by observing the interior-level glass 94 the exact location of the leak will have been determined. Loop 97 98 is also provided with a water jacket 99. By opening valve 98 a by-passed hot flow is at once established into the engine bound gases, its temperature however being controlled by said water jacket. Glass 94 may be similarly used when the generator is running to show the water-level within the combustion-tube as contrasted with the water-level within the cooling chamber and thus indicate the volume of the hot flow which is passing out from the combustion-tube.

Where the engine is located at a considerable distance from the generator it may be desirable to transfer a part of the superheating operation to a point near the motor, and for this purpose I have shown an internal-combustion superheater 100 in the branch supply-pipe 34 leading to the turbine motor, and which embodies a burner 101 supplied with compressed air and gas from the conduits 28 and 29 through branches 102 103 and controlled by an **I-T** valve-mechanism similar to the valve-mechanism 22. The burner valve 105 has a small groove 106 cut in its face for maintaining a flame when said valve is closed. The burner 101 imparts a suitable superheat to the engine-bound fluid and is under the control of a thermostat 107 in the pipe 34 between superheater and motor, the rod 108 of said thermostat being connected with the stem 109 of the burner valve 105 through a spring-arm 110 whereby the differential of the **I-T** valve is increased upon a predetermined increase in the temperature of the engine-bound fluid, which results in a smaller measure of flow, for the instant, through conduits 102 and 103. The burner 101 has external fins 111 in the paths of the entering air for preheating the air-supply and cooling the parts exposed to flame heat.

The combination of main and auxiliary internal combustion generators shown in Fig. 1 at 20 and 100 has certain special advantages. Generator 20 is primarily an evaporator and secondarily a superheater. Generator 100 is primarily a superheater and secondarily it may be an evaporator, if occasion requires. For evaporation in 20 a cooling chamber area should preferably be provided sufficient for permitting the easy liberation of gases from the water, this area being far greater than that necessary for the flow of these gases after they have separated. (The proportions in the drawings are not intended to be exact). Providing it, makes the generator pot large, and constriction of its area results in the lifting of a fine spray or fog, which spray may be measurably evaporated in the generator by means of baffle-plates such as are shown in my application Serial No. 275,861, or the spray may pass over with the superheating gases and be gradually evaporated during its journey through the engine pipe or through the engine. A feature noted in practice is that, when this spray or fog passes over with the engine flow, a thermometer at the generator does not take cognizance of it but records simply the temperature of the gases and the already-evaporated steam. Then, the fog experiencing evaporation during its journey, the superheat temperature is sensibly abated thereby and this is shown by a markedly lower reading on a thermometer placed near the engine inlet.

Now it would be practicable to make the pot of generator 20 so small as to increase, to any degree desired, this spraying effect. Such a spray, without any superheating burner 100, would be simply a disadvantage; but with a subsequent superheating device competent to bring back temperatures to the desired level at the point of use, the spraying action in a small first generator is of a superior character, for it occurs coincidentally with the presence of a pool capable of dominating temperatures beyond question for all sizes of fire. In this respect such a pool-spray combination has points of superiority over mere jet sprays which have to be regulated in volume to the requirement of the fire at the passing moment.

The diminution in the size of generator 20 made possible by the presence of superheater 100 is also an important advantage. Again, were generator 20 to be used wholly for both evaporation and superheat, the superheat would probably be best obtained by some by-passing of unquenched gases. It is found that with these there may occur a dust which the complete quenching of the gases would prevent. Obviously, therefore, there is here a further advantage in divorcing the evaporative work from superheating work, if the latter is to be effected by unquenched gases.

For the arrangement last above described and, indeed, for any actual installation it is important that a separator be attached to the generator, and this is shown in Figs. 1 and 3 where the separator 240 catches any water which may by any accident come over in bulk. Pipe 242 and check-valve 243 return this water to the generator pot, since the hydrostatic head of water in 240 may easily be made sufficient for this.

241 is a convenient blow-off. Pot 240 also serves as an effective dust collector, when conditions are such that dust is possible.

At superheater 100 provision is made whereby the thermostat which controls this superheater also controls the needle-valve 250 in a pipe 251 through which hot water may flow into the bottom of the superheater as shown on Figs. 1 and 13. Through valve 250 a fine stream is admitted at those times when the superheat of 100 is too great, valve 250 being opened by the lever 252 fulcrumed at 253. Depriving generator 20 of its surface superheating function and making it simply an evaporator, incidentally permits the complete cooling of the combustion-tube 56 by steam or water, thus insuring increased life for this important element.

In the receiver-space between the high-pressure and low-pressure departments 31 32 of the turbine motor 30 I place a burner 112 similar to the one just described and fed with compressed air and gas through pipes 113 114, whereby the motive fluid is reheated by internal combustion in its passage through the motor. Pipes 113 114 are connected with the intercoolers 115 116 of the air and gas compressors and as the intercooler pressures may not always be equal I connect the pipes 113 114 with a pressure-balance mechanism 117 shown in detail in Fig. 12. It includes valves 118 119 in the respective pipes attached to a diaphragm 120 which receives on opposite sides the pressures terminal to said valves and accordingly tends to maintain said pressures equal by moving in one direction or the other according as one pressure or the other tends to predominate, throttling that pressure and decreasing the throttle of the other.

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

1. In constant-pressure generating apparatus, the combination of an internal-combustion generator having an outer casing, and a combustion-chamber attached at both ends to said casing and having a yielding connection between its points of attachment.

2. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a water-pot, an upright combustion-chamber therein discharging into said water-pot, and a compensating connection between the lower end of said combustion-chamber and the wall of the water-pot.

3. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a ledge, a combustion-tube within said generator having a flange to engage said ledge, and a key-bolt connecting the wall of the generator with the discharge end of said combustion-tube.

4. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a main casing, a combustion-tube within the same having a burner at the end opposite its discharge end, a key-bolt connected with said discharge end and passing through the wall of the casing, and an outside spring engaging said key-bolt for seating the burner end of the combustion-tube.

5. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a main casing, a combustion-tube within the same having a burner at the end opposite its discharge end, a key-bolt connected with said discharge end and passing through the wall of the casing, and an outside spring engaging said key-bolt for seating the burner end of the combustion-tube.

6. In constant-pressure generating apparatus, the combination of an internal-combustion generator, a combustion-tube within the same having a burner at one end and a discharge outlet at the other end within a water space in said generator, and a staying device engaging said discharge end and formed as a feed-duct for the introduction of feed-water to said water-space.

7. In constant-pressure generating apparatus, the combination of an internal-combustion generator, a combustion-tube having a discharge end therein, a key-bolt connected with said discharge end and located in the path of unquenched products of combustion, and means for cooling said key-bolt.

8. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a main casing provided with a body portion, a burner at the upper end of said portion, standards supporting said body portion, and a water-pot at the lower end of said body portion removable therefrom independently of said standards.

9. In constant-pressure generating apparatus, the combination of an internal-combustion generator, a combustion-tube within the same, means for supplying compressed air to said generator, and means for forming an air envelop in the wall of said combustion-tube.

10. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a double-walled combustion-tube with a burner at its upper end, a fluid-space between the walls of said tube, and an outlet from said space at the lower end of the combustion-tube.

11. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a burner, a water-pot, a combustion-tube extending between the burner and the water-pot and formed with an annular wall-space embracing the combustion-space, and means to supply compressed air to said wall-space.

12. In constant-pressure generating apparatus the combination of an internal-combustion generator having a burner, means to supply primary air to said burner, means for by-passing a portion of the air around the burner to join with the products of combustion, and a combustion-tube having a wall-space forming a channel for the by-pass air.

13. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a burner and a water-pot, a combustion-tube extending between the two, and a removable liner projecting from the burner within said tube and extending for the major portion of the length of the latter.

14. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a combustion-tube, a burner at one end thereof, a removable liner extending from the burner into said combustion-tube and separated from said tube by an annular space, and means for supplying compressed air to said space.

15. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a casing, a combustion-tube having a separable fluid-tight joint with said casing, a burner, and a removable liner extending from the burner into the combustion-tube and supported by the casing from a point back of said joint.

16. In constant-pressure generating apparatus, the combination of an internal-combustion generator having an upright combustion-tube with a discharge-outlet at its lower end, means for forming a water-pool immersing said outlet, and means for projecting a water-spray into the upper end of said combustion-tube.

17. In constant-pressure generating apparatus, a generator having a burner at its upper end, a water-collecting receptacle at its lower end in the path of the hot gases from said burner, an intermediate combustion-tube, and means for spraying water against the exterior surface of said combustion-tube at a point above said water-receptacle.

18. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a burner, a combustion-chamber formed with a wall-space, means for supplying compressed air to said space, and means for injecting water into said space.

19. In constant-pressure generating apparatus, the combination of a combustion-chamber having a wall-space with an outlet into the path of the products of combustion, means for supplying compressed air to said space, and means for spraying water into the compressed air reaching said space.

20. In constant-pressure generating apparatus, the combination of an upright combustion-tube, a constant-pressure burner, means for supplying air to jacket said tube, and means for supplying water with the air at the upper end of said tube at several points around its periphery.

21. In constant-pressure generating apparatus, the com-

bination of a constant-pressure burner, an upright combustion-tube formed with a peripheral groove adapted to distribute water uniformly over the edge of said tube into its interior, and a water-spray nozzle discharging into said tube above said groove.

22. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a burner and means for vaporizing water with the products of combustion, a combustion-chamber, means for discharging a secondary supply of water into said chamber, and means for preheating the secondary water-supply.

23. In constant-pressure generating apparatus, the combination of an internal-combustion generator, means to spray water thereinto, means for preheating the water, and means controlled by the temperature of the output from said generator for controlling the quantity of heat in the entering spray.

24. In constant-pressure generating apparatus, the combination of an internal-combustion generator, a water injector therefor, a water preheater, and a thermostat heated by the generator output and controlling the supply of water.

25. In constant-pressure generating apparatus, the combination of an internal-combustion generator, a water injector therefor, a water-preheating burner, and a thermostat subject to the temperature of the generator output and controlling the burner heat.

26. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a burner and means for maintaining a pool of water in the path of the products of combustion, a combustion-chamber, means for connecting the spaces on opposite sides of the water-pool, and means for indicating the water-level within and without said combustion-chamber.

27. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a burner, a water-pot in the path of the product of combustion, a water-reservoir elevated above the normal level in said water-pot, and a feed-and-vent connection between said reservoir and the water-pot controlled by the water-level in said pot.

28. In constant-pressure generating apparatus, the combination of an internal-combustion generator having a burner, a water-pot in the path of the product of combustion, a water-reservoir elevated above the normal level in said water-pot, a feed-and-vent connection controlled by the water-level in said pot, and an upper vent from said reservoir for removing non-condensable gases.

29. In constant-pressure generating apparatus, the combination of an internal-combustion generator supplying a mixture of steam and products of combustion, an engine operated by said mixture, and an internal-combustion superheater in the supply-line between said generator and engine.

30. In constant-pressure generating apparatus, the combination of an internal-combustion generator supplying a mixture of steam and products of combustion, a delivery-conduit extending therefrom, an internal-combustion burner in said conduit, and means controlled by the temperature in the conduit beyond said burner for controlling the burner.

31. In constant-pressure generating apparatus, the combination of an internal-combustion generator supplying a mixture of steam and products of combustion, an engine operated by said mixture, an internal-combustion burner in the supply-line between the engine and generator, a regulating valve for controlling the amount of heat supplied by said burner, and a thermostat between the burner and engine controlling said regulating valve.

32. In constant-pressure generating apparatus, the combination of an engine expanding its motive fluid in a series of stages, an internal-combustion steam-and-gas generator supplying said motor, and an internal-combustion reheating burner located in the path of the motive fluid between the stages of said engine.

33. In constant-pressure generating apparatus, the combination of a plural-stage motor, an internal-combustion steam-and-gas generator supplying said motor, an internal-combustion reheater located between the stages of said motor, and a compressor supplying both said generator and said reheater.

34. In constant-pressure generating apparatus, the combination of a plural-stage motor, an internal-combustion reheater located between the stages thereof, means to supply compressed air and gas to said reheater, and means to equalize the pressures of the air and gas.

35. In constant-pressure generating apparatus, the combination of a plural-stage motor, an internal-combustion burner for reheating the motive fluid between stages, a generator for supplying said motor, a plural-stage compressor to supply combustion-fluid to the generator, and means for supplying said fluid to the burner from between the stages of the compressor.

36. In constant-pressure generating apparatus, the combination of a plural-stage motor, an internal-combustion generator for reheating the motive fluid between the stages, an internal-combustion generator supplying said motor, plural-stage air and gas compressors supplying the generator and burner, air and gas conduits leading to the burner from between the stages of said compressors, and an automatic pressure-balance mechanism for equalizing the pressures in said conduits.

37. In constant-pressure generating apparatus, means for burning combustible under pressure, means for completely cooling the combustion products to a predetermined temperature by means of water added to said products and separate means for reheating the mixture of gases and steam to a desired higher temperature.

38. In constant-pressure generating apparatus, a pressure line containing a plurality of internal combustion burners, and means in the path of the products of combustion from a prior burner for evaporating water thereby.

39. In constant-pressure generating apparatus, a pressure line including an internal combustion generator having a burner and means for providing a pool of water in the path of the products of combustion therefrom and a second generator later in said line having an internal combustion burner and means for adding water to the products of combustion therefrom.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses, the 19th day of September, 1905.

EDWARD P. NOYES.

Witnesses:
C. F. BROWN,
E. BATCHELDER.