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INTERNAL COMBUSTION HYDRAULIC PUMP.

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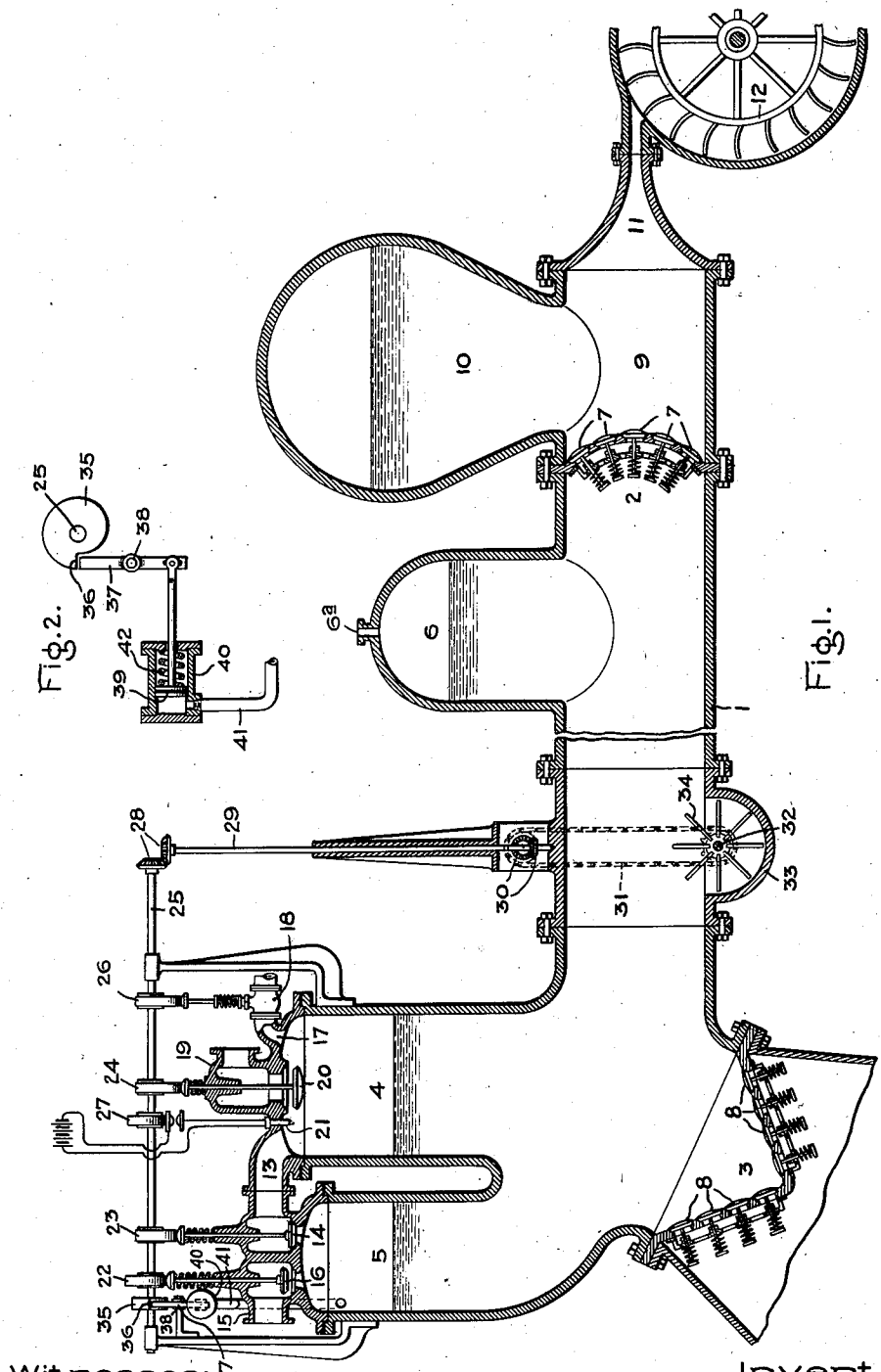


Fig. 1.

Fig. 2.

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION HYDRAULIC PUMP.

1,259,338. Specification of Letters Patent. Patented Mar. 12, 1918.

Application filed July 29, 1913. Serial No. 781,781.

To all whom it may concern:

Be it known that I, ERNST F. W. ALEXANDERSON, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Internal-Combustion Hydraulic Pumps, of which the following is a specification.

My invention relates to internal combustion hydraulic pumps, one of its principal objects being to enable such pumps to be operated on the two cycle principle in a novel manner, and another object being to improve such pumps as regards both construction and operation, irrespective of their particular operating cycle.

I have hereinafter described specifically a particular pumping apparatus adapted for two cycle operation that is the best for the purposes of my invention at present known to me, referring to the liquid in the pump as water. It is, however, to be understood that while the invention extends to the particular apparatus described and to specific features and details of both its operation and its construction, which are of special importance because of their special advantages, yet it is not confined to this apparatus and its details, or to the exact mode of operation set forth, but can be otherwise carried out and applied, and that other liquids can be operated with or pumped instead of water or along with water. It will also be understood that while a pump embodying my invention is specially useful for supplying water to a water wheel as herein shown, yet its usefulness is not confined to this or any other particular application.

Various advantages besides those above referred to obtainable through the invention will hereinafter become apparent, and its scope will be indicated in my claims.

In the operation of an internal combustion hydraulic pump on the two cycle principle in accordance with my invention, I arrange that in the introduction of fluid to the combustion chamber or space of the pump such fluid shall be compressed by the water in the pump in some chamber or space separate from the combustion chamber and be transferred to the latter for the combustion therein. The fluid introduced in this manner may be either air or fuel,—if the fuel used is a fluid susceptible of compression,—or both. I further arrange that the combustion chamber and the compression chamber aforesaid shall communicate freely with a common chamber or space in such a way that in the operation of the pump the water may pass back and forth between said chambers and said space. As for the fuel itself, it may be of any desired character, such as crude oil, gasolene, coal dust, producer gas or other combustible gas or vapor, etc. As for the ignition, it may be brought about either as a result of compression or by any well-known or approved ignition device.

In the accompanying drawing, Figure 1 shows a longitudinal section through an apparatus constructed in accordance with my invention, a portion being broken out and removed to bring the rest within the limits of the paper.

Fig. 2 is a fragmentary detail view, one of the parts shown being in section.

The water pump shown comprises a water barrel 1 having a water discharge 2 at one end and also having a water inlet 3, shown as at the other end. The combustion chamber 4 of the pump communicates with the barrel 1 at the end remote from the discharge, this chamber 4 being shown as opening directly downward into the barrel 1. As it is intended that in this pump the compression of fluid by the water shall occur on the return stroke, the compression chamber 5 through which fluid is introduced into the combustion chamber 4 communicates with the barrel 1 at the same end as the combustion chamber 4, and, as shown, in like manner but a little beyond. Means for storing energy from the working stroke of the pump communicates with the barrel 1 at or near the discharge end, the means shown comprising a chamber 6 opening downward into the barrel 1 and affording an air cushion space. This chamber 6 has an opening 6^a through which air may be forced to replace any absorbed by the water or to initiate a return stroke when the pump is to be started, etc. The discharge means at 2 comprises a plurality of openings in the dished end wall of the barrel 1 proper, these openings being provided with spring actuated outwardly opening non-return valves 7 which remain closed until the pressure tend-

ing to force out water through them attains a certain magnitude, and the inlet means at 3 comprises a plurality of openings in a conical diaphragm at this point which are provided with spring actuated inwardly opening non-return valves 8 that likewise remain closed until the suction tending to draw in water through them attains a certain magnitude. The pressure and the suction under which for the best practical results the valves 7 and 8 should be allowed to open will depend on the conditions of operation, etc., as will be readily understood by those skilled in the art. I may here mention, however, that the pressure under which the valves 7 open may to some extent determine the compression of the air in the chamber 6 on the working stroke and the compression of the working charge produced on the return stroke, the compression of the charge of course determining the thermodynamic efficiency of the pump.

As shown, the pump discharges into a receiver 9 (formed as a prolongation or extension of the barrel 1) wherewith communicates a device for steadying and equalizing the pressure and flow of the water delivered,—this device comprising a chamber 10 opening downward into the receiver and affording both water storage and air cushion space,—and from the receiver 9 water is delivered to the inlet 11 of a water wheel 12. When the pump is used for purposes other than supplying water to a water wheel, the parts beyond the barrel 1 proper may, of course, be modified, changed, or entirely dispensed with.

The transfer of fluid from the compression chamber 5 to the combustion chamber 4 is provided for by means of a passage or conduit 13 through which communication may be established between the chambers by the opening of controlling valve means 14 which when closed cuts off such communication. As it is intended that in this pump the ingredient of combustion dealt with in the compression chamber 5 should be air and that the fuel should be separately introduced into the combustion chamber 4, the compression chamber 5 has inlet means 15 through which air at atmospheric or other relatively low pressure may be admitted or supplied, said inlet means 15 being provided with controlling valve means 16, and the combustion chamber 4 has inlet means 17 through which crude oil or coal dust, for example, may be admitted or supplied from a device 18 such as is used with motors operating on the high compression plan,—said inlet means 17 being controlled by valve means or its equivalent, forming part of or associated with said device 18. The combustion chamber 4 has also exhaust means 19 through which the spent products of combustion may be discharged, said exhaust means being controlled by valve means 20. An ignition device 21 in the combustion chamber 4 can be used to bring about or insure the combustion therein if it is not practicable or desirable to depend or rely solely on compression for producing it.

The inside height of the combustion chamber 4 above the upper interior surface of the barrel 1 may be about one tenth of the length of the barrel or less, for example, and the relative dimensions of the other parts may be approximately about as shown, or may be altered according to the judgment of the designer and the conditions of each particular case.

I will now describe a cycle of operation of the pump proper, at the same time describing the accompanying cycle of the compressor 5. The apparatus is shown with the water at rest at the conclusion of an outstroke of the pump after the burning of a charge of fuel in the combustion chamber 4. The water being without momentum, the air in the chamber 6 will expand and force it to the left through the barrel 1, thus producing the return stroke of the pump. As the return stroke begins, the air admission valve 16 will be closed, while the exhaust valve 20 will remain open. The water will rise in the combustion chamber 4 and expel the spent products of combustion,—with the exception of any residue that may be desirable to form a cushion,—at the same time also rising in the compression chamber 5 more or less and compressing the air therein. As the water reaches the top of the combustion chamber 4, the exhaust valve 20 will be closed; and the energy of the body of water in the barrel 1 not having been completely expended, the water will rise still higher in the compression chamber 5 and compress the air therein still more.

Shortly before the water comes to rest at the conclusion of the return stroke, the transfer valve 14 will open and the compressed air in the compression chamber 5 will pass into the combustion chamber 4, fuel being at about this time supplied through the inlet 17. The relief of the pressure in the compression chamber 5 due to the opening of the transfer valve 14 will accelerate the rise of the water in it; and the column of water in the combusion chamber 4, being practically at rest, will readily and quickly fall a sufficient distance to accommodate all or enough of the air in the compression chamber 5 and the necessary amount of fuel without the main body of water in the water barrel 1 having any considerable movement. Hence if the design of the apparatus and its operating adjustment and regulation are suitable, the admission of air and fuel to the combustion chamber 4 may be completed before the main body of water comes to rest at the end of the return stroke,

so that the highest degree of compression may only be reached after the transfer.

About when the water has fully come to rest at the end of the return stroke or a little earlier, the transfer valve 14 will be closed, the combustible mixture in the combustion chamber 4 will be ignited, and the products of combustion will expand and force the water downward and to the right and produce the outstroke or working stroke. As the body of water in the barrel 1 moves to the right, it will compress the air in the chamber 6 again and will also eventually open the valves 7 at the discharge; and during a portion of the outstroke, also, the momentum of the water will cause an expansion in the left hand end of the water barrel 1 such that the valves 8 will open against their springs and permit water from without to flow into the barrel 1, or to be drawn in, and to rise in the chambers 4 and 5 to about the height shown. Before the outstroke is over, also, the air admission valve 16 will be opened to admit a new supply of air to the compression chamber 5 and the exhaust valve 20 will also open (preferably a little later than the air admission valve) to permit an influx of air to the combustion chamber 4. When the momentum of the water has been expended, it will come to rest and the water valves 7 and 8 will close. Thus one cycle of operation of both the pump proper and the compressor 5 will be completed, and the apparatus will be in the condition shown in the drawing, ready for the beginning of another return stroke and another cycle.

While the valves 14, 16 and 20 may be operated by various forms of mechanism such as are known to those skilled in the art, either through the action of the water in the pump or from a separate motor, I have herein shown and described a novel mechanism for this purpose in which motor means operated by the water is employed, this mechanism being adapted to actuate or control the fuel supply device 18 and the ignition device 21 as well as the valves above mentioned.

As will be seen from the drawing, the valves 14, 16 and 20 are mounted on stems whose upper ends are surrounded by compression springs which tend to lift them. The movement of these valves is controlled by cams 22, 23 and 24 on a shaft 25, and the devices 18 and 21 are similarly actuated or controlled by cams 26 and 27 on said shaft. The shaft 25 is connected by gearing 28 with an upright shaft 29 which is in turn connected by gearing 30 with a short transverse horizontal shaft (not shown) having on it a sprocket wheel which is connected by a chain 31 with a similar sprocket wheel on a horizontal shaft 32. This last mentioned shaft extends into a semi-circular chamber 33 opening into the lower side of the barrel 1 and has on it a paddle wheel device 34. The cams and the various other parts are so designed and proportioned that the movement of the water in the barrel 1 to the right during the working stroke will not affect any of the valves or either of the devices 18 and 21 until toward the end of said stroke, when it will cause the valves 16 and 20 to open in the order named, and that the movement of the water to the left on the return stroke will almost at the beginning cause the valve 16 to close, will cause the valve 20 to close about as the water reaches the top of the combustion chamber 4, will cause the valve 14 to open and close at or shortly before the end of the return stroke, and will cause the injection and the firing of the fuel by the devices 18 and 21 respectively just about at the very end of the return stroke.

The actuation of the valve operating mechanism, etc., by the water to give the correct timing with reference to the events of the stroke may be controlled by means responsive to the pressure conditions in the pump. As shown (see Figs. 1 and 2), there is on the shaft 25 a part 35 which has a shoulder 36 but is otherwise of a smooth, rounded outline. A latch member or lever 37 fulcrumed at 38 engages under the shoulder 36 as the shaft 25 is rotated in a counter-clockwise direction on the return stroke and thereafter prevents further rotation of the shaft 25 or the parts driving it until the air pressure in the chamber 5 becomes sufficient to force back the piston 39 in a cylinder 40 connected with the chamber 5 through a conduit 41 against the resistance of a spring 42 and so force the upper end of the lever 37 to the left and release the shaft 25. This serves to insure the opening of the valve 14 at exactly the right time in each stroke, which will ordinarily be sufficient to insure the occurrence of the other events at nearly enough the proper times.

I have above described both the exhaust of the spent products of combustion from the combustion chamber 4 and the compression of air in the compression chamber 5 as taking place during the return stroke. If desired, however, enough water can be allowed to enter through the valves 8 during the working stroke to expel the spent products of combustion from the combustion chamber 4, and only the compression in the compression chamber 5 occurs during the return stroke. In this case the air admission valve 16 must of course be opened and closed during the working stroke with due regard to the entry of water through the valves 8, so as to insure an adequate amount of air in the compression chamber 5, and the exhaust valve 20 must be closed as this water reaches

the top of the combustion chamber 4 during the working stroke instead of during the return stroke, as above described.

In describing the transfer of air from the compression chamber 5 to the combustion chamber 4, I have pointed out that such transfer can be completed before the main body of water comes to rest at the end of the return stroke. In case fuel is admitted into the compression chamber 5 and transferred therefrom to the combustion chamber 4 mingled with the air, the final degree of compression in the combustion chamber 4 after the transfer may be made sufficient to effect ignition without that in the compression chamber 5 ever becoming high enough therefor,—the transfer valve 14 in this case being if necessary opened somewhat sooner than would otherwise be preferred, and of course closed somewhat before the end of the return stroke.

In accordance with the provisions of the Patent Statutes, I have described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative, and that the invention can be carried out by other means.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. A two cycle internal combustion hydraulic pump comprising a barrel having liquid discharge and inlet means; a combustion chamber communicating freely with said barrel, so that the water may pass back and forth between the chamber and the barrel; means for introducing air and fuel into said combustion chamber, such means including a compression chamber also communicating freely with the barrel and means for admitting air thereinto to be compressed by the liquid in the pump during the return stroke and for transferring air so compressed to the combustion chamber at about the conclusion of said return stroke; and means for discharging the products of combustion.

2. A two cycle internal combustion hydraulic pump comprising a barrel having liquid discharge and inlet means; a combustion chamber communicating freely with said barrel, so that the water may pass back and forth between the chamber and the barrel; means for introducing air and fuel into said combustion chamber, such means including a compression chamber for compressing one of the aforesaid constituents of the working charge also communicating freely with the barrel and means for admitting such ingredient into said compression chamber to be compressed by the liquid in the pump during the return stroke and for transferring the ingredient so compressed to the combustion chamber at about the conclusion of said return stroke; and means for discharging the products of combustion.

3. A two cycle internal combustion hydraulic pump comprising a barrel having liquid discharge means at one end and also having liquid inlet means; a combustion chamber communicating freely with said barrel at the end remote from the discharge, so that the water may pass back and forth between the chamber and the barrel; means for introducing air and fuel into said combustion chamber, such means including an air compression chamber communicating freely with the barrel at the same end thereof as the combustion chamber and means for admitting air thereinto to be compressed by the liquid in the pump during the return stroke and for transferring air so compressed to the combustion chamber at about the conclusion of said return stroke; and means for discharging the products of combustion from the combustion chamber.

4. A two cycle internal combustion hydraulic pump comprising a barrel having liquid discharge means at one end and also having liquid inlet means; a combustion chamber communicating freely with said barrel at the end remote from the discharge so that the water may pass back and forth between the chamber and the barrel; means for introducing air and fuel into said combustion chamber, such means including a compression chamber communicating freely with the barrel at the same end thereof as the combustion chamber and means for admitting air into said compression chamber to be compressed by the liquid in the pump during the return stroke and for establishing communication between the compression chamber and the combustion chamber to allow the air so compressed to be transferred from the former to the latter and for cutting off such communication, all prior to the conclusion of the return stroke and the immediately ensuing working stroke; and means for discharging the products of combustion from the combustion chamber.

5. A two cycle internal combustion hydraulic pump comprising a barrel having liquid discharge and inlet means; means for storing energy from the working stroke of the pump communicating freely with said barrel at the discharge end and a combustion chamber communicating freely with said barrel at the other end so that water may be forced from said combustion chamber into the barrel and from the barrel into said means for storing energy on the working stroke, and vice versa on the return stroke; means for introducing air and fuel into said combustion chamber, such means including a compression chamber communicating freely with the barrel at the same end thereof as the combustion chamber and

means for admitting aid thereinto to be compressed by the liquid in the pump during the return stroke and for establishing communication between said compression chamber and the combustion chamber to permit the transfer of air so compressed from the former to the latter and for cutting off such communication, all prior to ignition in the combustion chamber and the ensuing working stroke; and means for discharging the products of combustion.

6. A two cycle internal combustion hydraulic pump comprising a barrel having liquid discharge and inlet means; a combustion chamber communicating with said barrel; means for introducing air and fuel into said combustion chamber, such means including a compression chamber also communicating with the barrel, inlet means for admitting fluid into said compression chamber to be compressed by the liquid in the pump, means of communication between the compression chamber and the combustion chamber for allowing fluid so compressed to be transferred from the former to the latter; outlet means for discharging the products of combustion from the combustion chamber; valve means for controlling the inlet to the compression chamber, the outlet from the combustion chamber, and the communication between said chambers; means for operating said valve means actuated by the movement of the liquid in the pump; and means responsive to the pressure conditions in the pump for controlling the actuation of said valve means to insure the proper timing thereof with reference to the events of the stroke.

7. An internal combustion hydraulic pump comprising a barrel having liquid discharge and inlet means, a combustion chamber communicating with said barrel, means for introducing air and fuel into said combustion chamber including controlling valve means, means for discharging the products of combustion from the combustion chamber including controlling valve means, means actuated by the movement of the liquid in the pump for operating the valve means aforesaid, and means responsive to the pressure conditions in the pump for controlling the actuation of said valve means to insure the proper timing thereof with reference to the events of the stroke.

In witness whereof, I have hereunto set my hand this 26th day of July, 1913.

ERNST F. W. ALEXANDERSON.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.