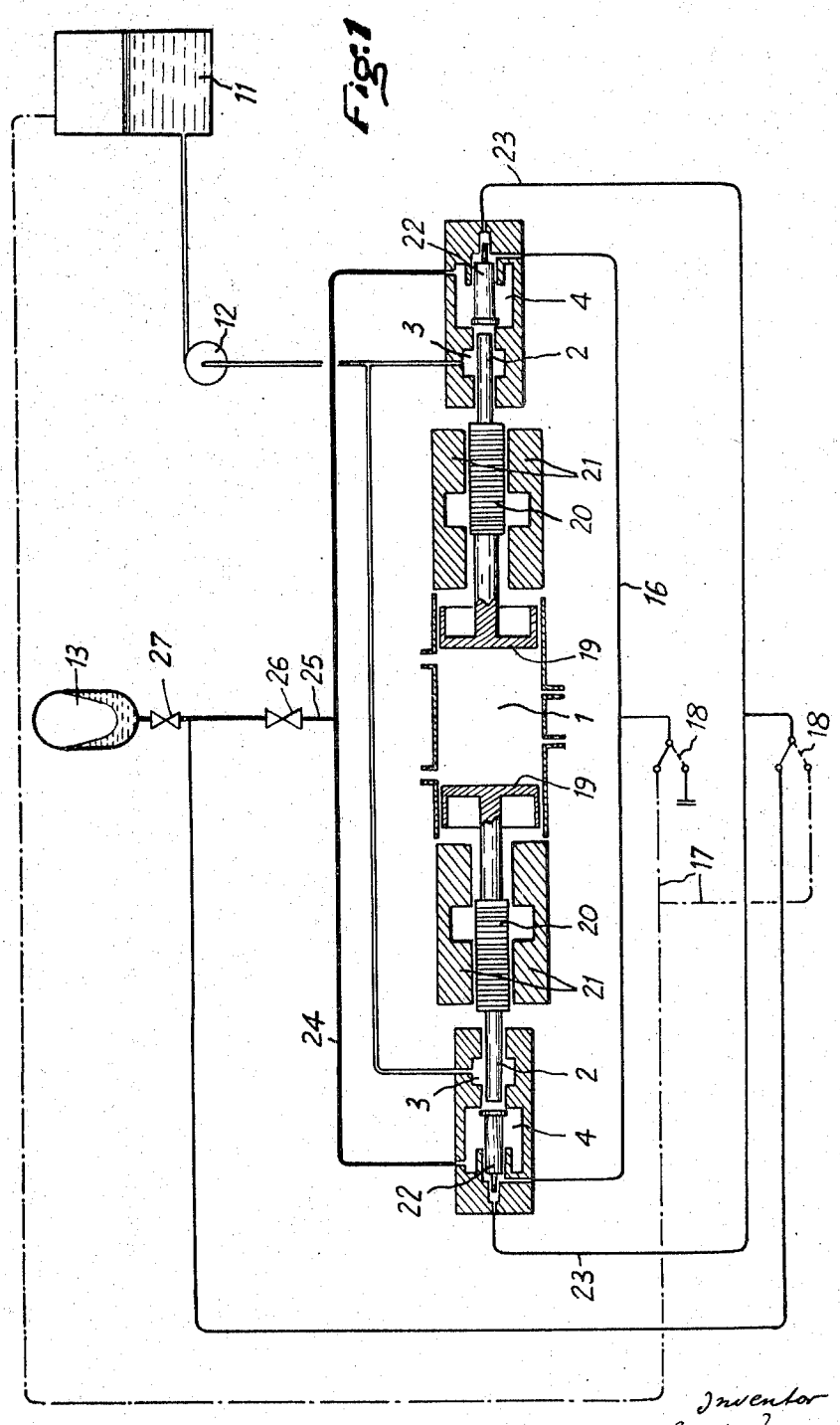
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ENGINE STARTING DEVICE

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Fig. 1



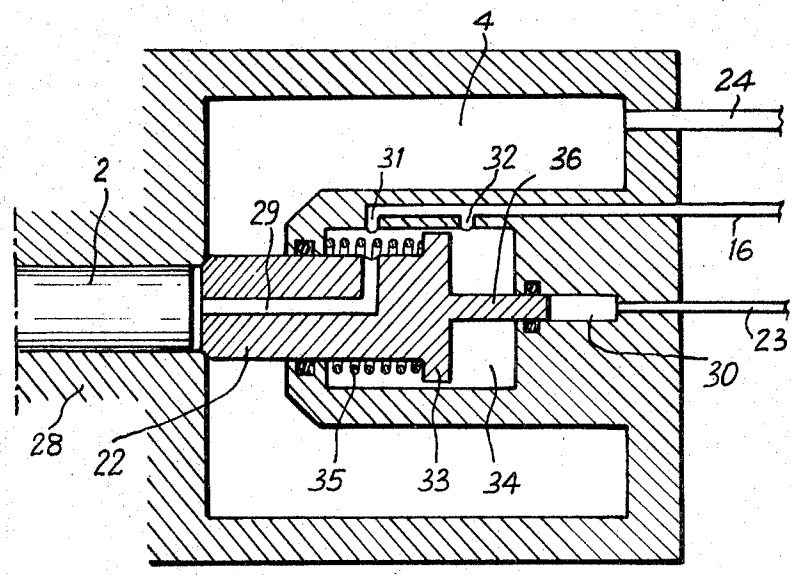
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Fig. 2



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ENGINE STARTING DEVICE

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5 Claims. (Cl. 123—46)

The present invention relates to engines.

More particularly, the present invention relates to engine starting devices.

The present invention is particularly adapted for use with two-stroke diesel engines where the cylinder of the diesel engine has a pair of floating pistons slideable therein. These floating pistons deliver the work to any desired source for which the engine is used and the pair of floating pistons move from outer dead center positions in synchronism toward each other to inner dead center positions and then back tto the outer dead center positions. In engines of this type it is possible to use a hydraulic means which stores the energy of the pistons as they move outwardly away from each other so as to return the pistons inwardly toward their dead inner center positions whereupon an explosion takes place in the cylinder so as to again throw the pistons away from each other outwardly to their outer dead center positions.

It is of course important with engines of this type to maintain the pair of freely floating pistons functioning in opposition to each other and the pistons should also be maintained in synchronism, and it is preferred to maintain this synchronism electrically by a known structure which includes a pair of armatures respectively connected to the pistons for movement therewith and moving through coils supplied with electrical energy so that in this way magnetic forces are set up to automatically react when there is any tendency of one piston to become out of phase with the other in such a way as to retard the movement of one of the pistons and restore the synchronism therebetween. Through this electromagnetic system where there is a variable impedance which changes the flow of flux to produce the above retarding force in an automatic manner it is possible to maintain the pair of floating pistons in synchronism without providing any mechanical connection therebetween. The electromagnetic system for maintaining the pistons in synchronism does not form part of the present invention and may have the construction shown, for example, in French Patent No. 1,163,512.

It is extremely important with structures of this type to start the engine in such a way that the pair of pistons move simultaneously from their outer dead center positions toward each other toward their inner dead center positions during the initial stroke of the engine, and the present invention primarily relates to structure for guaranteeing the simultaneous movement of the pair of floating pistons toward each other in order to start the engine.

The precise starting of an engine of this type depends upon a plurality of different conditions which must be satisfied. In the first place there must be sufficient potential energy stored in order to be able to advance the pair of pistons toward each other in a manner capable of achieving the compression necessary for the diesel engine.

Furthermore, it must be possible for the pair of pistons to remain in their outer dead center positions while there is sufficient energy stored in the structure for moving the pair of pistons from their outer dead center positions toward their inner dead center positions.

In addition, the strokes of the pair of pistons must begin simultaneously.

The initiation of the motion of the pair of pistons simultaneously and in perfect synchronism with each other is extremely difficult to achieve in practice particularly where the pair of pistons are not mechanically interconnected. In a case where there is a suitable linkage such as a parallelogram linkage or the like operatively connected to the pair of floating pistons for guaranteeing that they remain at all times in synchronism, it is a simple matter to start the engine with the force of compressed air.

Of course, the disadvantages of mechanical interconnections between the pistons are avoided with an electromagnetic structure of the type referred to above for maintaining the pistons in synchronism, but in addition, with this latter type of electromagnetic structure it is essential to be able to store sufficient potential energy to guarantee that during the initial stroke of the pistons from their outer tto their inner dead center positions there will be sufficient compression to achieve ignition of the charge in the cylinder in spite of the retarding action which is provided on both pistons by the electromagnetic structure for synchronizing the movement of the pistons.

It is therefore a primary object of the present invention to provide a structure which is capable of guaranteeing proper starting of an engine of the above type where the pair of floating pistons are not mechanically interconnected.

In particular, it is an object of the present invention to achieve proper starting of an engine of the above type with a structure where the pistons are hydraulically driven toward each other.

In particular it is an object of the present invention to provide a structure which will enable sufficient hydraulic pressure to be achieved for bringing about proper starting of the engine while at the same time preventing movement of the pistons until there is sufficient hydraulic pressure available for proper starting of the engine, and for then simultaneously releasing both of the pistons to the force of the hydraulic energy to guarantee the proper starting with the pistons moving in synchronism.

A further object of the present invention is to provide a structure which operates hydraulically to bring about simultaneous initiation of the movement of the pair of floating pistons toward each other.

Also, it is an object of the invention to provide a structure which will operate mechanically to release the pair of pistons for simultaneous movement toward each other.

In particular, it is an object of the present invention to provide a single simple control structure capable of being actuated by the operator in an extremely convenient manner requiring no particular skill on the part of the operator in order to guarantee that the pair of floating pistons are released for movement toward each other at precisely the same instant and in a manner which will guarantee simultaneous movement of the pistons toward each other at the same rates of speed.

With the above objects in view, the invention includes, in an engine, a cylinder and a pair of floating piston means which respectively extend into this cylinder for respective movement from outer dead center positions, respectively, inwardly toward the interior of the cylinder toward each other to inner dead center positions, respectively, and then simultaneously and in synchronism from said inner dead center positions respectively back to said outer dead center positions. A pair of hydraulic means are operatively connected to the pair of floating piston means for respectively urging the latter, at least during starting of the engine, from the outer dead center positions simultaneously toward each other to the inner dead center positions, respectively. A blocking means of the invention temporarily cooperates with at least one of the above two

pairs of means for temporarily blocking movement of the pair of piston means by the pair of hydraulic means respectively from the outer to the inner dead center positions, and a single control means is operatively connected with this blocking means for rendering the latter ineffective to prevent movement of the pair of piston means by the pair of hydraulic means in a manner which simultaneously releases the pair of piston means for movement by the pair of hydraulic means toward each other from their outer to their inner dead center positions, respectively.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is a schematic partly sectional illustration of one possible embodiment of a structure according to the present invention; and

FIG. 2 is an axial sectional view on an enlarged scale of a hydraulic structure of FIG. 1 for controlling the starting of the engine.

Referring to FIG. 1, it will be seen that a pair of floating pistons 19 extends slidably into the cylinder 1 of the engine, these floating piston means 19 forming assemblies movable from their outer dead center positions illustrated in FIG. 1 toward each other to their inner dead center positions and then back to their outer dead center positions. In order to electromagnetically synchronize the movement of the pair of floating piston means 19 they respectively carry armatures 20 which respectively extend through electromagnetic assemblies 21 in the form of coils and magnetic elements which are electrically connected with each other and to a source of electricity in such a way as to electromagnetically maintain synchronism between the pair of floating piston means 19 while they move oppositely to each other, the electromagnetic structure for maintaining synchronism in this way being well known.

During operation of the engine the pair of piston means will move away from each other toward their outer dead center positions where they are most distant from each other, and during this movement they will compress hydraulic liquid, which can take the form of gas oil, the pair of floating piston means 19 including outer piston portions 2 which extend into high pressure chambers 4 in which the hydraulic liquid is situated. During the movement of the pair of piston means 19 outwardly away from each other the pistons 2 respectively enter into the high pressure chambers 4 so as to compress the hydraulic liquid thus storing energy subsequently used for returning the pistons toward each other to provide the required compression as the pistons approach their inner dead center positions.

The pair of high pressure chambers 4 are interconnected by a conduit 24 which communicates with a conduit 25 extending from an accumulator 13 which can contain oil and compressed air above the oil, and this accumulator 13 serves to place the pair of hydraulic means 4 under pressure prior to starting of the engine. The conduit 25 carries a valve 26 which enables the accumulator 13 to be separated from the pair of hydraulic means 4 after the pressure in the latter has been increased to a value sufficient to provide proper starting of the engine.

The structure of FIGS. 1 and 2 includes a blocking means operatively connected to the pair of hydraulic means 4 in order to prevent the latter from moving the pair of piston means from their outer dead center positions toward each other until the blocking means releases the pair of hydraulic means 4. In this embodiment the blocking means takes the form of a pair of elongated valve members 22 situated in the pair of hydraulic high pressure chambers 4. A conduit 23 communicates with the outer ends of the pair of valve members 22. Thus, it will be seen that each valve member 22 has an elongated outer piston portion 36 sliding in a cylindrical chamber 30 with which the conduit 23 communicates. By applying pressure to the piston portions 36 through the conduit 23 and the chambers 30 it is possible to press the valves 22 toward each other so that they engage the valve seat formed at the shoulder of the high pressure chamber 4 where the diameter thereof is reduced to accommodate the piston 2 at the outer end of each floating piston means 19, and as is particularly apparent from FIG. 2 when the valves 22 are pressed in this way to their closed positions illustrated in FIG. 2 the interior of the high pressure chamber 4 cannot communicate with the piston 2. A double valve assembly 18, described in greater detail below and shown in FIG. 1, cooperates with the conduit 23 so as to place the latter either in communication with accumulator 13 or in communication with a reservoir 11, so that when the conduit 23 communicates with the accumulator 13 pressure will be applied to the pistons 36 for closing the valves 22 while when the valve 18 places the conduit 23 in communication with the reservoir 11 through the low pressure return flow conduit 17 the valves 22 are free to move to their open positions so that the high pressure in the chambers 4 can act on pistons 2 so as to drive the pair of floating piston means 19 toward each other.

As is apparent from FIG. 2, the outer portions of the valve members 22 are situated in chambers 34 which are in communication with a conduit 16 which can be placed in or out of communication with the return flow conduit 17 by the double valve assembly 18, as is also indicated in FIG. 1. In each of the chambers 34 the conduit 16 terminates in a pair of openings 31 and 32 situated on opposite sides of a flange 33 carried by each piston 22, and in addition it will be noted that each valve 22 is formed with a bore 29 communicating with the space between the left end of the chamber 34, as viewed in FIG 2, and the flange 33. In addition, a spring 35 is coiled about each valve member 22 between the flange 33 and the left end wall of the chamber 34, as viewed in FIG. 2.

A pump 12 (FIG. 1) communicates with the low pressure chambers 3 from which the hydraulic liquid which is pumped into these chambers 3 from the reservoir 11 is displaced into the high pressure chambers 4 by the pistons 2 during reciprocation of the pair of floating piston means 19. In addition, the structure includes a valve 27 situated between the accumulator 13 and the conduit 23 to separate the accumulator 13 from the conduit 23 as well as the conduit 24 when desired.

Referring to FIGS. 1 and 2, the pair of floating piston means 19 will initially be moved out to their outer dead center positions either electrically by exciting the outer poles of the pair of electromagnetic assemblies 21 which then attract the armatures 20 together with the floating piston means 19 towards the outer dead center or through any suitable structure. During this time the conduit 16 is connected through the conduit 17 to the reservoir 11, The pressure from the accumulator 13 is applied to the chambers 30 through the conduit 23 for advancing the valve members 22 toward each other to their closed positions engaging the housing 28 of the high pressure chambers 4 in the manner described above. In this way the pair of floating piston means 19 can be insulated from the pair of high pressure chambers 4 which can now be placed under a pressure sufficiently high to produce effective starting of the engine. The bore 29 of each valve 22 communicates with the conduit 16 which is connected to the reservoir 11 at this time so as to enable return of any leakage liquid to the reservoir 11.

In order to start the engine, the valve 26 is closed so as to separate the high pressure chambers 4 from the accumulator 13. Also the communication between the conduit 16 and the return flow conduit 17 is terminated. The actuation of the valve 18 to cut off communication

between the conduit 16 and the return flow conduit 17 also acts to cut off communication between the conduit 23 and the accumulator, the conduit 23 now communicating with the return flow conduit 17, so that the springs 35 can now act tto expand and displace the pair of valves 22 away from their closed positions. The result is that a very sudden exposure of the outer piston portions 2 of the pair of floating piston means 19 to the high pressure of the fluid in the chambers 4, so that the considerable force in these chambers is applied to the pair of floating piston means to drive them toward each other. During the movement of the pair of valve members 22 away from their closed positions the flanges 33 thereof will close the outlets 32 of the conduit 16 so as to compress the liquid remaining in the chambers 34 between the right ends thereof, as viewed in FIG. 2, and the bore 32, and thus the compression of the hydraulic liquid remaining in the chambers 34 at this time will act as a cushion to damp the outward movement of the valves 22 away from each other. Thus, the flange 33 also functions as a damping device for cushioning the movement of the valve 22.

In order to guarantee simultaneous movement of the pair of piston means in synchronism with each other at precisely the same instant, the double valve 18 acts as a single unitary control means capable of being actuated in such a way that release necessarily takes place simultaneously at the pair of hydraulic means 4 while at the same time there is also a simultaneous closing of the conduit 16 to terminate communication thereof through the return flow conduit 17 with the reservoir 11.

It is to be noted that an exceedingly simple yet high effective hydraulic circuit is provided by interconnecting the pair of hydraulic means with the common conduits 23 and 16 while a single double-valve assembly 18 cooperates with both of these common conduits to provide the single control means which is capable of releasing the blocking means formed by the pair of valves 22 in perfect synchronism at precisely the same instant so as to produce proper starting of the engine.

It is furthermore to be noted that not only does the structure guarantee simultaneous starting of the pair of piston means 19 but in addition guarantees maintenance of equal pressure on the pair of piston means at each instant.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of engines, differing from the types described above.

While the invention has been illustrated and described as embodied in engine starting devices, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In an engine, in combination, a cylinder; a pair of floating piston means respectively extending into said cylinder for respective movement from outer dead center positions inwardly toward the interior of said cylinder toward each other to inner dead center positions, respectively, and then simultaneously and in synchronism from said inner dead center positions respectively back to said outer dead center positions; a pair of hydraulic means operatively connected to said pair of floating piston means for respectively urging the latter, at least during starting of the engine, from said outer dead center positions simultaneously toward each other to said inner dead center positions, respectively; blocking means operatively connected to said pair of hydraulic means for temporarily blocking movement of said pair of piston means by said pair of hydraulic means respectively from said outer to said inner dead center positions, said blocking means including a pair of valves which are respectively in closed positions preventing communication between said pair of hydraulic means and said pair of piston means while said blocking means temporarily blocks movement of said pair of piston means by said pair of hydraulic means; and a single control means operatively connected with said blocking means for rendering the latter ineffective to prevent movement of said pair of piston means by said pair of hydraulic means in a manner simultaneously releasing said pair of piston means for movement by said pair of hydraulic means toward each other from said outer to said inner dead center positions, respectively.

2. In an engine as recited in claim 1, accumulator means communicating with said pair of hydraulic means for maintaining in the latter fluid under pressure and said accumulator means also communicating with said valves for urging the latter to their closed positions.

3. In a device as recited in claim 2, said single control means simultaneously cutting off communication between said accumulator means and said valves and connecting the latter to a low pressure return line for simultaneously exposing said pair of piston means to the pressure of said pair of hydraulic means.

4. In a device as recited in claim 3, means for directing leakage fluid of said pair of hydraulic means from the latter to a reservoir while said valves are in their closed positions, said single control means preventing flow of leakage fluid from said pair of hydraulic means to said reservoir simultaneously with the release of said blocking means.

5. In an engine as recited in claim 4, said means for directing leakage fluid to said reservoir including a conduit common to said pair of hydraulic means and said accumulator means communicating with both of said valves through a conduit common thereto, said single control means being operatively connected to both of said latter common conduits for simultaneously acting on the latter to cut off communication between said accumulator means and said valves and to prevent return of leakage fluid to said reservoir.

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