H. M. & T. M. CHANCE.

METHOD OF OPERATING INTERNAL COMBUSTION PUMPS AND COMPRESSORS.

APPLICATION FILED MAY 5, 1911.

1,011,410.

Patented Dec. 12, 1911.

2 SHEETS—SHEET 1.

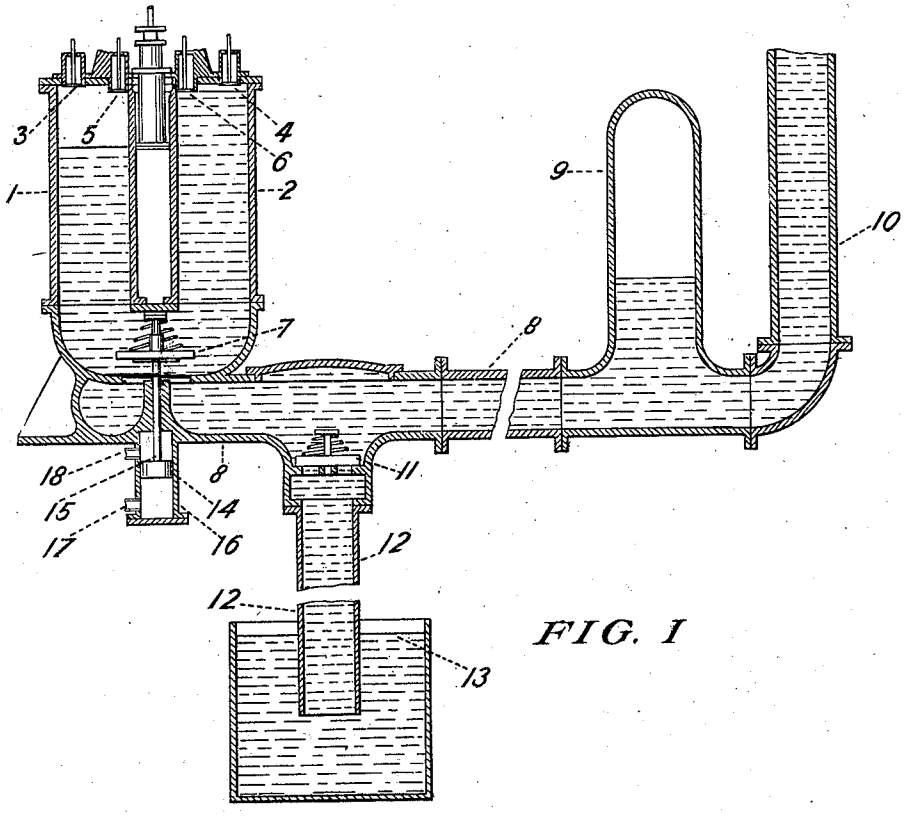

FIG. 1

WITNESSES:

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Carlos Busch

INVENTORS

Henry M. Chance

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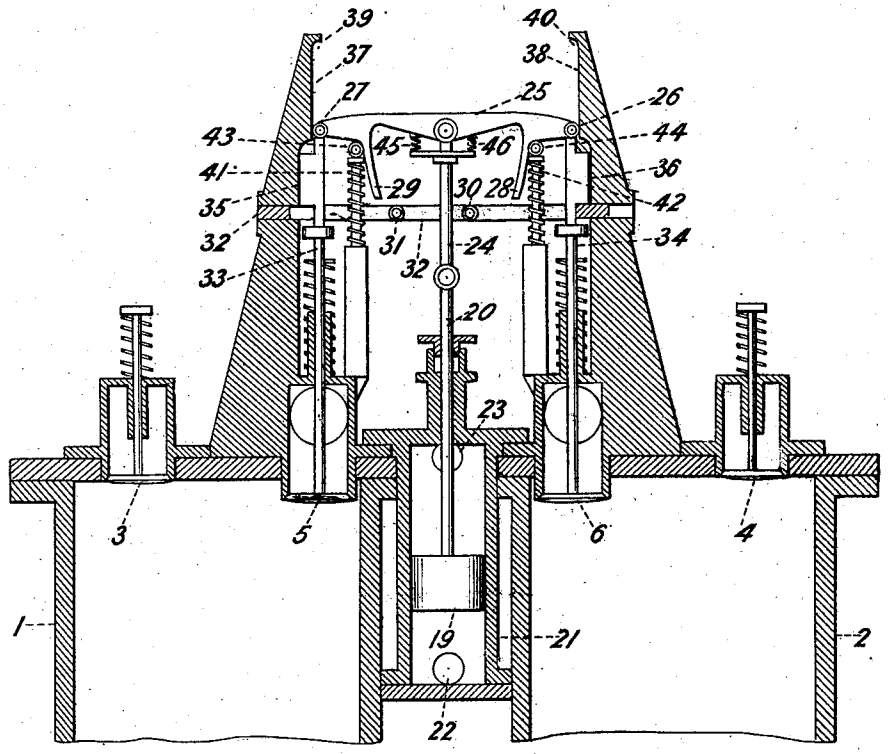

FIG. II

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METHOD OF OPERATING INTERNAL-COMBUSTION PUMPS AND COMPRESSORS.

1,011,410. Specification of Letters Patent. Patented Dec. 12, 1911.

Application filed May 5, 1911. Serial No. 625,365.

To all whom it may concern:

Be it known that we, HENRY M. CHANCE and THOMAS M. CHANCE, citizens of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented a certain new and useful Method of Operating Internal-Combustion Pumps and Compressors, whereof the following is a specification.

Our invention relates especially to the operation of internal combustion pumps and air compressors in which the pressure and expansive force of the products of combustion of a combustible mixture are directly used to impart velocity to a body of liquid (which may be described as a liquid oscillating fly-wheel) each stroke of which absorbs and gives out energy; and is applicable to pumps and compressors having two or more combustion chambers in which combustion occurs alternately, each out-stroke of the body of liquid being a power-stroke. Pumps and compressors of this type heretofore have been operated by causing the combustible charge to be drawn into one chamber by the continued travel of the body of liquid after the waste gases in the other chamber have dropped to low pressure and this continued travel must be sufficient to draw in the required new charge, the expulsion of waste gases being effected by the return stroke of the body of liquid and must be completed before the continued travel of the body of liquid in completing its return stroke can compress the medium in the other chamber in preparation for the combustion thereof. The necessity for prolonging both the out-stroke and return-stroke of the body of liquid, to permit of the drawing in of combustible charge and of the expulsion of the waste gases, introduces time elements in the cycle of pumps so operated, by which the capacity and speed of operation are correspondingly reduced.

Our invention is intended to provide a method of operation which will increase the rapidity of action by decreasing the time necessary for each out-stroke and return-stroke, and thus increase the rate of operation, so that greater power may be developed with an apparatus of given size than can be developed by methods heretofore in use. We accomplish these objects by cutting off communication between the combustible mixture chambers and the moving body of liquid when the pressure of the expanding gases has fallen to the pressure at which it is desired to open the exhaust, permitting the moving body of liquid to complete its out-stroke and make its return-stroke after this communication is closed; during this period of travel, including the out- and in-stroke, a new increment of liquid to be pumped may be taken into the apparatus external to the pump chambers, and during this same period a new charge of explosive mixture is introduced into one of the chambers, displacing liquid from that chamber and simultaneously causing liquid to flow into the other chamber, partially or wholly displacing the waste products of combustion from that chamber, the exhaust outlet of said chamber having been opened slightly before, or at or about, the time when communication between the pump chambers and the moving body of liquid was closed. We thus cause the new charge of combustible mixture to be introduced while the waste products of combustion are being discharged.

It will be understood that our method of operation may be applied to pumps in which the fuel, whether gaseous, liquid, or solid, is introduced into the combustion chamber during or subsequent to the compression of the air in which the fuel is to be burned, and we therefore use the terms "combustible mixture," "combustible medium," "charge of combustible medium," etc., to include air or a charge of air which may be compressed prior to the introduction of the fuel.

We do not limit ourselves to the forms of valves or the mechanism for operating valves shown by the drawings, for it will be understood that other types of valves, and of mechanisms for operating them commonly used for such purposes may be employed in operating pumps by our method.

The regulation of pumps operated by our method may be effected by varying the quantity of fuel contained in each combustible charge or by varying the volume, by methods in common use in operating internal combustion engines, comprising throttling, increasing or decreasing the pressure under which the combustible mixture is admitted and other methods in common use; and the rapidity of operation may be controlled by governors such as are used in governing the rate of operation of internal combustion pumps in which a liquid oscillating fly-wheel is used.

Our improved method of operation therefore consists in cutting off communication between the pump chambers and the liquid to be pumped, and in causing liquid to be displaced from one chamber by gravity or by the expansion of an elastic cushion or by the pressure of inflowing combustible mixture or by a combination of these forces, and in causing the liquid so displaced simultaneously to produce a flow of liquid into the other chamber, thereby causing the introduction of new combustible mixture to take place while the waste products are being discharged.

It will be understood that our method of operation may be used in operating gas pumps or air compressors of those types in which an oscillating body of liquid is used as a fly-wheel to absorb and give out energy, as well as in operating pumps used to pump liquids.

The drawing Figure I is a central vertical cross-section of a pump of a type which may be operated by our method. Fig. II is a central vertical cross-section and elevation of a valve gear suitable for operating pumps of the type shown by Fig. I, and reproducing on a large scale a portion of the pump shown by Fig. I.

Fig. I shows two combustion chambers 1 and 2 provided with inlet valves 3 and 4 for introducing combustible mixture, and exhaust valves 5 and 6 for the discharge of waste products of combustion, a valve 7 to control communication between these two chambers and a conduit 8 which is connected to an accumulator 9 and discharge main 10. An inlet valve 11 controls communication with the intake 12 and source of supply 13 of liquid to be pumped. As operated by our method, assuming chamber 1 to contain a compressed charge of combustible mixture which has been ignited, the valve 7 being open and chamber 2 being filled with liquid (or containing a small compressed gaseous cushion in its upper portion) the pressure due to the combustion of the combustible mixture drives liquid through the valve 7 producing relatively high velocity in the body of liquid in the conduit 8. When by expansion the waste gases in chamber 1 have fallen to the pressure at which it is desired to open the exhaust, the exhaust valve 5 is opened, and the valve 7 is closed by the movement of the piston 14 transmitted by the rod 15. The piston 14 works in a cylinder 16 one end of which through the connection 17 is in communication with the liquid in chambers 1 and 2, and the other end through the connection 18 is in communication with a source of pressure slightly greater than that at which it is desired to exhaust the waste products of combustion. When the pressure in either chamber 1 or 2 falls below this predetermined chamber the piston 14 by its movement operates valve 7. The exhaust valve 5 to chamber 1 is opened at or slightly before the closing of valve 7, and the waste products escape at atmospheric pressure, the liquid in chamber 2 now falls by gravity, (with or without the assistance of a small gaseous cushion contained in that chamber), the automatic inlet valve 4 opens and new combustible mixture enters chamber 2 while liquid rises in chamber 1 and by the momentum produced by its down-stroke in chamber 2 expels waste products from chamber 1 and inlet valve 4 closes. Upon commencing its return-stroke the body of liquid in the conduit 8 opens valve 7 forcing liquid into chamber 1 completing the expulsion of waste gases from that chamber (except possibly a small body to act as a gaseous cushion) and the exhaust valve 5 is closed by the impact of liquid against its under surface. The momentum of the body of liquid in conduit 8 now causes liquid to rise in chamber 2 compressing the charge in that chamber, which is then ignited and the operations as above described are repeated; the next new charge of combustible mixture is drawn into chamber 1, and is duly compressed and ignited, thus completing the cycle for both chambers.

In Fig. II, 19 is a piston, 20 a piston rod, 21 a cylinder, 22 a connection communicating with the liquid in chambers 1 and 2, 23 a connection to a source of pressure slightly greater than that at which it is desired to exhaust the waste products of combustion, 24 a connecting rod, 25 a rocking beam with rollers 26 and 27 at its extremities and with curved arms 28 and 29 extending down to engage with tappets 30 and 31 which project from the locking bar 32 (which is beyond the plane of the section) and which by movement to right or left respectively locks or unlocks the valve-stems 33 and 34 by engaging with the eccentric collars or tappets 35 and 36 attached to said stems. The motion of the rock beam 25 is controlled by guides 37 and 38 along which the rollers 26 and 27 may travel until further movement is restrained by the curved ends of the guides 39 and 40. With the lock-bar 32 in either position one of the valve-stems 33 or 34 is locked and downward movement of that end of the rock-beam 25 carrying the roller resting on that rod is prevented, so that downward movement of the piston-rod 20 causes the other end of the rock-beam 25 to move downward carrying down the valve stem which is not locked, and opening the valve attached to that stem, the roller finally slipping off of the top of this valve stem and leaving it free to close; this movement of the rock-beam 25 at the same time carries the curved arm nearest said valve down to a position below the corresponding tappet attached to the lock-bar 32. The

valve mechanism now remains at rest until the piston 19 begins it up-stroke, but before this occurs, exhaust through the open exhaust valve has been completed and liquid rising in that chamber has (by impact against its under surface or against a plate or float attached to its under surface) closed this valve, returning its valve-stem to its original position. Upward movement of the piston 19 now carries the rock-beam 25 upward without rocking movement, for one of its end rollers is now controlled in a path fixed by the valve stem of the valve which has just been closed, and the curved arm in its upward movement therefore engages with the corresponding tappet of the lock-bar 32 and moves said bar to a position in which the free valve stem is locked and the previously locked valve is released. The compression springs 41 and 42 provided with rollers 43 and 44 which ride along the under side of the rock-beam 25 prevent this beam from rocking in a direction in which it is otherwise unrestrained and the springs 45 and 46 tend to keep the rock-beam 25 in a horizontal position when said beam is above the point of contact with the rollers 43 and 44.

It will readily be understood that our method of operation may be used in operating pumps and compressors of the types herein described and which are provided with three or more combustion chambers, combustion occurring in each in turn, combustible mixture being admitted to one chamber during each out-stroke of the body of liquid, the expulsion of liquid from that chamber causing liquid to flow into and expel waste products of combustion from the chamber in which the last preceding combustion occurred.

Having described our invention we claim:

1. The hereinbefore described method of operating direct acting internal combustion pumps provided with a plurality of combustion chambers, in which pressure developed by the combustion is directly transmitted to a body of liquid designed to act as an oscillating fly-wheel, which consists in igniting a compressed charge of combustible mixture contained in one of said chambers, in opening an exhaust and in closing communication between said chambers and said body of liquid when the waste products of combustion have expanded to the volume at which it is desired to discharge said waste products, in opening an inlet to permit the entrance of a new charge of the combustible medium into another chamber, in introducing a new charge of combustible mixture through said inlet thus displacing liquid from said chamber and causing a like volume of liquid to flow into the chamber containing waste products of combustion, thereby simultaneously displacing and discharging through said exhaust a volume of said waste products equal to the volume of liquid flowing into said chamber, and in completing the introduction of the required charge of combustible mixture before the return-stroke of said oscillating body of liquid.

2. The hereinbefore described method of operating direct acting internal combustion pumps provided with a plurality of combustion chambers, in which pressure developed by the combustion is directly transmitted to a body of liquid designed to act as an oscillating fly-wheel, which consists in igniting a compressed charge of combustible mixture contained in one of said chambers, in opening an exhaust and in closing communication between said chambers and said body of liquid when the waste products of combustion have expanded to the volume at which it is desired to discharge said waste products, in opening an inlet to permit the entrance of a new charge of the combustible medium into another chamber, in introducing a new charge of combustible mixture through said inlet thus displacing liquid from said chamber and causing a like volume of liquid to flow into the chamber containing waste products of combustion, thereby simultaneously displacing and discharging through said exhaust a volume of said waste products equal to the volume of liquid flowing into said chamber, in completing the introduction of the required charge of combustible mixture before the return-stroke of said oscillating body of liquid, and in causing the return-stroke of said body of liquid to discharge through said exhaust any remaining waste products, to close said exhaust and to compress said charge of combustible mixture in preparation for the combustion thereof.

3. The hereinbefore described method of operating direct acting internal combustion pumps provided with a plurality of combustion chambers, in which pressure developed by the combustion is directly transmitted to a body of liquid designed to act as an oscillating fly-wheel, which consists in igniting a compressed charge of combustible mixture contained in one of said chambers, another chamber containing a small compressed gaseous cushion, in opening an exhaust and in closing the communication between said chambers and said body of liquid when the waste products of combustion have expanded to the volume at which it is desired to discharge said waste products, in opening an inlet to permit the entrance of a new charge of the combustible medium into the chamber containing the gaseous cushion after the expansion thereof, in introducing a new charge of combustible mixture through said inlet thus displacing liquid from said chamber and causing a like volume of liquid to flow into the chamber containing waste prod-

ucts of combustion, thereby simultaneously displacing and discharging through said exhaust a volume of said waste products equal to the volume of liquid flowing into said chamber, and in completing the introduction of the required charge of combustible mixture before the return stroke of said oscillating body of liquid.

4. The hereinbefore described method of operating direct acting internal combustion pumps provided with a plurality of combustion chambers, in which pressure developed by the combustion is directly transmitted to a body of liquid designed to act as an oscillating fly-wheel, which consists in igniting a compressed charge of combustible mixture contained in one of said chambers, another chamber containing a small compressed gaseous cushion, in opening an exhaust and in closing the communication between said chambers and said body of liquid when the waste products of combustion have expanded to the volume at which it is desired to discharge said waste products, in opening an inlet to permit the entrance of a new charge of the combustible medium into the chamber containing the gaseous cushion after the expansion thereof, in introducing a new charge of combustible mixture through said inlet thus displacing liquid from said chamber and causing a like volume of liquid to flow into the chamber containing waste products of combustion, thereby simultaneously displacing and discharging through said exhaust a volume of said waste products equal to the volume of liquid flowing into said chamber, in completing the introduction of the required charge of combustible mixture before the return stroke of said oscillating body of liquid, and in causing the return-stroke of said body of liquid to discharge the remaining waste products except a small gaseous cushion, to close said exhaust and to compress said cushion and the said charge of combustible mixture in preparation of the combustion thereof.

In testimony whereof we have hereunto signed our names at Philadelphia, Pennsylvania, this first day of May 1911.

HENRY M. CHANCE.
THOMAS M. CHANCE

Witnesses:
CHAS. BUSH,
E. R. BARNARD.