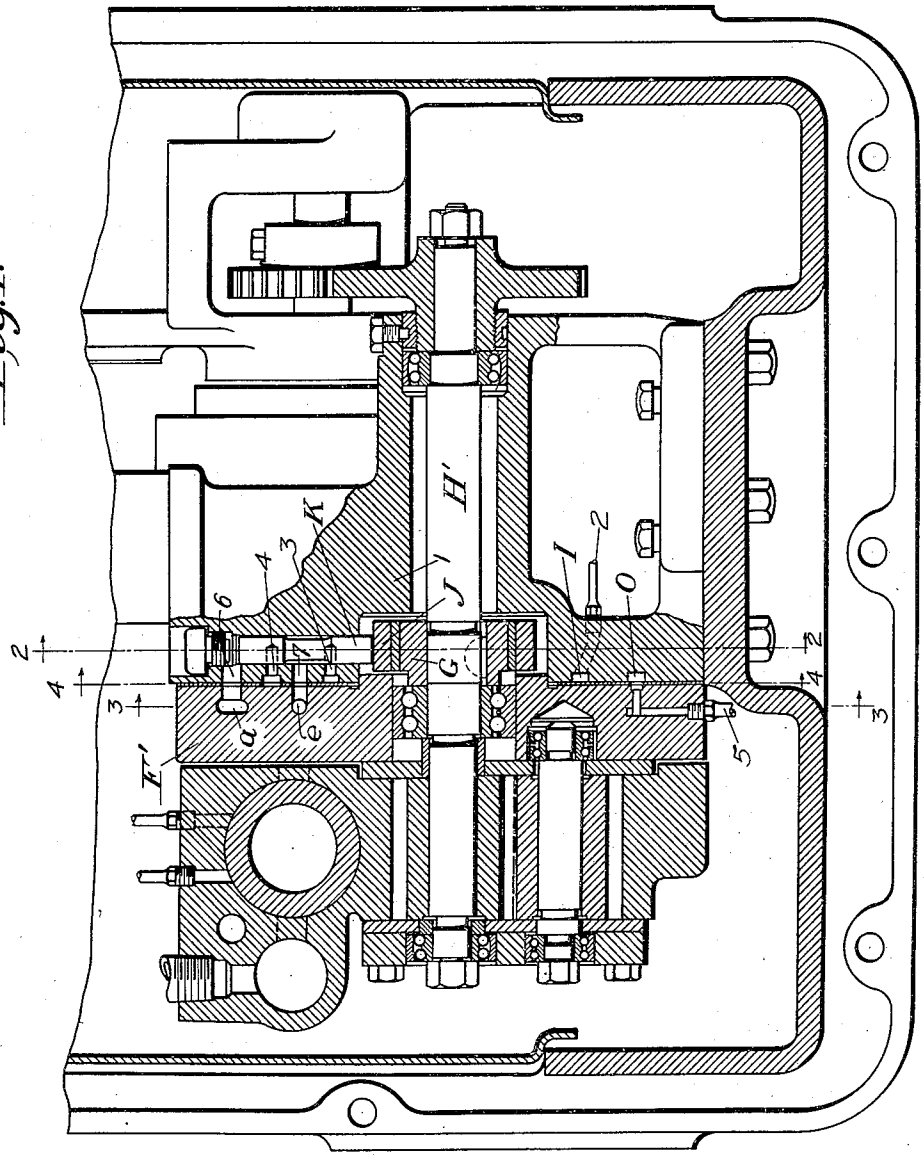
Jan. 10, 1933. H. ERNST 1,893,825

HYDRAULIC TRANSFORMER

Filed Dec. 6, 1929 2 Sheets-Sheet 1

Fig. 1.



Inventor

Hans Ernst

By Nathan & Bowman

Attorneys

Jan. 10, 1933. H. ERNST 1,893,825

HYDRAULIC TRANSFORMER

Filed Dec. 6, 1929 2 Sheets-Sheet 2

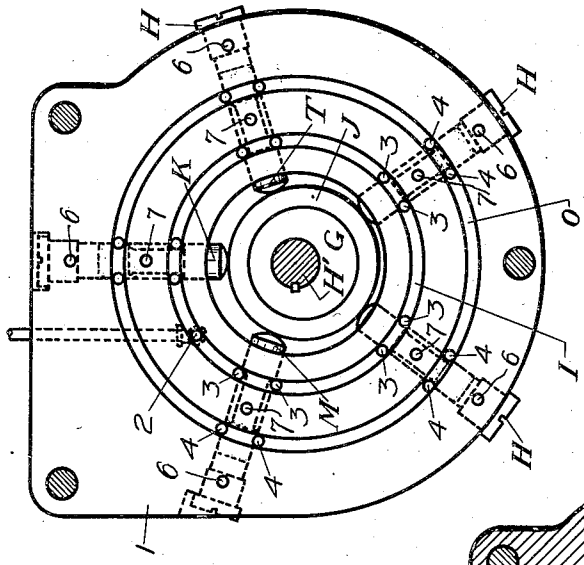


Fig. 4.

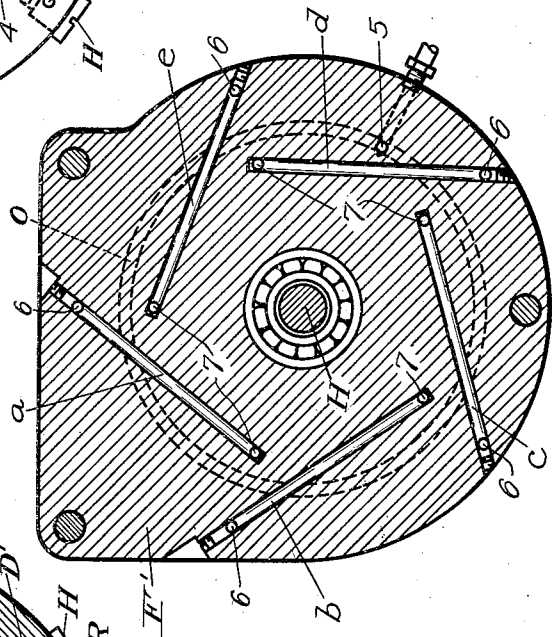


Fig. 3.

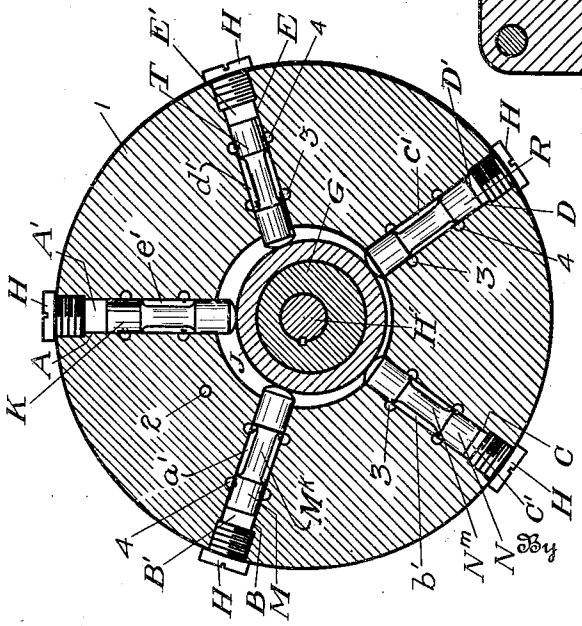


Fig. 2.

Inventor

Hans Ernst

Nathan & Bowman

Attorneys

Patented Jan. 10, 1933 1,893,825

UNITED STATES PATENT OFFICE

HANS ERNST, OF CINCINNATI, OHIO, ASSIGNOR TO THE CINCINNATI MILLING MACHINE COMPANY, OF CINCINNATI, OHIO, A CORPORATION OF OHIO

HYDRAULIC TRANSFORMER

Application filed December 6, 1929. Serial No. 412,231.

This invention proposes a simplified fluid actuator suitable to use as a motor or a pump according to whether it be desired to convert energy of fluid under pressure into mechanical movement, or to utilize the energy of available mechanical movement for increasing that of fluid.

Inasmuch as this invention is equally applicable for a motor or its converse, a pump, in the interest of both brevity and clearness, it may best be explained through its exemplification as a pump; it being understood, however, that the terminology will involve certain converse terms which are to be regarded as words of description rather than of limitation.

The fewer the parts, ceteris paribus, the closer to perfection, and this is the primary aim of my invention which was derived from my conception that a single unit could be contrived to serve a dual office; i. e. as a piston per se and also as a valve for a corresponding unit, and so on to whatever extent desired. Thereby could be attained a pump or motor of the positive cycle type yet of unprecedented simplicity.

This invention contemplates, in its physical sense, a series of plungers or so-called pistons arranged either in line or in ring, as may be preferred, and all cyclically related by their mechanical engagement with a common crank or cam shaft which is rotatively driven by the pistons, when a motor, or rotatively driven by external power, when a pump. A portion of each piston, preferably its skirt is grooved valve-like. Each piston, of course, reciprocates in its cylinder; the various cylinders being cast or otherwise formed in any manner desired but being ported and channeled to provide for the inlet and discharge of the fluid. A significant and characteristic feature of the conduit system of these cylinders is that, before the fluid can enter the head or working-chamber of a given cylinder, it must first be permitted to flow through an intermediate portion of a related cylinder. So also, the fluid may exit from that given cylinder only when permitted to flow through an intermediate portion of a related cylinder. The permission, as has been previously mentioned, is afforded at the proper time by the valve-formation of the skirt of the piston in such related cylinder or cylinders, as the case may be. The timing of the pistons is determined by a cam or crank-shaft, and the length of their strokes by the eccentricity with reference to any given cylinder, among the series, for its related cylinder, there should be selected one disposed at, or about at, a quadrant in the cycle; to wit, at a phase-angle as near to 90° as the number of cylinders will permit. With four units, the phase angle will be 90°; with five units, it will be 72°; with nine units, it will be 80°; etc.

Where the above-mentioned principles are embodied in an internal combustion engine, the work-chamber of each cylinder will be provided with the spark plug of a conventional ignition system, and the conduit system for the supply-fluid may be fed by an explosive gas, as from a suitable carburetor. In this case, a four stroke cycle is preferable. Or where there is available a source of elastic fluid under pressure, as from a steam-boiler, or from a common combustion chamber of the type maintaining automatically a constant pressure of hot gas, each piston valve will be proportioned and timed in its cut-off to furnish an expansion stroke at each forward stroke of the propelled piston; a two-stroke cycle being resorted to.

How the fundamentals of this invention may be so applied in a practical way, will be more thoroughly understood by those skilled in the art upon considering the specific example which is herein detailed.

Figure 1 is a vertical section of a pump adapted for boosting the pressure of an incompressible fluid, such as oil, in an hydraulic system used for actuating a machine-tool. Figures 2 and 3 are cross sections through lines 2—2 and 3—3 respectively, of Fig. 1. Fig. 4 is a face view along line 4—4 of Fig. 1.

The cylinders, A, B, C, D and E are formed, it matters not how in point of detail, by a suitable casing-means which, in its elementary form, is here shown as a main casting 1. This is bored out at spaced in-

tervals, radially in this example as seen best in Fig. 2, and their ends are closed by appropriate cylinder-head means H which may be, and preferably are, removable.

Each cylinder comprises two portions; a work-chamber (A′ B′ C′ D′ and E′) and a valve-chamber (*a′*, *b′*, *c′*, *d′* and *e′*) and these are respectively connected (except when closed by the valve) by ports 6, conduits *a*, *b*, *c*, *d*, and *e* and port 7. In this illustrated case, these conduits each convey the fluid as well to as from the respective work-chambers; for example, fluid in work-chamber A′ of one cylinder passes to or from valve chamber *a′* of a related cylinder, through port 6, conduit *a*, and port 7; work-chamber B′, connects with valve chamber *b′*, etc.; this arrangement being quite suitable, from the standpoint of simplicity, where the fluid is in the nature of a liquid, such as oil, which is but slightly compressible. But where a combustible gas is contemplated, it is more desirable to use a lead-in conduit and also a separate lead-out conduit for each work-chamber. Otherwise some, even if not much, energy will be lost; to wit, that of the amount of unconsumed gas. It may be remarked, as a matter of practical manufacture, that these conduits admit of being made very readily by a drilling operation, as will be seen from Fig. 3, and this likewise applies of others to be described.

To bring the fluid from its external source to each valve-chamber, ready for passage therethrough when the valve is appropriately positioned, it is proposed to provide the casing means with a first conduit system for the supply-fluid. This is herein indicated generally by the character I and need be nothing more than passage-ways extending from a common inlet port 2 to port-grooves 3, 3, 3, in the wall of each valve-chamber.

Similarly, there is a second conduit-system O for conveying the discharged fluid from the port-grooves 4, 4, 4, to the common outlet port 5.

The annular shape of these two conduit systems is of no consequence and, in the illustrated case, is a mere incident to the fact that this particular casing 1 happened to be made, though it need not have been, with a cover plate F′.

The pistons require but little description for they are made self-evident by the drawings. They are designated by K, M, N, R and T. A suitable portion of each piston-unit (its outer-end in this example) serves as a piston-head. Another portion, which we may call a skirt, is given a valve formation. Thus, the piston M at an intermediate point M^k is grooved after the manner of a piston valve so that it may, according to its shift position, open or cut-off the passage of fluid through the ports 3—7 or 4—7. Thereby one piston serves as a valve for another; the valve-portion M^k acting as the valve for piston K; N^m for M; etc. To illustrate, when piston K reaches the low point of the cam J, ports 3 and 7 are in communication, a preceding piston, T, is moving inwardly, and fluid from the common conduit I passes through channels 3, valve chamber *e′* of the cylinder A, channels 7, *e*, and 6 to the work chamber E′ of the related cylinder E. Further movement of the cam moves the valve piston K outwardly, closing off inlet ports 3 and connecting conduit *e* and port 7 with the discharge ports 4. As piston T moves outwardly, under the further action of the actuator J, the fluid in the work chamber E′ is discharged back through channels 6, *e*, 7, valve chamber *e′*, ports 4 to the common discharge channel O and line 5. When the last mentioned piston has started its inward stroke, its related piston K will have moved to a position closing discharge ports 4 and again connecting intake ports 3 with port 7. Meanwhile, valve piston T is controlling the flow to and from cylinder D; valve-piston R, cylinder C, etc.

For co-ordinating the reciprocations of the various pistons, and at the same time serving to receive from or apply power to them, a rotary mechanism common to each piston will be employed. In this example, the axis of rotation of this mechanism, is concentric to all the pistons; this being an incident of this instance in which the pistons have been radially arranged, though of course they may be arranged in line after the conventional manner of an automobile engine.

Here, the mechanism assumes its most elementary form as a single simple circular cam G set eccentrically on a shaft H′. To reduce the friction, a ball-bearing ring J is mounted on the cam. The inner ends of the pistons set against the ring J which thereby controls their positions and movements. This construction is quite suitable for oil pumping, but in certain other embodiments it will be desirable to use a conventional crank-shaft connected positively to each piston.

It will be noted that, in this example, the eccentricity of the mechanism is fixed and consequently the pistons have an invariable throw and a constant volume will be pumped if the shaft H′ be driven at a constant speed. But should it be desirable to have a variable delivery pump, it is only necessary to arrange for an adjustment in the eccentricity of the mechanism, adopting any of the well-known adjusting means heretofore commonly used in any sort of variable-adjustment pumps.

Apart from those already mentioned, many advantages will be perceived. The valve action is positive and not dependent upon springs and no separate valve mechanisms are required. And furthermore a very important object is attained in that the mecha-

nism admits of being manufactured cheaply and accurately. And as a finished article, it is rugged, fundamentally simple and capable of withstanding hard service.

Without further analysis, the foregoing will so fully reveal the gist of this invention that others can, by applying current knowledge, readily adapt it for various utilizations by retaining one or more of the features that, from the standpoint of the prior art, fairly constitute essential characteristics of either the generic or specific aspects of this invention and, therefore, such adaptations should be, and are intended to be, comprehended within the meaning and range of equivalency of the following claims:—

Having thus revealed this invention, I claim as new and desire to secure the following combinations and elements, or equivalents thereof, by Letters Patent of the United States:—

1. An hydraulic pump device combining a series of radially arranged pistons; a reduced valve portion formed intermediate the ends of each piston; casing means providing cylinders for the pistons, and also providing concentric annular channels, one for supply fluid and one for exhaust fluid, a series of ports connecting the said channels with portions of the respective cylinders, said casing also providing a series of tangential conduits connecting the end portion of each cylinder with an intermediate portion of a related cylinder; and means for cyclically actuating said pistons to cause fluid to be discharged from the cylinders and to position the pistons of related cylinders so that the valve portion thereof establishes communication between said cylinders and said exhaust channel and said cylinders and said supply channel in a predetermined sequence.

2. A mechanism of the nature disclosed combining a series of radially arranged similar pistons, each having a head portion, and a valve portion formed intermediate its ends; casing means providing radially disposed cylinders for said pistons, each cylinder having a work chamber and a valve chamber, said casing means having an annular channel formed therein for supply fluid and an annular channel formed therein for exhaust fluid, said channels being concentrically arranged, a series of cross-ports connecting the respective channels with the valve portions of the respective cylinders, said casing also providing a series of tangentially arranged conduits each connecting the work chamber of one cylinder with the valve chamber of a related cylinder; and means for cyclically and independently actuating said pistons to cause the valve portions thereof to establish communication first between said supply channel and said work chambers and then between the work chambers and said exhaust channel.

3. A force pump combining a series of radial pistons, each having a head portion; a valve portion formed intermediate the ends of each piston; casing means providing radial cylinders for said pistons each having a work chamber and a valve chamber, said casing means having two concentric channels formed therein and arranged substantially in the same plane, one for supply fluid and one for exhaust fluid, each of said channels being in communication with the respective cylinders, said casing also providing a series of tangentially arranged conduits each connecting the work chamber of one cylinder with the valve chamber of a related cylinder; and means for independently actuating said pistons to cause the valve portions thereof to establish communication between said supply channel and said work chambers and between the work chambers and said exhaust channel in a predetermined cycle.

4. A mechanism of the nature disclosed combining a series of similar pistons; casing means providing cylinders for said pistons each having a work chamber and a valve chamber, said casing means also having two concentrically arranged channels formed therein and arranged substantially in the same plane and providing a conduit system for supply fluid and a conduit system for exhaust fluid, ports arranged transversely of said channels and connecting the channels with said cylinders; a series of tangentially arranged conduits, each conduit being in constant communication with the work chamber of one cylinder and the valve chamber of a related cylinder; means for controlling the discharge from said cylinders comprising a reduced portion formed intermediate the ends of each piston adapted in one position thereof to connect one of said channels with said tangential conduit and in another position thereof to connect said tangential conduit with the other of said channels; and means for actuating said pistons.

In witness whereof, I have hereunto subscribed my name.

HANS ERNST.