

Jan. 26 , 1926.

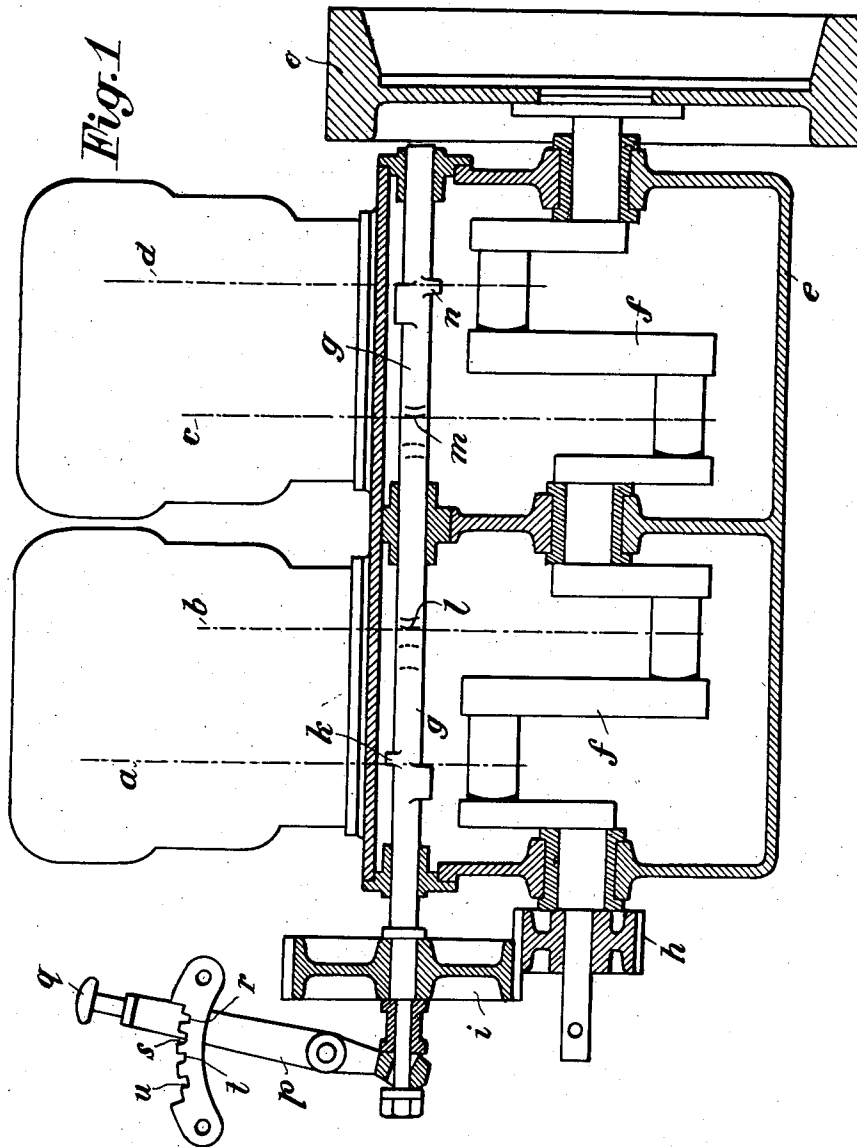
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1,570,914

STARTING MECHANISM FOR INTERNAL COMBUSTION ENGINES

Filed March 25, 1921

2 Sheets-Sheet 1



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Fig. 2

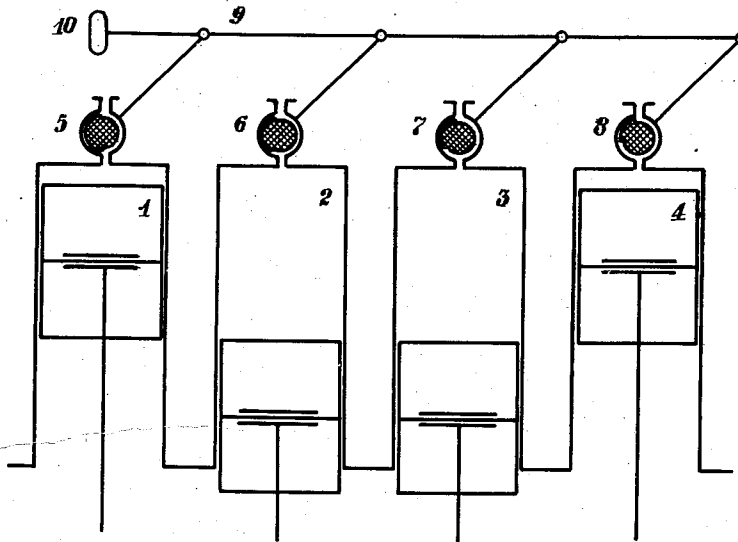


Fig. 3

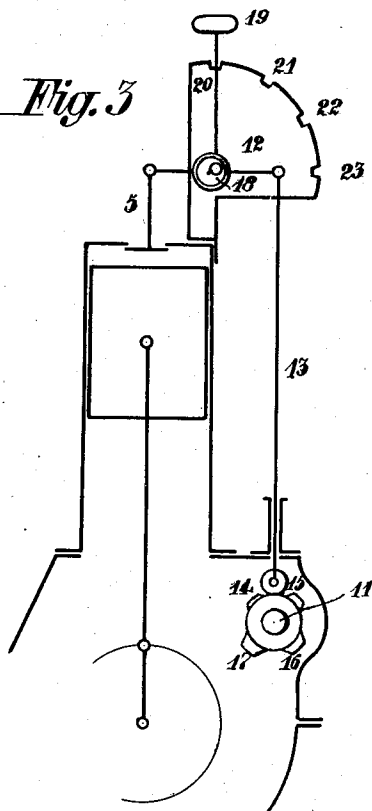
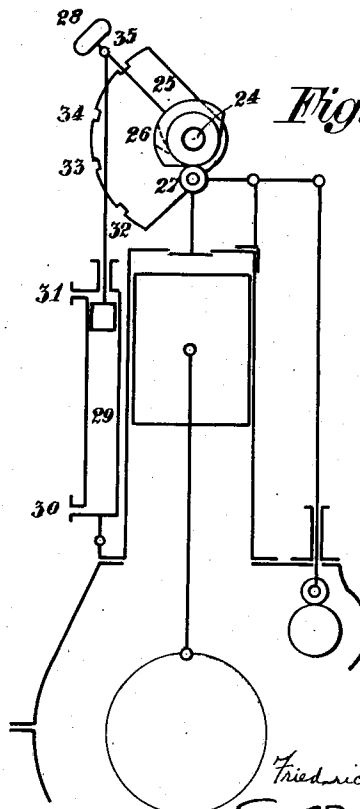


Fig. 4



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UNITED STATES PATENT OFFICE.

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STARTING MECHANISM FOR INTERNAL-COMBUSTION ENGINES.

Application filed March 25, 1921. Serial No. 455,575.

(GRANTED UNDER THE PROVISIONS OF THE ACT OF MARCH 3, 1921, 41 STAT. L., 1313.)

To all whom it may concern:

Be it known that I, FRIEDRICH MÜLLER, a citizen of the Republic of Switzerland, residing at IV Prinz Eugenstrasse 80, Vienna, Austria, have invented certain new and useful Improvements in Starting Mechanism for Internal-Combustion Engines (for which I have filed applications for patents in Austria June 23, 1915, November 16, 1916, November 16, 1916, and May 4, 1918, and applications for patents on said invention were duly filed in Germany, Norway, France, Denmark, Sweden, Hungary, Czechoslovakia, and Switzerland), of which the following is a specification.

It has already been proposed to facilitate the starting of internal combustion engines by removing or reducing the compression resistances occurring during the compression strokes, by opening air escape means in the working cylinders. As soon as the first ignitions occur or the flywheel has gained enough momentum for the engine to be able to overcome the compression resistances, the normal compression is put in operation for all the cylinders and the engine is in running order. In the case of multicylinder engines the drawback is frequently met with, that on passing from the decompression to the full compression, a number of compression strokes have to be overcome immediately one after another, for overcoming which the starting means are not sufficient. The engine stops and the next starting is still more difficult than the previous one, when the starting medium is already partly used up or exhausted.

The present invention relates to a method, by which this drawback is overcome. The method consists in this, that in the case of multicylinder engines the passing to the normal compression is effected not for all the working cylinders at the same time, but gradually for the separate cylinders. Thus, for instance, according to the invention, only one cylinder is brought up to the full compression and, on the first ignition or combustion taking place in this cylinder, the second cylinder is brought up to the full compression stroke etc. The method according to the invention is carried out in such a manner that the air escape means provided on the working cylinders are opened during a portion of the compression stroke or are held open during the whole starting period and

that these means are closed one after another, singly or in groups, in a suitable sequence, on the separate cylinders passing to the normal compression.

The method is suitable more particularly for multicylinder Diesel engines, which in consequence of the high compression pressure have a very great starting resistance. In this case the starting is difficult for this reason that, on partial compression taking place, there will be no combustion and that the overcoming of the compression resistance must be effected entirely by the source of energy available for putting the engine in operation. The possibility to cause at first a combustion in one single working cylinder only, while in the other cylinders the resistances are cut out, and thereupon to let the other cylinders start in suitable sequence ensures a very rational and safe starting with a minimum waste of energy. Hence, the invention represents an important improvement in such engines.

Fig. 1 is a longitudinal vertical sectional view through a four-cylinder engine and on the line of the main and the cam shafts;

Fig. 2 is a diagrammatic vertical sectional view through the cylinders and their air escape members and showing a modified plan of operation;

Fig. 3 is a diagrammatic vertical transverse sectional view through one of the cylinders and showing another modified plan;

Fig. 4 is a similar view with certain parts otherwise adjusted according to a further modified plan.

In the constructional example shown in Fig. 1 of the drawing *a*, *b*, *c* and *d* are the centres of the four working cylinders, *e* is the engine case, *f* the crank shaft and *g* the cam shaft. The drive of the latter is effected by the two spur wheels *h* and *i*. The cam shaft is in the first starting position, in which the auxiliary starting cams *k*, *l*, *m* and *n* open all the exhaust valves during a part of the compression stroke. In this position the engine is started by means of starting air or by hand. On combustible mixture being sucked in ignition will occur in one or more cylinders, after which the first displacing of the cam shaft will be effected. On this being done the auxiliary cam *k* is put out of operation and the cylinder *a* receives the full charge. The compression of this charge is effected jointly by the inertia

of the flywheel *o* and by the combustion pressures of the cylinders working with reduced compression and possibly also by the continued action of the driving means used for starting.

As soon as the cylinder *a* is in full operation, the cam shaft is again displaced and brought into the second starting position. Thereby the auxiliary cam *n* is put out of operation and the cylinder *d* is given the full charge. After the cylinder *d* has been put in operation, it is the turn of the cylinders *b*, and *c*, the auxiliary cams *l* and *m* being put out of operation. The engine then reaches its normal number of revolutions.

The reason of the transition from cylinder *a* to cylinder *d*, instead of to cylinder *b* is due to the position of the crank. In the case of cylinders *a* and *d* the cranks are displaced relatively by 180°. Thus, in this case, the compression resistances follow each other at equal intervals, whereby there will be a better utilization of the inertia of the fly-wheel.

The step by step displacement of the cam shaft is effected by means of the hand lever *p*. The handle *q* of this lever is pressed by means of a spring into the notch *r*, which corresponds to the first starting position. The notches *s* and *t* form the limits of the second and third cam shaft displacement, while the notch *u* fixes the lever in the operative position.

The constructional forms shown by way of example in Figs. 2-4 differ from the arrangement of Fig. 1 substantially in this that the air escape members are jointly operated without the cam shaft taking part in this movement. As compared with an arrangement having an axially displaceable cam shaft, such an arrangement has the advantage that, on the air-escape members being operative, the auxiliary cams and the cam shaft may be omitted and that when automatically operated by the cam shaft these cams may be formed as round discs. Hence, such a constructional form of the arrangement is also adapted for engines operated by slide valves, in which the cam shaft cannot be displaced, and for reversible engines, in which a round starting auxiliary disc is correct in every position.

In the four-cylinder engine in Fig. 2 the working cylinders are marked 1, 2, 3 and 4. The escape of air is effected through the cocks 5, 6, 7 and 8. The latter are in the starting position, in which all the working cylinders are decompressed, and are connected together by the rod 9.

The transition to the full charge is effected by the handle 10 being moved intermittently to the left. The air escape cocks are so constructed that they are not closed simultaneously, but one after another, singly or in groups. The handle 10 must be operated

four times during the transition to the operative position, cock 5 being closed by the first movement, cock 6 by the second, cock 7 by the third and cock 8 by the fourth.

Fig. 3 shows a four-cylinder engine in cross-section with separate air escape valves, which may in certain cases be formed by cut-off members of the cylinders, which are provided for other purposes. The air escape members are brought into engagement, during starting, with auxiliary cams mounted on the cam shaft, for instance, by displacing the gear between the auxiliary cams and the air escape valves. The working cylinder is marked 1, the corresponding air escape valve 5 and the cam shaft 11. The raising of the air escape valve is effected by a lever 12 and valve rod 13. The auxiliary cams for the four working cylinders mounted on the cam shaft are marked 14, 15, 16 and 17. The pivotal point of the lever 12 is formed by an eccentric 18, which, before the engine is put into operation, is turned to the bottom, whereby the valve rod 13 comes in contact with the auxiliary cam 14. The air is caused to escape from the working cylinder 1 by this cam, while the cams 15, 16 and 17 effect the decompression of the other working cylinders. The cams differ from one another in the drawing by each having a different lift. The auxiliary cam 14 is lower and the cams 16 and 17 are higher than the cam 15.

When putting the engine in operation the lever 19, which is held in position by the notch 20 is displaced as far as the notch 21. By this means the eccentric 18 is moved upwards and the valve rod 13 is moved away from the auxiliary cam 14, whereby the cylinder 1 receives the full charge and is put in operation. The remaining auxiliary cams, however, which are higher, remain in engagement with the corresponding air escape valves. By a further displacement of the lever 19 as far as the notch 22, the auxiliary cam 15 is put out of engagement and the second working cylinder thereby put in operation. Thereupon the lever 19 is moved as far as the notch 23, thus causing the cams 16 and 17 to be put out of operation and the third and fourth cylinders to be brought up to the normal compression pressure.

The auxiliary cams 14, 15, 16 and 17 can in case of need be formed as round discs, for instance, by being given different diameters. The air escape members will then open during all the strokes of one working cycle and will be closed by the corresponding movements of the lever 19.

Fig. 4 shows a four-cylinder engine, in which the air is caused to escape from the working cylinders by holding open one or more main valves during the whole of the starting period. The decompression in this

case is effected by turning the auxiliary shaft 24 with the cams 25, 26 and 27. The cam 25 opens the first, the cam 26 the second and the cam 27 the two other working cylinders.

5 The auxiliary shaft can be displaced by hand by means of the handle 28, or hydraulically by means of the cylinder 29 or by compressed air, according as the pressure medium is supplied through the apertures 10 30 or 31. The notches 32, 33, 34 and 35 effect the fixing of the lever 28 during starting. Notch 32 corresponds to the first starting position, in which the decompressed engine is put in motion by the starting medium and notch 33 corresponds to the second starting position, in which the cam 25 is moved away from the air escape valve of the corresponding working cylinder. As soon as the first combustions have started in this cylinder the lever 28 is displaced as far as the notch 34. In this position the cam 26 is brought out of engagement with the air escape valve operated by it and the second cylinder is brought into the operative position. The notch 35 corresponds finally to the normal working position, in which, in all the working cylinders, the compression is cut in.

The same method of starting and the means used therefore can, with advantage, be used for the independent step by step regulation of the output of engines, in which the change of output is not normally effected automatically, i. e. by governor arrangements, but by hand, as is for instance generally the case with the engines of motor vehicles. Such engines give their greatest output when they are fed with the greatest amount of fuel, while running at the greatest speed, and their least output in the opposite case. The supply of fuel to the separate working cylinders should be complete and uniform, even at the lower output. When, however, multi-cylinder engines are kept working with a very low output, i. e. when fed at a low speed with a small amount of fuel per working stroke (for instance when running light), on the one hand it is difficult to feed the very small amount of fuel in a uniformly divided state, on the other hand the efficiency will be very low in any case and therefore a relatively large amount of fuel will be used. This well known phenomenon is accounted for, not only by the high mechanical, i. e. frictional resistances, in the engine, which in many respects do not vary, but also by the well known poor thermal efficiency of any unloaded engine, as

compared with one which is fully loaded. The said phenomena are particularly prejudicial in the case of injection internal combustion engines with self-ignition (such as Diesel engines, hot-bulb engines and the like) as in these engines the compression pressure must be uniformly high if an ignition of the fuel is to take place at all, irrespective of whether the engine is running at a high or a low speed and is fully loaded or running light, all the more as the thermal losses are greater at a low speed than at a higher speed.

What I claim is:

1. In an internal combustion engine having relief valves and a camshaft therefor, a plurality of cams on said shaft for each valve and means adapted to shift said camshaft step by step to produce successive engagement between said cams and said valves.

2. In a multi-cylinder internal combustion engine, an air relief valve for each cylinder, normal operating mechanism therefor, including a camshaft, and compression relief cams on said camshaft adapted to be selectively engaged with said valves in a sequential manner.

3. In starting mechanism for multiple internal combustion engines the combination of air escape means in the cylinders of said engines and means common to a plurality of cylinders for keeping open and for closing the air escape means in the cylinders in sequence in such a manner that first only one cylinder goes into operation and later the other cylinders in suitable sequence.

4. In starting mechanism for multiple internal combustion engines the combination of air relief means in the cylinders of said engines and means common to all the cylinders for keeping open and for closing the air relief means in sequence in such a manner that first only one cylinder goes into operation and later the other cylinders in suitable sequence.

5. In starting mechanism for internal combustion engines the combination of air escape means in the cylinders of said engines and means common to a plurality of cylinders for keeping open and for closing the air escape means in sequence, said means comprising a shaft, the displacement of which causes the air escape means of the individual cylinders or cylinder groups to be closed one after the other at different times during the transition of normal working.

Vienna, Austria, July 18, 1921.

FRIEDRICH MÜLLER.