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⑤④ **Top dead centre varying system for an internal combustion engine.**

⑤⑦ A system to change with continuity and under control during running the position of the pistons of internal-combustion engines at the top dead center of the operating cycle, wherein a means is provided to vary the position of the piston 14 relative to the head 11 of the cylinder in which the piston slides.

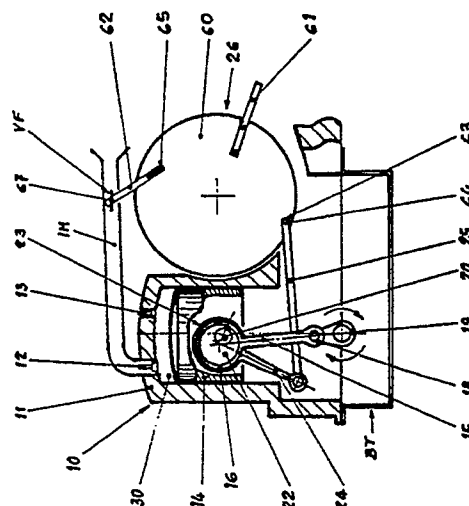


FIG. 1 B1S

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SYSTEM TO CHANGE WITH CONTINUITY AND UNDER CONTROL DURING RUNNING THE POSITION OF THE PISTONS OF INTERNAL-COMBUSTION ENGINES BY VARYING THE TOP DEAD CENTER IN THE OPERATING CYCLE

The present invention relates to a system to change with continuity and under control during running the position of the pistons of internal-combustion engines at the top dead center of the operating cycle.

This is achieved by means of an arrangement causing the variation of the position of the piston relative to the head of the cylinder in which the piston slides.

In particular both the position of the piston with respect to the connecting rod small end connected thereto and the position of the driving shaft with respect to the engine block can be varied.

It is known that the parameters relative to the strokes of the internal-combustion engines used in the motor vehicles generally are the result of a compromise as the optimum operation of such engines requires several parameters varying according to the speed rate, the load a.s.o., i.e. as a function of the running conditions of the vehicles.

The electronic control of the different parameters used in modern engines allows a number of such parameters to be optimized under different operating conditions. Among them spark advance, stroke variation, injection conditions, a.s.o. should be mentioned.

However, there is only one parameter that has never been changed by means of an easy arrangement. This is the ratio between capacity of the cylinder and capacity of the combustion chamber, i.e. the compression ratio.

The result of the above circumstance is the low average efficiency of the Otto cycle engines. Therefore, since the compression ratio is the main factor of the engine efficiency, it might be stated that the efficiency of the internal-combustion engines could not heretofore be improved by varying such parameter as a function of the cylinder filling rate and namely the revolution per minute.

In fact the power of the internal-combustion engine is varied by metering the amount of the fuel mixture injected into the cylinder. This is carried out by controlling the opening of the throttle valve of the carburetor or the injectors of the mechanical or electronic injection system.

The result is that such a motor has the maximum efficiency at full power because in such case the combustion takes place when the maximum compression ratio of the cylinder compatible with the used fuel has been reached.

When the amount of the fuel mixture injected into the cylinder is reduced in order to decrease the power, also the compression ratio is reduced accordingly. Therefore, if the fuel mixture is reduced to the half,

also the compression ratio is reduced by the same amount.

Since the engine efficiency is a function of the compression ratio : $\eta = 1 - 1/r^{k-1}$, where $r = V_1/V_2$, (where V_1 is the volume of the cylinder and V_2 is the volume of the combustion chamber), it is decreased as the operating power is reduced. With motors operating under variable conditions such as motors of motor vehicles, the average efficiency decreases far below the maximum efficiency because the power is about 50%.

The present invention seeks therefore to provide a system by which the volume of the combustion chamber can be varied by changing the relative position of the piston when the motor is running.

This is achieved according to the preferred embodiment of the invention by mounting the piston pin of each piston eccentrically on a shaft to which the relative connecting-rod small end is connected.

Each shaft is connected to a positioning means defining the angular position thereof with respect to the connecting rod small end and inside the latter so that the piston at the top dead center can assume a continuously variable position between a minimum and a maximum with respect to a stationary reference center such as the motor head. Of course, as mentioned above, this causes also the volume of the combustion chamber to vary.

The control of the positioning means defining the position of the shaft within each connecting rod small end can be accomplished in several ways, preferably by interlocking to a known electronic control unit which controls said means according to the other operation parameters of the motor.

The invention will be now described more in detail with reference to the accompanying drawing and according to its application to a single-cylinder motor under the assumption that, mutatis mutandis, it can also be applied to any multi-cylinder motor.

In the drawing :

Fig. 1 is an axial section of a motor provided with carburetor and embodying the invention, in which the piston is in the lowest position and its upper surface is at the top dead center of the cycle, i.e. at the greatest distance from the head ; Fig. 1bis shows transmission means ;

Fig. 2 is a similar section in which the piston is in the same position as Fig. 1 but at the bottom dead center ;

Fig. 3 is a similar section showing the piston in its lowest position with respect to the connecting rod small end at the top dead center ;

Fig. 4 is a similar section as Fig. 3 showing the

piston at the bottom dead center ;

Fig. 5 is a perspective, fragmentary section view showing the cylinder, the connecting rod small end, the shaft, the piston pin eccentrically disposed on the latter, and the upper part of the positioning means controlling the position of the shaft; Fig. 6 shows schematically a modified embodiment in which the variation of the relative position of piston and head is accomplished by eccentrically disposing the big end of the connecting rod, the piston being in the lowest position with respect to the head ;

Fig. 7 is a similar view showing the piston in its highest position ; and

Fig. 8 shows schematically the control unit of the embodiment of Figs 7 and 8.

With reference to Figs. 1 and 2 the single-cylinder motor shown together with its parts involved by the invention provides a cylinder 10, a head 11 with intake and exhaust valves 12 and 13, a piston 14 slideable within cylinder 10, a connecting rod 15 having a connecting rod small end 16 and a big end 18, and a crank shaft 19.

According to the invention piston pin 20 pivotally mounted on piston skirt 14 is eccentrically supported by a shaft 22 which is surrounded by connecting rod small end 16. Integral with shaft 22 is head 23 of control lever 24, to the lower end of which one end of a toggle lever 25 is attached. Attached to the other end of toggle lever 25 is a connecting member 26 schematically shown in Fig. 1, which can be driven, for example, through suitable, driving means (here not shown) by the control means setting the throttle valve VF of the carburetor, namely the accelerator of the motor vehicle.

According to the invention the above described parts are in the positions of Fig. 1 (top dead center) and Fig. 2 (bottom dead center) when the motor is running at full power, i.e. when throttle valve VF is open and cylinder 10 is filled up.

Under such conditions the correct compression ratio is reached when combustion chamber 30 has the maximum volume as the angular position of shaft 22 within connecting rod small end 16 is such that piston pin 20 is positioned at the lower part of such connecting rod small end.

On the contrary, when the motor is slow running, the connection between throttle valve VF and toggle lever 25 will cause control lever 24 to rotate from the position of Figs. 1 and 2 to the position of Figs. 3 and 4 so that shaft 22 correspondingly rotates in counterclockwise direction, and piston pin 20 reaches the upper part of the connecting rod small end 16. Such rotation causes of course the position of piston 14 to vary with respect to the connecting rod and then the head 11 so that piston 14 will be closer to the latter. Of course, this reduces the volume of combustion chamber 30 (Fig. 3) so that the fuel mixture injected

into the cylinder because of the partial closure of throttle valve VF will be compressed at the optimum compression ratio even if the amount of such mixture is smaller. Of course, a corresponding relationship between amount of injected fuel mixture and volume of the compression chamber is provided with a certain continuity in all intermediate positions of throttle valve VF and shaft 22.

In Figs. 6-8 a second embodiment of the invention is shown.

Driving shaft 49 is eccentrically mounted with respect to bearings SP of base BT because of the interposition of two intermediate eccentric supports 50. Integral with both supports 50 is a control member 51 the angular position of which can be set by suitable adjusting means so as to set the angular position of supports 50.

Thus, the position of driving shaft 49 with respect to head 111 will vary continuously as a function of the angular position of supports 50 between a lowered position (Fig. 6), in which the volume of combustion chamber 130 is the greatest, and a raised position in which the volume of combustion chamber 130 is the smallest (Fig. 7).

This will provide the same advantages relative to the compression ratio as mentioned with reference to the embodiment of Figs. 1 to 5.

Fig. 1bis shows, less schematically, the single-cylinder engine of fig. 1 and an embodiment of the driving means controlling the position of the shaft, whereon the small end of connecting rod is eccentrically mounted.

As shown, above mentioned connecting device 26 comprises a wheel 60, a rod 61, directly connected to the accelerator of the engine integral with wheel 60 and a link 62.

End 63 of toggle lever 25 is connected to pin 64 eccentrically mounted on wheel 60 while end 65 of link 62 has a slot wherein a second pin 66 is fitted, eccentrically mounted on wheel 60, diametrically opposite to pin 64. By this construction, any action on accelerator 61 will cause wheel 60 to rotate accordingly.

In the assumption that the starting situation is the situation illustrated in fig. 1 wherein throttle valve VF is completely open and accelerator 61 is completely pressed down, any release of accelerator 61, in the direction of arrow F, intended to slow down the engine speed, will cause wheel 60 to rotate counterclockwise in order to cause link 62 to rotate clockwise about shaft 67 of throttle valve VF.

In the same time this clock-wise rotation of wheel 60 will move toggle lever 25 to the right in fig. 1, thus causing a counterclockwise rotation of control lever 24 and then of shaft 22 that will reach the position illustrated in fig. 3.

As shown, in this position of shaft 22, piston 14 will be in a higher position, in respect of base BT, con-

tinuously from bottom dead center to top dead center.

This higher position of piston 14 in top dead center will result in the desired reduction of volume of combustion chamber 30.

In fig. 1bis the other componing parts of the engine are also indicated for sake of clearness as follows : Reference BT indicates the engine base whereon crank shaft 19 is pivotally mounted ;

Reference IM indicates the engine intake manifold containing throttle valve VF of the carburetor (not shown) and ending on the intake opening controlled by intake valve 12 while exhaust manifold (controlled by exhaust valve 13) is not shown.

Please note that also the necessary spark has been omitted.

It should be understood that the invention herein illustrated and described with reference to an Otto cycle motor can advantageously be applied to any Diesel cycle motor with suitable modifications.

Claims

1. System to change with continuity and under control during running the position of the pistons of internal-combustion engines at the top dead center of the operating cycle, wherein a means is provided to change the relative position of the piston with respect to the head of the cylinder in which the piston slides.
2. The system of claim 1, wherein the variation of the position of each piston (14) with respect to the head is provided by controlled means (22) supporting the assembly formed of gudgeon pin-connecting (20) rod (15) piston (14), the position of said controlled means (22) being variable so as to cause the distance from piston (14) to head (11) to vary between a minimum and a maximum value at the top dead center.
3. The system of claim 2, wherein said controlled means (22), the position of which is variable comprises a member adapted to pivot supporting said assembly gudgeon pin-connecting rod-piston (20, 15, 14) so that the angular position thereof (22) defines the position of said assembly (20, 15, 14) with respect to the engine head (11).
4. The system of claim 3, wherein said controlled means (22) is formed as a shaft (22) eccentrically carrying the piston skirt (14) through gudgeon pin (20).
5. The system of claim 3, wherein said controlled means (22) is formed as two discs (50) supporting eccentrically the bearing of the crank shaft (49) of the motor.
6. The system of claim 4, wherein the position of said shaft (22) eccentrically carrying the piston skirt (14) is controlled by a lever (24), one end of which is integral with said shaft (22) and the other end is connected to a toggle lever (25) connected in turn to the control means (VF) metering the air-fuel mixture introduced into the cylinder (10).
7. The system of claim 5, wherein said discs (50) are controlled by two toggle levers connected to each other and defining the angular position of said discs (50), respectively.
8. The system of claim 6, wherein between said toggle lever (25) and said control means (VF) metering the air-fuel mixture a connection device (20) is located comprising : a wheel (60), a rod (61), directly connected to the accelerator of the engine, integral with said wheel (60) and a link (62) and wherein one end (63) of said toggle lever (25) is connected to a pin (64) eccentrically mounted on said wheel (60) while end (65) of said link (62) has a slot wherein a second pin (66) is fitted, eccentrically mounted on said wheel (60), diametrically opposite to said first pin (64) so that any action on said accelerator (61) will cause said wheel (60) to rotate accordingly than controlling the position of said toggle lever (25) and, consequently, of said controlling lever (24).

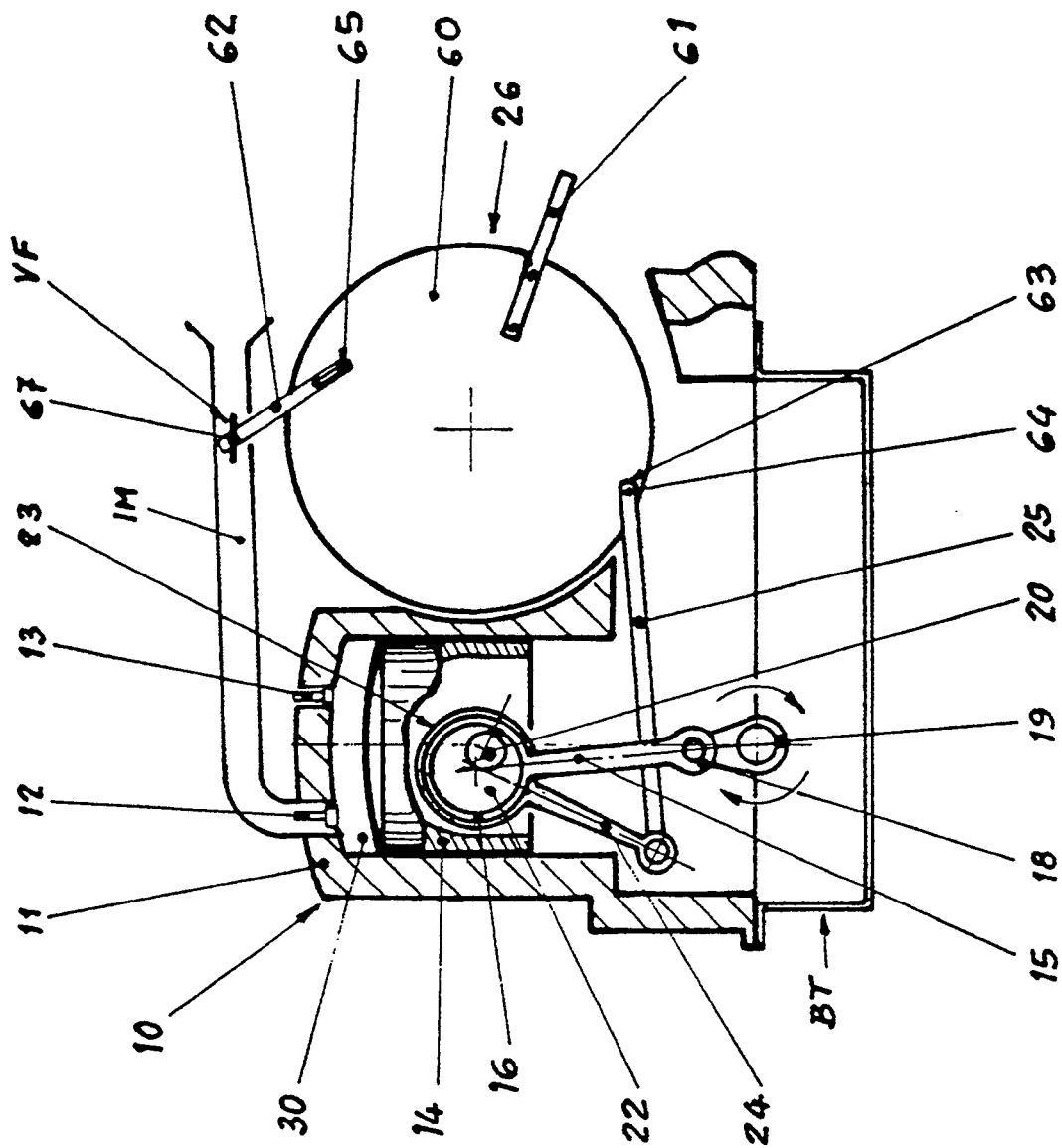
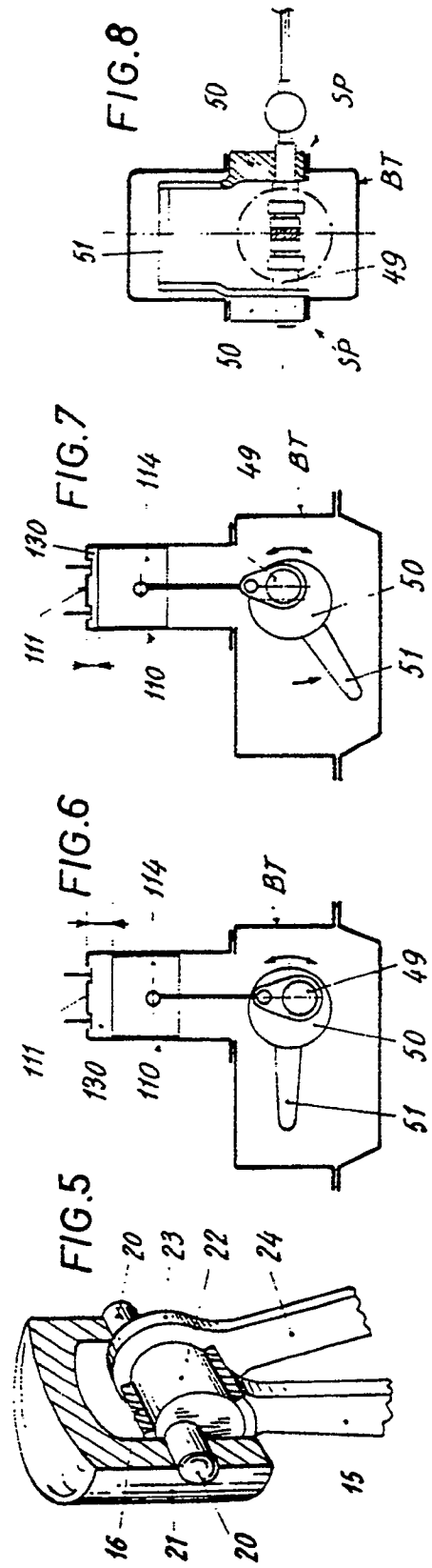
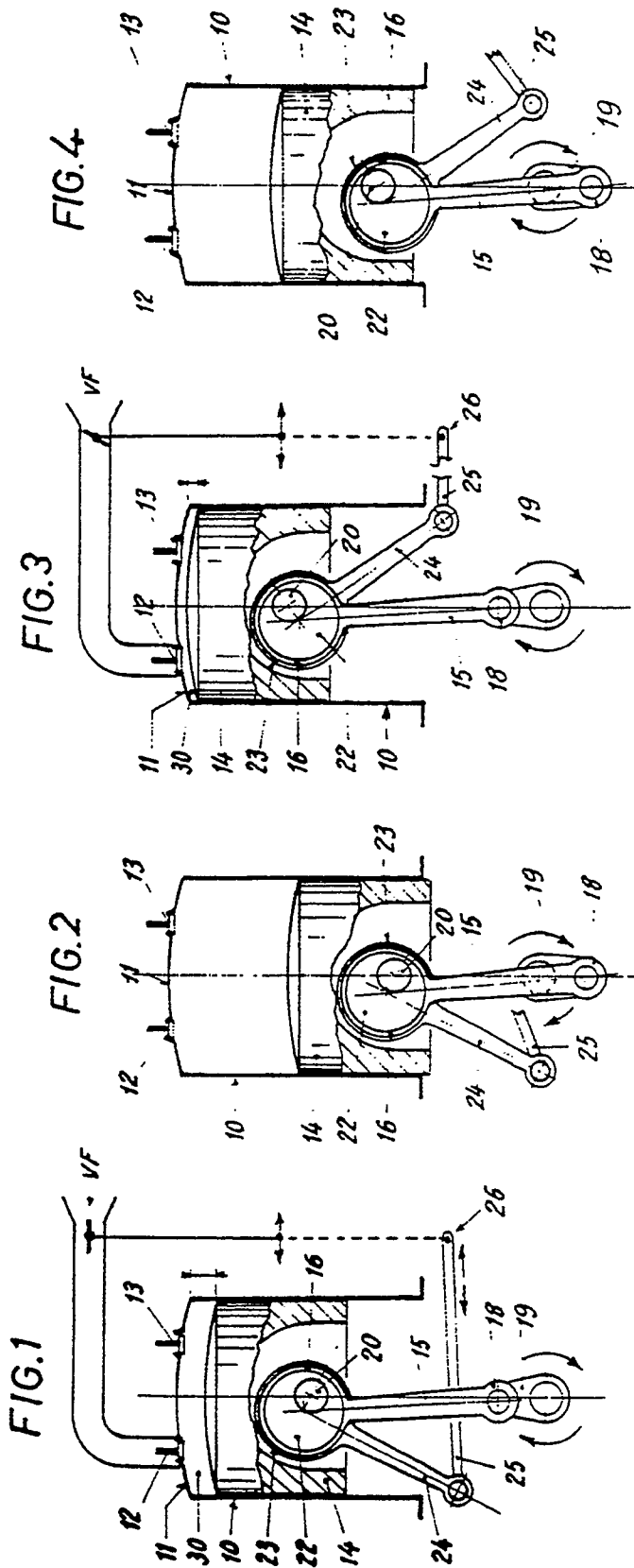


FIG. 1BIS





European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 83 0607

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP-A-297904 (HONDA GIKEN KOGYO K.K.) * claim 1; figures 3-6 *	1-4	F02D15/02 F02B75/04
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 145 (M-224)(1290) 24 June 1983, & JP-A-58 57040 (TOYOTA JIDOSHA KOGYO K.K.) 5 April 1983, * the whole document *	1-5, 7	
X	PATENT ABSTRACTS OF JAPAN vol. 7, no. 120 (M-217)(1265) 25 May 1983, & JP-A-58 38344 (TOYOTA JIDOSHA KOGYO K.K.) 5 March 1983, * the whole document *	1-4	
X	GB-A-412781 (L. VITALBA) * the whole document *	1-4	
A	FR-A-807242 (M.Y. HIRONAKA ET AL.) * page 1, lines 1 - 33; figures 1-3 *	6	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F02D F02B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 17 FEBRUARY 1991	Examiner ALCONCHEL Y UNGRIA J
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application I : document cited for other reasons & : member of the same patent family, corresponding document			

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