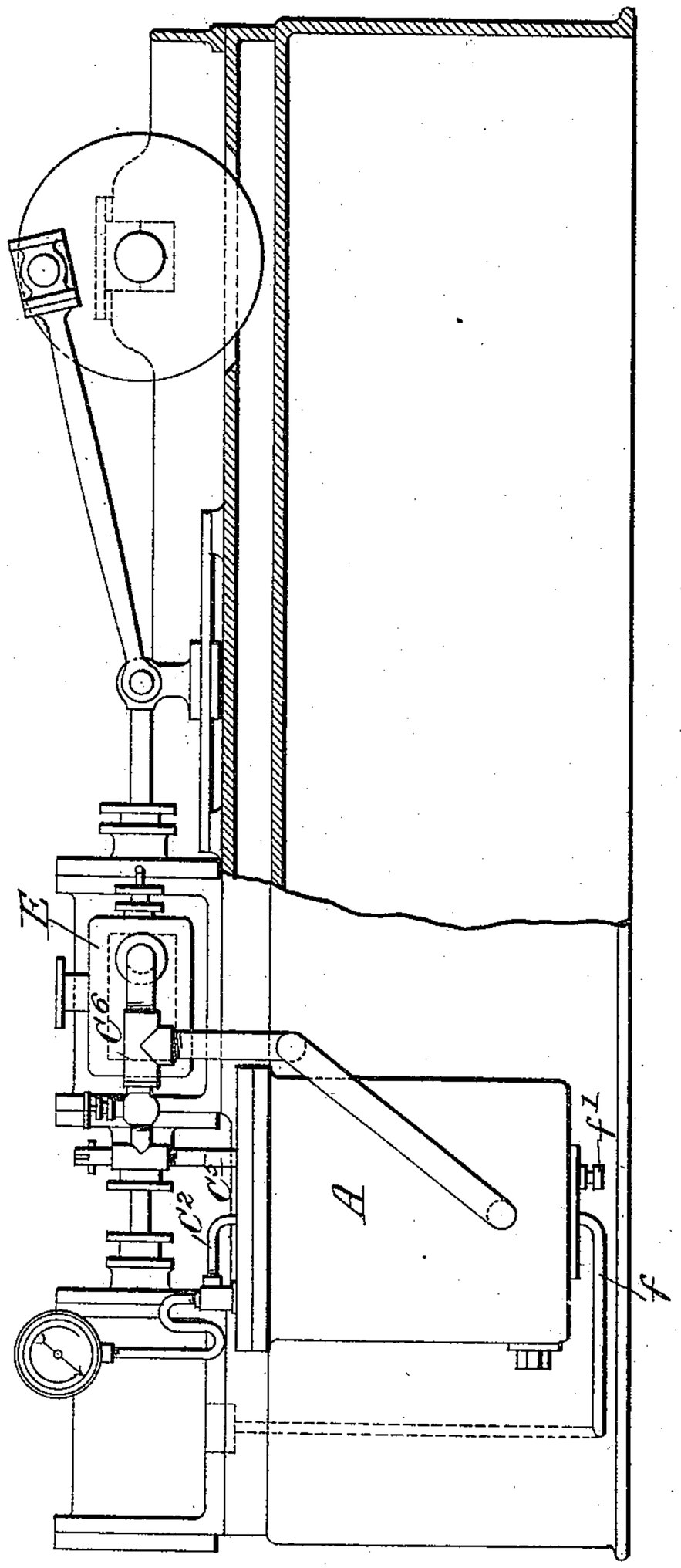
(No Model.) 3 Sheets—Sheet 1.

J. BOURNE.

APPARATUS FOR OBTAINING MOTIVE POWER.

No. 442,793. Patented Dec. 16. 1890.

Fig. 1.



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(No Model.) 3 Sheets—Sheet 2.

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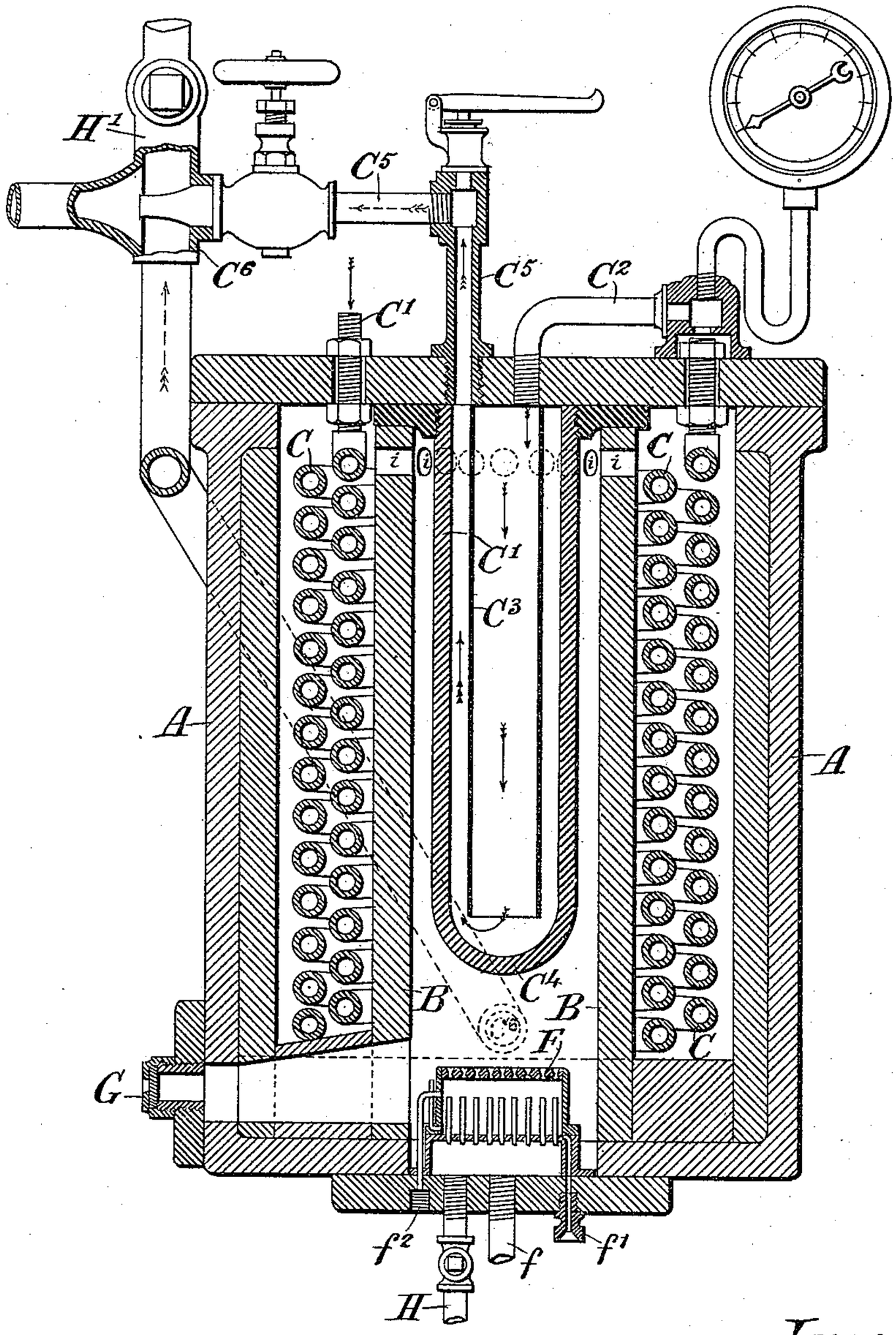
Fig. 2.



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(No Model.) 3 Sheets—Sheet 3.

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Fig. 4.

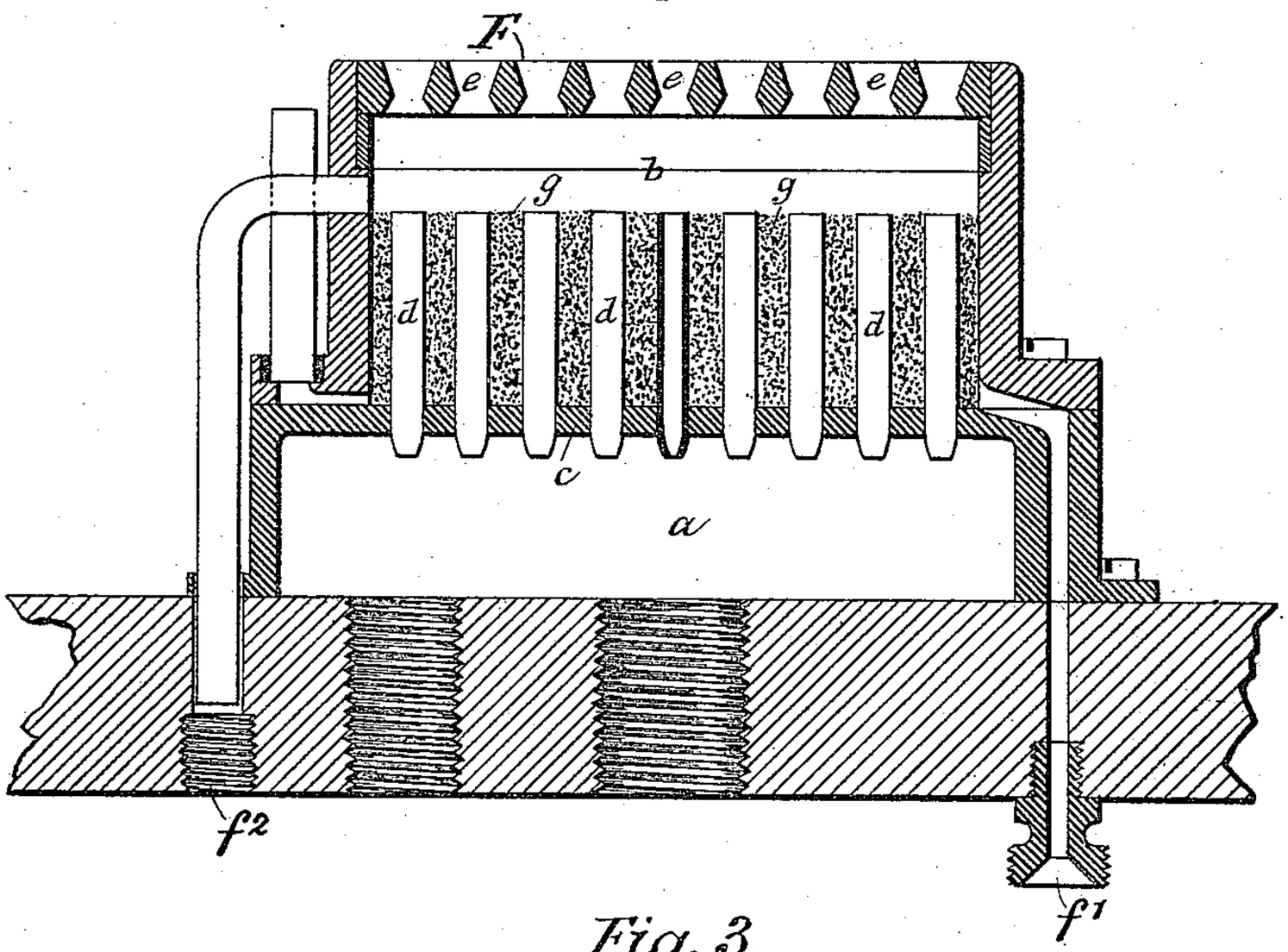
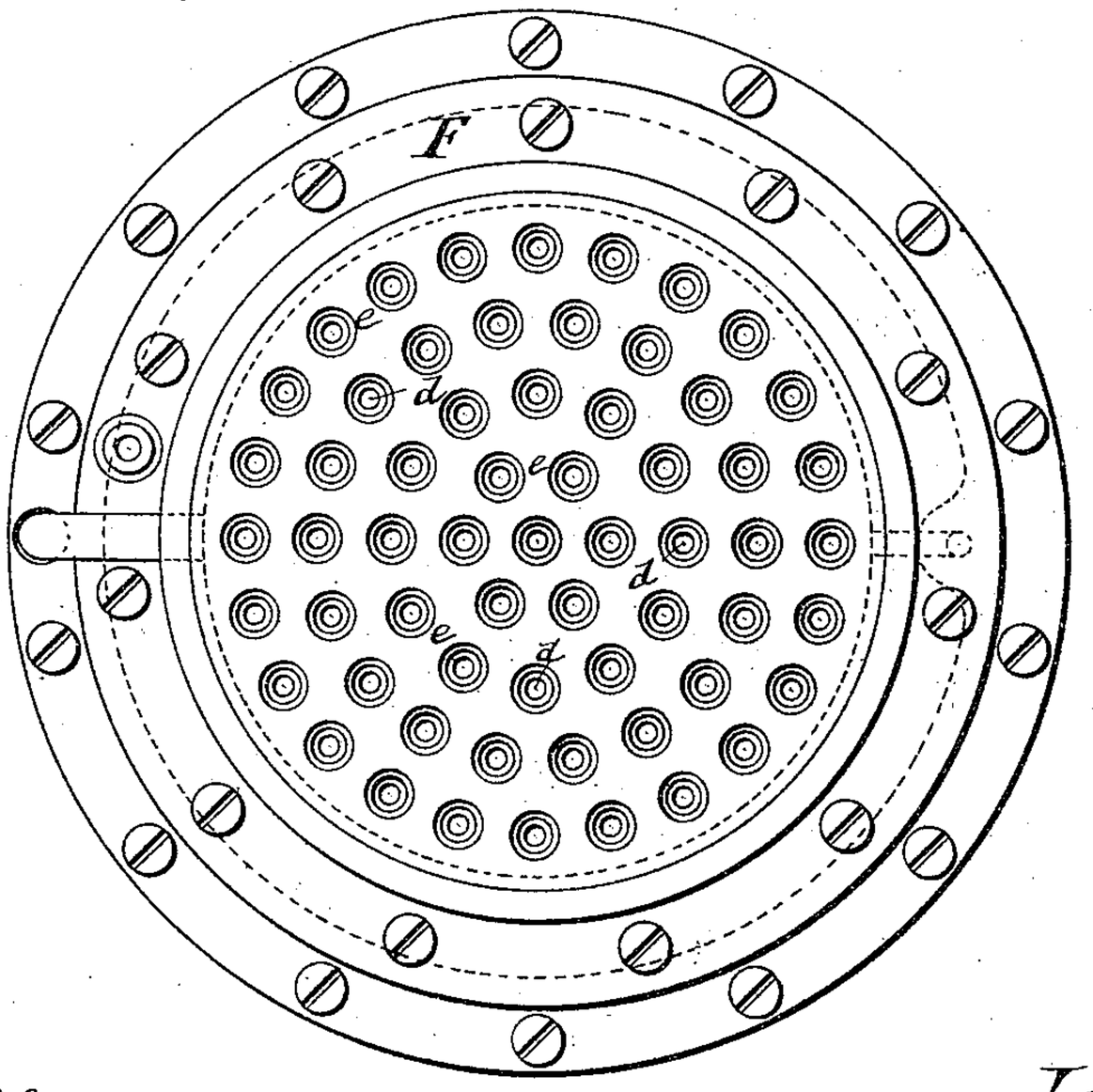


Fig. 3.



Witnesses
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UNITED STATES PATENT OFFICE.

JOHN BOURNE, OF SHEPHERD'S BUSH, ENGLAND.

APPARATUS FOR OBTAINING MOTIVE POWER.

SPECIFICATION forming part of Letters Patent No. 442,793, dated December 16, 1890.

Application filed April 3, 1889. Serial No. 305,848. (No model.) Patented in England March 24, 1888, No. 4,531; in France March 13, 1889, No. 196,685; in Belgium March 15, 1889, No. 85,400; in Cape of Good Hope April 12, 1889, No. 521; in Victoria April 27, 1889, No. 6,706; in Italy July 6, 1889, L, 61; in Canada July 19, 1889, No. 31,766; in India August 24, 1889, No. 1,855, and in Austria-Hungary October 8, 1889, No. 13,723.

To all whom it may concern:

Be it known that I, JOHN BOURNE, of 25 Warbeck Road, Shepherd's Bush, in the county of Middlesex, England, have invented a new and useful Improvement in Apparatus for Obtaining Force for Actuating Motive-Power Engines, (for which I have obtained patents in Great Britain, No. 4,531, dated March 24, 1888; in France, No. 196,685, dated March 13, 1889; in Belgium, No. 85,400, dated March 15, 1889; in Italy, No. 61, Vol. 50, dated July 6, 1889; in Austria-Hungary, No. 13,723, dated October 8, 1889; in Canada, No. 31,766, dated July 19, 1889; in the Cape of Good Hope, No. 521, dated April 12, 1889; in Victoria, No. 6,706, dated April 27, 1889, and in India, No. 1,855, dated August 24, 1889,) of which the following is a specification.

This invention relates to apparatus for obtaining force for actuating motive-power engines from a mixture of steam and the gases of combustion of liquid hydrocarbons.

I will first proceed to describe my invention with reference to the accompanying drawings, and afterward point out its novel features in claims.

Figure 1 represents a side elevation of a motive-power engine of ordinary construction having my invention applied. Fig. 2 represents, on a larger scale than Fig. 1, a central vertical section of the generating apparatus which constitutes my invention. Fig. 3 represents a plan view, and Fig. 4 a vertical section, on a still larger scale, of the hydrocarbon-burner which constitutes my apparatus.

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

A is the combustion-chamber, consisting of a flanged vertical cylinder of iron lined with fire-clay and closed at top by a flat cover. Within this flat chamber is a cylinder B, of fire-clay, extending from the bottom of the cylinder to the cover and pierced near the cover with a ring of holes. Within the annular space formed by the two cylinders is a double coil of pipe C, for receiving water to be heated to a high temperature of, say, 500° Fahrenheit. The water enters the inner coil by a pipe C′, leading from a force-pump, and after circulating through the double coils it passes out of the chamber by a pipe C^2 and enters a central pipe C^3, pendent from the cover of the combustion-chamber and open at bottom. Surrounding this pipe C^3 is a pipe C^4, also pendent from the cover, but closed at bottom. This pipe C^4 communicates by a pipe C^5 with an elbow-pipe C^6, which connects the lower part of the combustion-chamber A with the valve-chest E of the engine.

To quicken the discharge of the gases of combustion from the furnace, the pipe C^5 where it connects with the elbow-pipe C^6 may be fitted with a nozzle, as shown at Fig. 2, to create an exhaust at the elbow and increase the impelling force of the current.

F is a burner situate within the cylinder B and immediately under the dependent pipe C^4. This burner, to which is supplied the liquid fuel used for the generation of heat, consists of a circular box made fast to the bottom of the combustion-chamber A, and having lower and upper compartments *a* and *b*, separated by a horizontal partition or diaphragm *c*, in which are set numerous upright short tubes or nipples *d*. The top or cover of the said box is perforated, as shown at *e*, and the space below the partition *c* communicates with a pipe *f*, leading to an air-pump, which supplies air to the burner for supporting combustion. The nipple-pan is packed with a layer of pumice-stone or equivalent porous material *g*, reaching up to about the top of the nipples, which form passages for the compressed air admitted to the air-space below. Leading up through the bottom of the combustion-chamber is also a pipe *f′*, in communication with a hydrocarbon force-pump. This pipe serves to supply petroleum or other hydrocarbon oil to the porous bed covering the nipple-pan, and above this pan is fitted a metallic cover pierced with holes, which correspond in position with the nipples on the pan below, and are of sufficient diameter to permit the passage through each of them of an annulus of vapor surrounding a central jet of air. Thus it will be understood that when air is admitted under pressure to the air-space it will pass up in jets through the nipples and through the pierced cover,

carrying with it the vapor of the oil with which the porous bed is saturated. f^2 is an overflow-pipe for returning the surplus oil to the oil-reservoir. G is a screw-plug or door closing an opening through the wall of the combustion-chamber and continued through the wall of the cylinder B a little above the level of the pierced metal cover. By the removal of this screwed plug or door G access is obtained to the interior of the cylinder B for the purpose of lighting the burner F. To facilitate the commencement of operations, provision is made to admit air from the atmosphere to the air-space in the burner. This is indicated by the pipe H. Similarly for turning the products of combustion into the atmosphere during the heating up of the apparatus a two-way cock may be applied to the pipe C^6, as indicated at H', one outlet of which delivers into a small chimney.

It will now be understood that when the furnace is lighted jets of flame will be maintained on the top of the burner so long as the supply of oil and air is kept up. So soon as sufficient heat is obtained in the combustion-chamber to insure the flashing of the superheated water into steam, on its discharge from the coils, the pipe H and cock H' are close, and the operation of the apparatus will proceed, the liquid fuel and the air for maintaining its combustion being supplied by the pumps or other injectors connected, respectively, by the pipes f' f. Under this arrangement it is clear that none of the heat generated by the combustion of the fuel is lost. No part of it escapes by a chimney; but the whole is utilized in the production of power, except that small part that escapes by the exhaust-pipe of the engine. In this closed combustion-chamber the consumption of the fuel is more perfect than it is in common furnaces, there being no smoke generated if no excess of liquid fuel is supplied to the burner. Instead of delivering the fuel in a liquid state to the chamber, it may be heated therein, so as to be discharged in the form of gas or vapor into any approved construction of gas-burner.

It is well known that steam worked expansively in an engine will generate more power relatively to the amount of fuel consumed than if worked with its full pressure throughout the stroke, and this economy will be greater the greater the range of the expansion.

The most concentrated state in which steam can exist and at which expansion can begin is the state of superheated water, and in any steam-engine the maximum performance will be obtained if the motive fluid can be expanded in the cylinder from this condition of maximum density to that of the terminal density or pressure, generating throughout the whole range of the expansion. In existing engines, however, such a result is quite unattainable. In them only the lower portions of the expansion range can be utilized in the production of power, while the higher portions are never called into activity and much potential energy is consequently wasted. By the present invention this evil is to a great extent corrected, seeing that the energy pertaining to nearly the whole expansion range is generated and is transferred to the stream of fluid working the engine, reappearing in the form of increased engine-power. It is in the higher ranges of pressure that the benefits of expansion are most conspicuous. Steam expanded into twice its volume nearly doubles its power, whereas it requires to expand into nearly eight times its volume to treble its power, and the large volume implies large cylinders, a heavy engine, and other evils. On the whole it appears to be expedient that there should be two expansions—the first, with the highest pressures, before the cylinder is reached, and the second within the cylinder itself. By this arrangement the engine is not subjected to the strain of the highest pressures, and a very moderate amount of expansion within the cylinder suffices. The first part of the expansion may be effected by wire drawing the motive fluid, and the second by the application of lap to the slide-valve or other mechanical equivalent.

Water heated under pressure to 500° Fahrenheit possesses within itself a very large proportion of the heat necessary for its transformation into vapor on the reduction of its pressure. According to this invention the water immediately that its high pressure is reduced by its being delivered among the gaseous products of combustion, which are of a lower pressure, flashes into vapor, and then seizing the surplus heat of the naked products of combustion is completely transformed into steam, which is thus also superheated, and as this complete transformation is effected not through the intervention of heating-surfaces, but by the direct contact of the confluent fluids, a boiler is not required, but only a heater having about one-tenth or one-twelfth of the heating-surface necessary for a boiler generating the same power. It is well known that the efficacy of the heating-surface of a boiler is not the same in all parts of it, but that in the hottest places it is about six times greater than the average efficacy of the whole. Seeing, then, that in this case the heater is subjected to the highest temperatures only, while the lower temperatures, which, in common boilers use up most of the surface, do not here require any surface at all, the motive fluids proceeding with their existing temperatures direct to the engine. Then as the heat imparted to the heater has only to be half the total amount expended, the other half being appropriated by the products of combustion, it follows that the surface of the heater, being five or six times more effective than the average boiler-surface and having to impart only half the total heat, need have only one-tenth or one-twelfth of the

heating area that is necessary in ordinary boilers generating the same power. With these explanations the rationale of the action of the engine under the new circumstances above set forth will be readily comprehended.

The system of working above described admits of many modifications; but all are dependent on the same general principle, which is that of introducing air and liquid fuel or its vapor into a combustion-chamber, where they are continuously burned, and the engine is worked by the products of their combustion mingled with water which is caused to flash into steam sufficient in quantity to reduce the temperature to a convenient working-point with any desired amount of superheating, while the volume or pressure, or both, are correspondingly augmented. In the structure and conformation of the engine employed to develop the motive force there is nothing peculiar, and any kind of engine may be adopted, whether of the cylinder and piston type or any other by which elastic fluids under pressure are made to generate power. The force-pumps employed may be of the plunger or of the bucket type, or bucket and plunger combined, or they may be jet-pumps for sucking or forcing by means of a jet of steam or other elastic fluid, or any other species of pump may be employed.

The heating power of coal-gas and of petroleum or other variety of liquid fuel being about the same, and small gas-engines having now come into extended use, it has been supposed by some persons that the gas-engine type of motor, which operates upon the principle of exploding a mixture of air and gas or hydrocarbon vapor within the cylinder, constitutes an eligible species of engine, even for large powers; but to the use of such engines of any considerable size there are two weighty objections. The first is that owing to the high speed at which modern engines have to run the piston frequently outruns the explosion, and the time necessary to accomplish between the strokes the intimate intermixture of the air and gas or vapor not having been afforded, a portion of the gaseous fuel is never burned at all. The second objection is that the products of the explosion are dismissed through the eduction-pipe at so high a temperature that a large part of the heat, amounting to nearly one-half of that generated, is necessarily wasted. In working according to the present invention both of these sources of loss are removed, for as the motive force is obtained not by explosion, but by steady and continuous combustion, the time necessary for mixing the ingredients and perfecting the combustion can be afforded without any diminution in the speed of the engine, while the introduction of water reconciles the existence of a high pressure within the engine with a very moderate temperature of the exhaust, so that the loss accruing from this source is almost wholly prevented. The apparatus by which this improvement is accomplished I call the "composite engine," as it is worked partly by the products of combustion and partly by the superheated water converted into steam by said products.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. The combination of the outer cylinder or combustion-chamber A, the inner cylinder B, concentric with said outer cylinder and having openings *i* in its upper part communicating with the annular space between the two said cylinders, the outlet-pipe C^6 from the lower part of the outer cylinder A, a hydrocarbon-burner at the bottom of the inner cylinder B, the pipe C^4, having a closed bottom dependent within the said cylinder B over said burner, the pipe C^3, having an open bottom within the pipe C^4, the water-coil C, arranged within the aforesaid annular space and having its outlet in communication with said pipe C^3, and the pipe C^5, constituting an outlet from said pipe C^4 and communicating with the outlet of the pipe C^6 from the combustion-chamber A, all substantially as and for the purpose herein described.

2. In an apparatus for obtaining motive force for actuating motive-power engines, the burner for liquid hydrocarbon, consisting of a box F, having upper and lower compartments separated by a partition or diaphragm *c*, upright tubes or nipples set in the said diaphragm, the perforated cover *e*, and the bed *g*, of porous material, on said diaphragm and between said tubes or nipples, the said burner being provided with a pipe *f* for admitting air below the diaphragm *c* and with a pipe *f'* for supplying liquid hydrocarbon to the porous bed *g* above the diaphragm, substantially as herein described.

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Witnesses:
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A. W. SPACKMAN.