April 28, 1925. 1,535,659

I. K. FOG

FLUID PRESSURE ENGINE

Filed Feb. 18, 1921 2 Sheets-Sheet 1

Fig. 1.

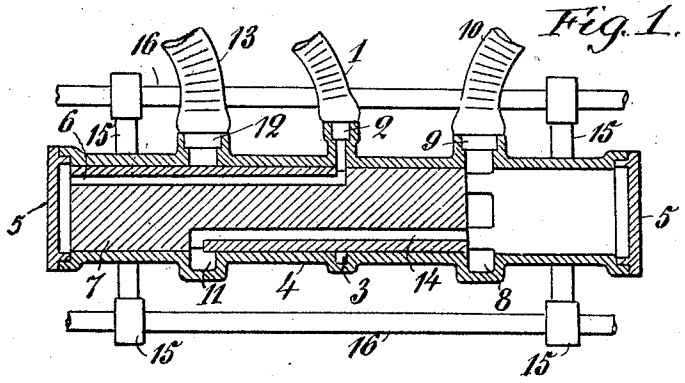


Fig 2.

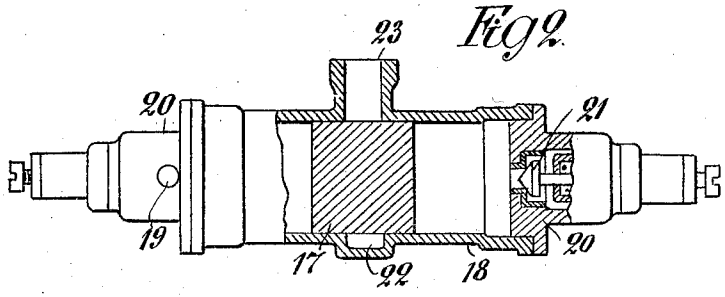
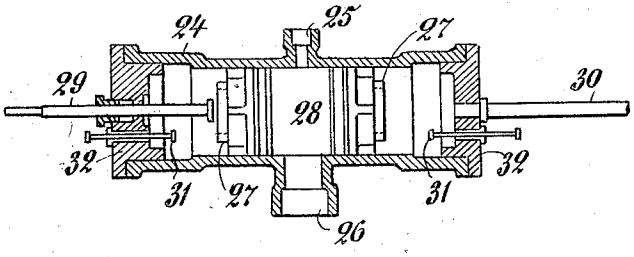


Fig 3.



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Fig. 4.

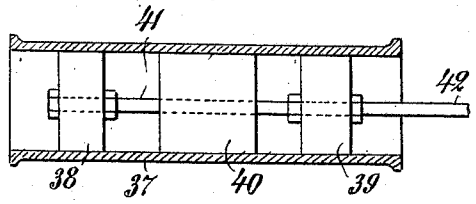


Fig. 5.

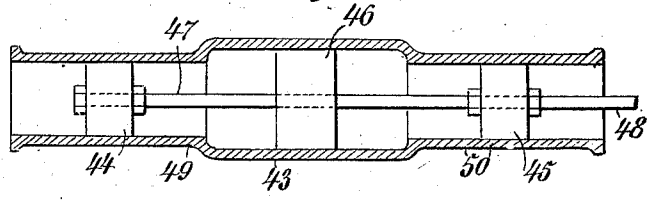
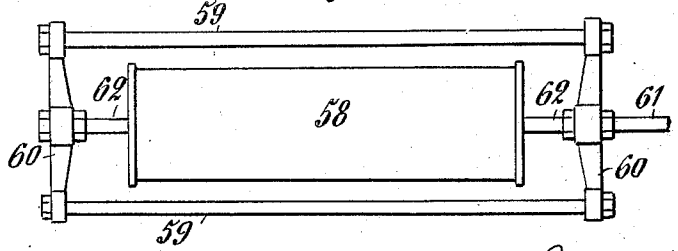


Fig. 6.



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UNITED STATES PATENT OFFICE.

IVAR KÖBKE FOG, OF COPENHAGEN, DENMARK.

FLUID-PRESSURE ENGINE.

Application filed February 18, 1921. Serial No. 446,043.

To all whom it may concern:

Be it known that I, IVAR KÖBKE FOG, a subject of the King of Denmark, residing at Copenhagen, Denmark, have invented new and useful Improvements in and Relating to Fluid-Pressure Engines; and I do hereby declare the following to be a full, clear, and exact description of the same.

This invention relates to fluid pressure engines or driving devices.

In piston engines as hitherto constructed the power developed relatively to the size of engine is rather limited owing to the fact that in each engine the average piston speed must be held below a comparatively low maximum value because the pressure of the driving medium used (such as steam, gas or compressed air) cannot be made sufficiently great to cause a very rapid acceleration of the masses of the piston and the reciprocating parts connected thereto. Another drawback in the known types of piston engines is that a loss of power is necessarily sustained due to friction in stuffing-boxes, in the cross-head, in the connection between connecting rod and crank-pin etc. Although such losses can be made small, especially in large and well constructed engines, yet the mechanical efficiency of the engines cannot be made approximately equal to 1.

The object of the present invention is to provide an engine or driving device capable of developing a high power in comparison to its size, and in which the mechanical losses are made as small as possible. This object is attained partly by so constructing and arranging the engine that the piston, where such is used, can attain an extremely high velocity; and partly by materially reducing the number of parts through which the power generated by the expansion of the driving fluid, are transferred to the energy consumer.

According to the invention the whole cylinder or its end covers, from the former or latter of which the generated power is taken off, are movable in the direction of the axis of the cylinder, while the piston moves freely (without any piston or connecting-rods) in the cylinder under the influence of the driving fluid which is supplied alternately to the opposite ends of the cylinder. Thus it is understood that the pressure of the driving fluid is not transferred by means of the piston to the energy consumer, but the piston operates as a movable pressure bottom, so that the reactions of the forces acting upon the piston cause the cylinder (or its movable covers) to reciprocate. This reciprocating movement of the cylinder or its covers is directly transferred to the energy consumer which latter may be electrical or mechanical.

The number of reciprocations of the engine per unit of time is dependent upon the weight of the piston, and consequently the maximum number of reciprocations is obtained when the piston is wholly omitted. In the latter instance the sole weight of the driving fluid creates the above mentioned reaction.

The invention will be further explained with reference to the accompanying drawings in which are shown diagrammatically some example of construction of the engine according to the present invention.

In the said drawings:—

Fig. 1 is an axial section through an engine having a heavy piston provided with channels for distributing the driving fluid;

Fig. 2 shows an elevation and partly sectional view of an engine provided with a light piston and valve gear;

Fig. 3 is an axial section through an engine working on the internal combustion principle;

Fig. 4 is a longitudinal section of an engine provided with mutually connected sliding cylinder end covers, the diameter of which is equal to that of the piston;

Fig. 5 shows in a similar manner a longitudinal section of an engine, in which the sliding cylinder covers and the piston have different diameters;

Fig. 6 is a plan view of an engine the interior parts of which may be constructed in a manner similar to that indicated in Fig. 4, the connection between the movable cylinder covers lying, however, outside the cylinder.

The following characteristic features are common to all of the examples of construction shown in Figures 1–3.

The cylinder which is closed at both ends and arranged to move axially to and fro is supplied alternately with pressure energy at opposite ends, so that the mass of the piston moving freely, in the cylinder without the use of connecting rods, or in the case of a piston-less engine, the mass of the expanding fluid, owing to the expansion of the lat-

ter receives energy in the form of kinetic energy. The cylinder likewise receives energy in the form of kinetic energy, but in the opposite direction to that of the piston or the expanding fluid, and in such a manner that compression takes place, at the end of the cylinder where no expansion occurs at the moment.

Thus when the expansion and the compression are completed the relative velocity between the piston and the cylinder is at zero. Part of the kinetic energy is converted into pressure energy whereas the balance of the generated energy minus the power losses is taken away from the engine from outside by braking the movement of the cylinder.

At the moment when the relative speed is at zero (the piston or the driving fluid is standing still with respect to the cylinder the expanded fluid is exhausted to an extent which forms the equivalent of the energy taken away from the engine (the available energy) plus the power losses. The available energy is taken away from the cylinder by braking its reciprocating movement as stated above.

The various constructions illustrated in Figures 1–3 will now be described.

In the construction shown in Fig. 1, the engine is supplied with the driving fluid, such as steam or compressed air, through a flexible hose or tube 1, an inlet branch 2 and a circumferential groove or channel 3 formed in the wall 4 of the cylinder, the latter being closed at both ends by covers 5.

In the position of the piston 7 shown in the drawing a conduit 6 in the piston communicates with the circumferential groove 3, so that the driving fluid streams to the left end of the cylinder 4 thereby forcing the piston 7 towards the right cylinder end. When the connection between the channel 6 and the groove 3 is shut off no more driving fluid is admitted, and the expansion of the fluid in the left end of the cylinder then commences. At the same time the right end of the cylinder 4 is in communication with the exhaust passages 8 and 11 and the exhaust takes place partly through the outlet branch 9 and the flexible hose 10 and partly through the bore or channel 14 of the piston, the outlet branch 12 and the flexible hose 13. The piston moves constantly towards the right and simultaneously the cylinder 4 moves towards the left. As soon as the right end of the piston 7 and the outlet of the conduit 14, terminating at the cylindrical surface of the piston, pass the exhaust passages 8 and 11 respectively the exhaust is cut off, and compression begin in the right end of the cylinder. When the left end of the piston 7 and the inlet opening of the conduit 6 reach the passages 11 and 8 respectively, the exhaust of expanded fluid from the left end of the cylinder begins, and when the inlet opening of the conduit 14 comes in to communication with the groove 3 the driving fluid is admitted to the right end of the cylinder. Just a moment later the relative velocity between the cylinder and the piston becomes zero, whereafter the movements are continued in directions opposite to those above indicated, and in this manner the operation of the engine continues.

The cylinder 4 is guided during its movements by means of cylinder supporting arms 15 which are adapted to slide along stationary guide rods 16.

In Figures 2 and 3 the flexible hose connections and the means for guiding the cylinder are not shown.

In the construction shown in Fig. 2 the piston 17 is short and is not provided with conduits. The cylinder 18 is supplied with driving fluid through openings 19 in the covers 20, the admission of fluid being controlled by valves 21 operated in a suitable manner not indicated on the drawing.

The expanded fluid escapes through the circumferential groove 22 and the outlet branch 23 communicating therewith, and the cylinder ends are alternately and automatically put in connection with this groove 22 and disconnected therefrom through the motion of the piston as will be understood from the above explanation of the operation of the engine illustrated in Fig. 1.

In the construction shown in Fig. 3 the pressure energy of the driving fluid is created by internal combustion in the cylinder 24, the fuel and air being admitted through the branch 25, while the exhaust gases escape through the outlet branch 26. Thus it will be understood that the embodiment in question works on the same principle as the well known valve-less two-stroke-internal combustion engines. The fuel and air mixture is ignited by means of electric sparks produced between rods 31 insulated from the cylinder covers and annular projections 27 upon the ends of the piston 28, said rods and projections co-acting in a manner similar to that of the well known make and break contacts. The engine is started by means of a displaceable rod 29, and during running of the engine the available power is transmitted to the energy consumer, (which may be an electric generator not shown) by means of the rod 30.

The inlet branch 25, is, by means of a flexible hose such as the hose 1 shown in Fig. 1 or by means of two telescopic pipes, connected with some suitable source of air and fuel mixture, for example a carburetter or a receptacle into which fuel and air

mixture is pumped by a separate pump. Let us now assume that the piston 28 occupies the position shown in Fig. 3 and is moving towards the right. The left cylinder space then contains expanding combustion gases and the right cylinder space contains a mixture of fuel and air. This charge is compressed during the movement of the piston towards the right, and when the left hand end of the piston uncovers the branch 26, the exhaust begins, and during a short movement later the piston end also uncovers the inlet branch 25 whereby the fresh charge will rush into the cylinder, forcing the remainder of the exhaust gases out through branch 26. The compressed charge in the right end of the cylinder is then ignited so that the piston is driven towards the left, and so on.

The construction of the invention shown in Figures 4, 5 and 6 differ from those shown in Figures 1–3, in that the covers of the cylinders are movable as pistons in the cylinder and are mutually connected by connecting rods lying inside or outside the cylinder. By this arrangement the cylinder proper can be made stationary so that the use of flexible hose connections can be obviated. The reactions of the forces acting upon the pistons cause the cylinder covers to move to and fro, and this reciprocating movement of the covers is transferred directly to the energy consumer.

The length of the travel of the movable cylinder covers with respect to the length of the travel of the piston may be varied by making the movable cylinder covers of a diameter different from that of the piston.

In Fig. 4 the cylinder is designated by 37, while 38 and 39 are the movable cylinder covers, 40 the piston, 41 a rod connecting the covers with each other, and 42 a rod for transmitting the power generated.

In Fig. 5 the part 43 of the cylinder in which the piston 46 reciprocates freely has a diameter different from the diameters of the cylinder ends 49 and 50 in which the covers 44 and 45 slide, whereby the length of travel of the inter-connected cylinder covers differ from that of the piston. The numeral 47 indicates a rod connecting the covers with each other, and 48 is a rod whereby the power generated may be transmitted to the energy consumer.

Fig. 6 shows a construction in which the movable covers (not shown) of the cylinder 58 are mutually connected by means of rods 62, transverse pieces 60 and connecting bars 59. The power generated is transmitted by means of the rod 61 which is firmly connected to the cylinder cover unit.

It should be noted that the word "cylinder" as used in this description and the following claims is not restricted to the ordinary meaning of this expression, but is intended to cover all such oblong containers and the like in which an elastic fluid expands for the purpose of generating power.

It should also be noted that where in this specification and the claims I refer to a freely-sliding piston or a freely-reciprocating piston, these terms are intended to cover a piston which reciprocates in the cylinder under the influence of the driving fluids without the use of mechanical connections, so that the piston does not transmit useful energy to exterior parts but serves only as a recoil element and to compress the fluid alternately at opposite ends of the cylinder.

Having this fully described my invention I claim as new and desire to secure by Letters Patent:

1. An engine or driving device comprising a cylinder, means for supplying driving fluid, alternately to the opposite ends of the said cylinder, means for exhausting said driving fluid when expended, a piston sliding freely in said cylinder and adapted to reciprocate therein under the influence of the driving fluid, said piston not being mechanically connected with any other part or parts of the engine and serving only as a recoil element and to compress the driving fluid alternately at opposite ends of the cylinder, and means independent of said piston for transmitting the power generated by the expansion of said fluid.

2. An engine or driving device comprising a cylinder arranged for reciprocating movement in the direction of its axis means for supplying driving fluid alternately to the opposite ends of the said cylinder, means for exhausting said driving fluid when expanded, and a piston sliding freely in said cylinder and acted upon alternately by the driving fluid from opposite ends of the cylinder, said piston not being mechanically connected with any other part or parts of the engine and said piston being adapted to act as a yielding pressure-bottom for causing the reaction of the forces acting upon the piston to impart a reciprocating movement to the cylinder.

3. An internal combustion engine or driving device comprising a cylinder, means for supplying fuel and air alternately to the opposite ends of the said cylinder, means for exhausting combustion products formed by combustion of said fuel, and a piston sliding freely in said cylinder and adapted to reciprocate therein under the influence of the expanding combustion products said piston not being mechanically connected with any other part or parts of the engine.

4. An internal combustion engine or driving device comprising a cylinder arranged for reciprocating movement in the direction of its axis, means for supplying fuel and air alternately to the opposite ends of the said cylinder, means for exhausting combustion

products formed by combustion of said fuel; and a piston sliding freely in said cylinder and acted upon alternately by the combustion products expanding in the opposite ends of the cylinder said piston not being mechanically connected to any other part or parts of the engine.

In testimony whereof I have affixed my signature in presence of two witnesses.

IVAR KÖBKE FOG.

Witnesses:
VIGGO BLOM,
CECIL V. SCHOLL.