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INTERNAL COMBUSTION ENGINES

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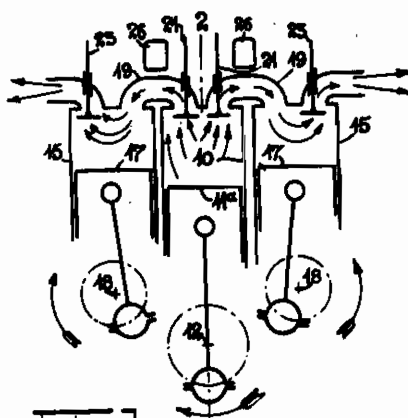

Fig.1.

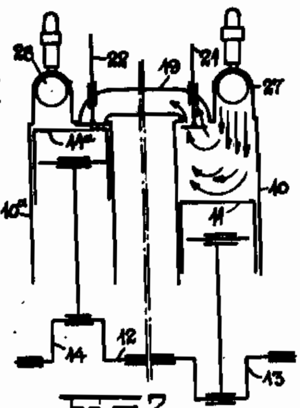

Fig.2.

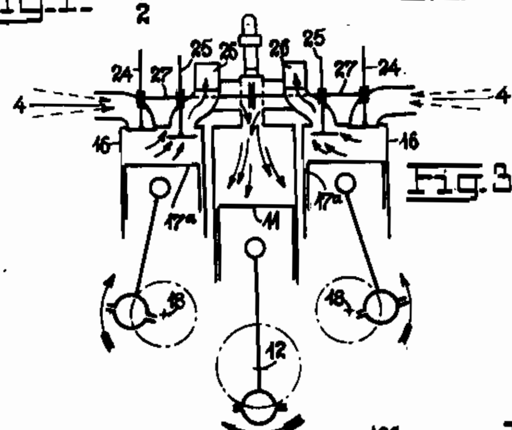

Fig.3.

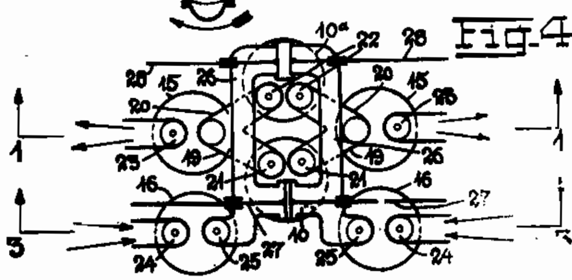

Fig.4.

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INTERNAL COMBUSTION ENGINES

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This invention relates to internal combustion engines and more particularly those operating on a twostroke cycle.

It is well known that the combustion gases of such engines possess a considerable amount of energy at the end of the expansion stroke when the piston in the combustion cylinder is approaching the outer dead centre. Also these gases are usually allowed to exhaust from the cylinder while they still possess an effective pressure of a few atmospheres and a not inconsiderable temperature, which is thus wasted.

Designers of internal combustion engines have made efforts in various ways to utilise the remaining energy of the combustion gases; it is for instance known that a fuller or more complete expansion may be obtained by allowing the combustion gases from the motor to pass into an exhaust turbine, and also boilers adapted to be heated by the exhaust gases have been suggested for the purpose of recovering the heat.

In the case of the exhaust turbine the fuel economy achieved is not particularly great as such an aggregate has certain inherent defects; thus it may be impossible to utilize the full pressure of the exhaust gases, because the pressure will drop considerably during the time that the gases pass from the combustion cylinder into a duct leading to the exhaust turbine. It will be understood that in this duct the gases become mixed with cold air or gases, and therefore the full initial temperature cannot be properly utilised.

Attempts have also been made to achieve a high degree of fuel economy by timing the valves in such a manner that the effective compression stroke is made shorter than the expansion stroke. The result, however, is a power diagram of an unsymmetrical type which will indicate high efficiency, but in actual practice such a diagram does not involve the running of the engine at its full power and output, and therefore there is a loss in mechanical efficiency.

It has also been suggested to pass the combustion gases into a low pressure expansion cylinder in the same way that steam is allowed to pass from a high pressure system cylinder into a low pressure steam cylinder, as in a compound steam engine. Such a principle has, however, not been successfully realised in practice because the corresponding construction becomes rather complicated and a low pressure cylinder should work as a two-stroke cycle and is not suited to an engine working on the four-stroke cycle.

The object of the invention to be hereinafter described is to utilise the energy of the combustion gases in a better way by making suitable arrangements whereby the combustion gases from a two-stroke cycle internal combustion engine are allowed to expand further in a low pressure cylinder.

The invention consists in an improved two-stroke cycle internal combustion engine provided with a pair of combustion cylinders or a multiple thereof and having pistons acting upon a primary crankshaft with a relative crank phase displacement of 180°, both combustion cylinders exhausting alternately into a low pressure cylinder having a piston operatively connected with an auxiliary crankshaft rotating at twice the speed of that of the combustion cylinders, the two crankshafts being so timed that the piston in the low pressure cylinder reaches its inner dead centre when those of the combustion cylinders are at a considerable distance from their respective dead centres.

The invention will now be described with reference to the accompanying drawings which illustrate one form of the improved motor unit according to the invention, in which:

Figure 1 is an elevation in section of the motor unit.

Figure 2 is a sectional elevation taken at a right angle through the centre of Figure 1.

Figure 3 is a vertical section of the engine on the line 3—3 of Figure 4, and

Figure 4 is a sectional plan view of the upper part of the motor on the line 4—4 of Figure 3.

In carrying the invention into effect a motor unit according to the invention will be described, it being understood that such a unit may be duplicated, triplicated or further multiplied according to the total power output desired. The motor unit comprises a pair of combustion cylinders **10**, **10**[a] adjacent one another and each having a piston **11**, **11**[a] respectively, such pistons being operatively connected to a primary crankshaft **12** having cranks **13**, **14** for the respective pistons, the cranks being arranged with a phase difference of 180°, so that when the piston **11** is at its outer dead centre the other piston **11**[a] is at its inner dead centre.

For this group or pair of combustion cylinders there is provided a low pressure cylinder **15** and a scavenging cylinder **16** to which are respectively fitted pistons **17**, **17**[a]. These pistons are operatively connected to an auxiliary crankshaft **18** which is geared through in suitable transmission (not shown) with the primary crankshaft **12** in such a way that the auxiliary crankshaft is driven at twice the speed of the primary shaft **12**.

It will be noticed by reference to Figure 4 that it is preferred to arrange the pair of combustion cylinders on a centre line, and to symmetrically arrange on each side of this pair two low pressure cylinders and also two scavenging cylinders. Such an arrangement makes for compactness and the various parts are balanced and symmetrical.

Both of the low pressure cylinders 15 are connected to the combustion cylinders 10 and 10a through channels 19, 20, so that the combustion gases may pass from the cylinders 10, 10a, to the receptive cylinder 15 whenever the exhaust valve 21 or 22 is opened.

Referring to one side of the motor unit the piston 17 of the low pressure cylinder 15 is controlled by the auxiliary crankshaft 18 in such a manner that it reaches its outer dead centre when the main piston 11 of the combustion cylinder 10, has already made its full expansion stroke and started on its compression stroke. The exhaust valve 21 opens when the piston 11 has reached a position corresponding to approximately 90° of the expansion stroke, and the piston 17 moving at double the speed of the piston 11 will reach its outer dead centre at about the same time as the latter so that the exhaust combustion gases will now be allowed to expand over a much larger volume and thus develop more work. Finally, the fully expanded gases will then excape through the valve 23 into the exhaust manifold.

The valve 23 may advantageously be closed before the piston 17 will reach its inner dead centre with the result that the remaining gases in the cylinder 15 will be subjected to a compression and reach a pressure in the channels 19, 20 that may equal the pressure in the combustion cylinder at the moment when the connection between the combustion and the low pressure cylinders is established. The effect of this will be that the dead space in the channels 19 and 20 will have no detrimental effect when the valve 22 in turn opens and the combustion gases, without loss of power, will pass from the cylinder 10a to the cylinder 15. It is evident that the piston 17 will not reach its full speed until the valve 22 is open and displacement of the combustion gases from the cylinder 10a to the cylinder 15 will take place without any loss of power or heat. Accordingly the valves 21, 22 will not noticeably be affected by heat and it should also be borne in mind that the exhaust gases are cooled down beyond that which is normal, due to the full or complete expansion in the motor unit according to the invention.

The combustion cylinders 10 and 10a may be scavenged and filled with fresh air, or with a mixture of fuel and air, in various ways and by various means. It is, however, an advantage to attain a high degree of supercharging since a high average pressure in the combustion cylinder will be profitably utilised owing to the extra degree of expansion which is effected. A high degree of supercharging may advantageously be obtained by giving each group of combustion cylinders 10 and 10a a scavenging cylinder 16 common to both, which as previously stated is driven through the auxiliary crankshaft 18 at twice the speed of the pistons 11 and 11a. This scavenging cylinder 16 has an intake valve 24 and it may also be provided with an outlet valve 25 for the purpose of rendering the dead space in the channel 26 harmless. The channel 26 connects the cylinder 16 with the two combustion cylinders 10 and 10a and this connection is governed by two valves 27 and 28, which serve as intake valves for the two combustion cylinders.

The air passes through the cylinder 16, through the valve 25, through the channel 26 and the valve 27 or 28 respectively into the cylinders 10 and 10a and displaces the combustion gases from out of the combustion cylinder through the exhaust valve 21 or 22 and into through the low pressure cylinder 15 from which it finally escapes through the valve 23 to the exhaust manifold. The movement of the air through the combustion chamber will be in the nature of down- and up-scavenging (as shown by the arrows in Figure 2). Moreover a high degree of supercharging is possible because the exhaust valve 21 should be shut before the intake valve 27 closes and while the piston 17a is moving towards the inner dead centre with considerable speed. The air or fuel mixture which is being compressed in the channel 26 may be released during the following scavenging operation by allowing the valve 27 to open before valve 25. This will reduce the valve acceleration of 27.

As will be understood from the preceding description and the drawings the various controlling devices are arranged symmetrically on each side of the centre plane of the motor unit. Such a grouping will give an engine of very small overall measurements as compared with the total piston displacement and attains also a great degree of compactness.

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