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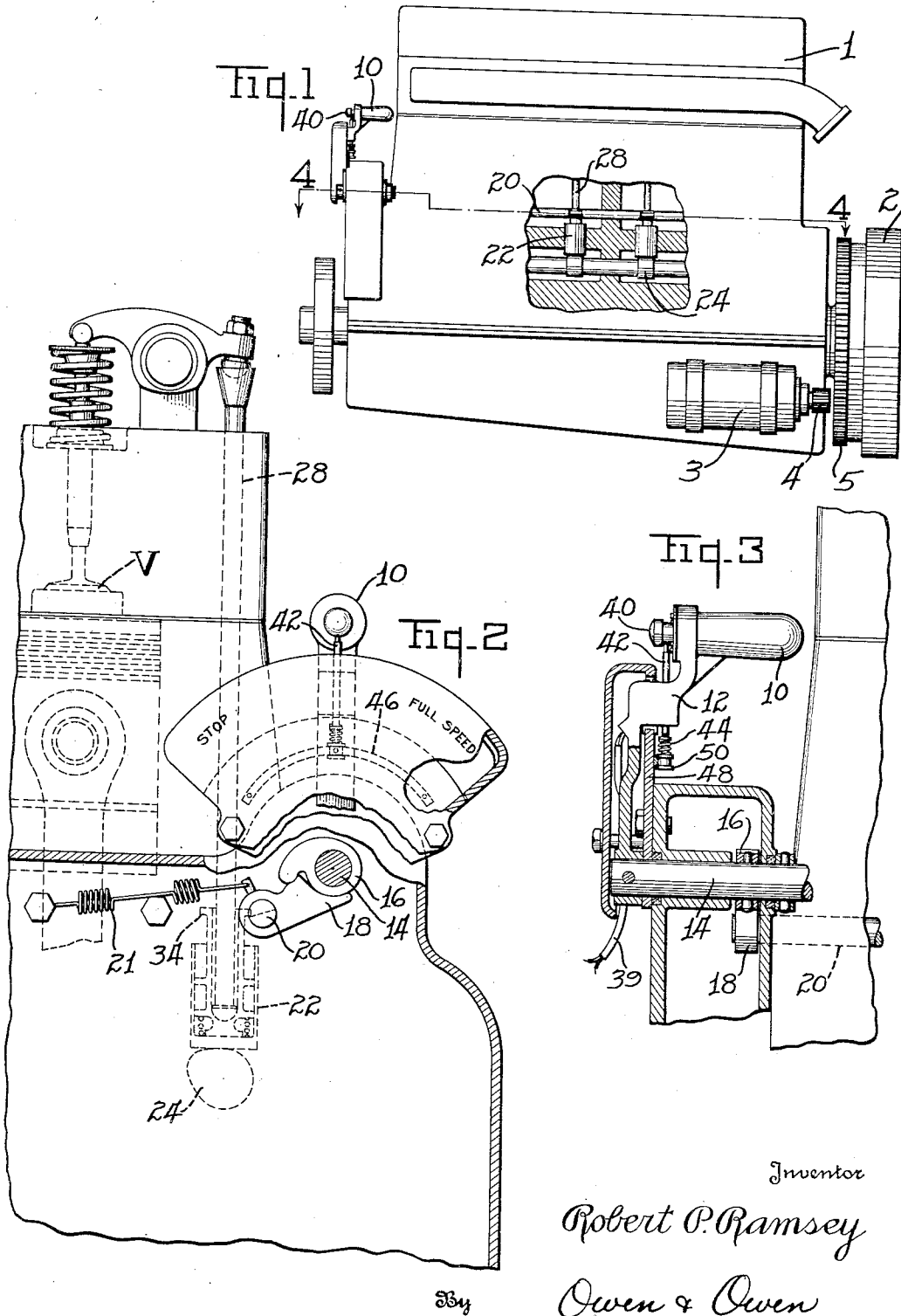
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STARTER CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINES

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2 Sheets-Sheet 1



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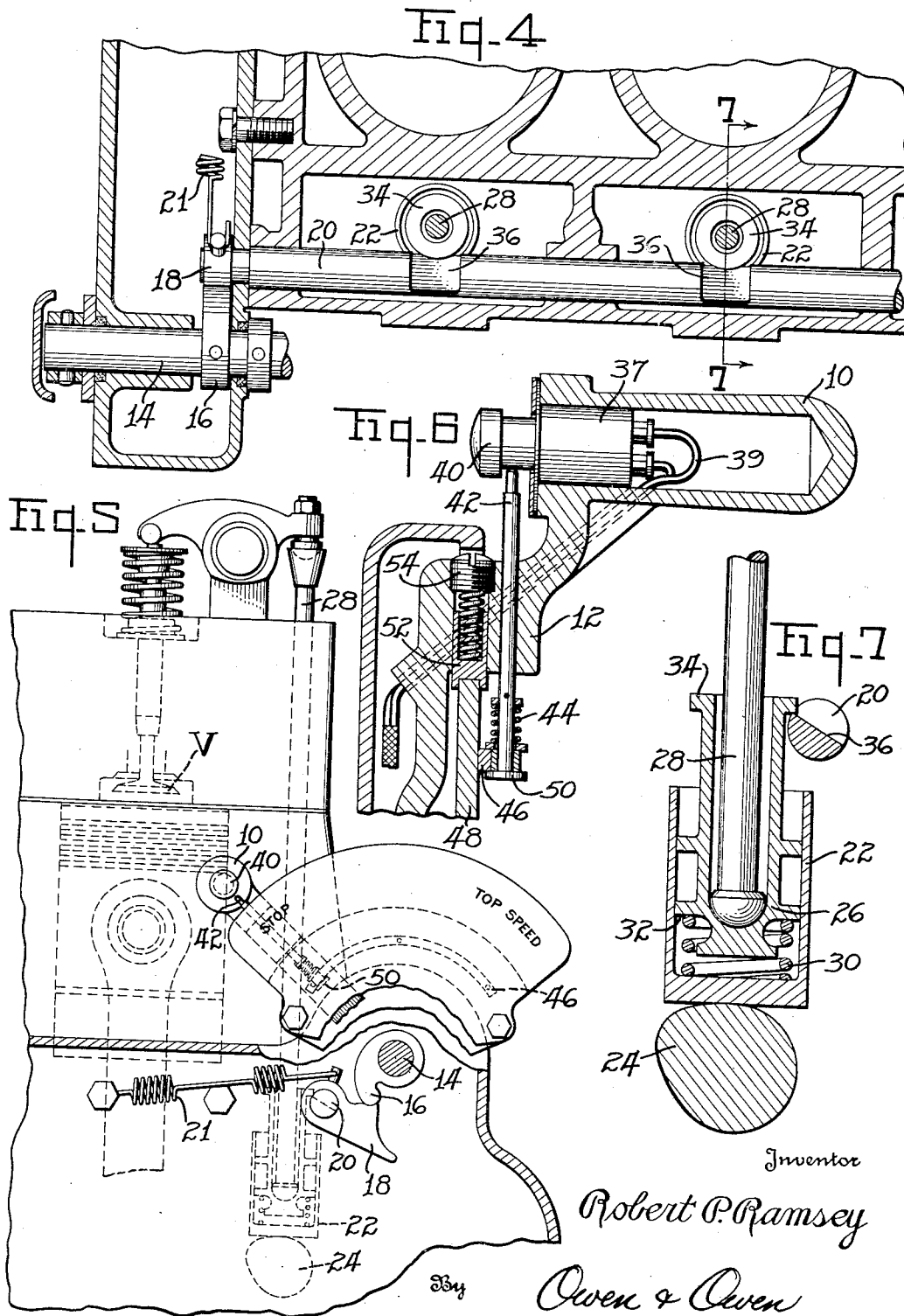
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UNITED STATES PATENT OFFICE

2,033,052

STARTER CONTROL DEVICE FOR INTERNAL COMBUSTION ENGINES

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9 Claims. (Cl. 123—179)

This invention relates to a method and apparatus for starting internal combustion engines and is more particularly directed to the control mechanism of such apparatus.

5 The primary object of the invention is the provision of means to reduce the initial dynamic load offered by the engine so that its rotating parts may be turned over rapidly by a small starting motor, and to then utilize the dynamic
10 energy of the rapidly rotating parts to assist the starting motor in its work.

Another object of the invention is the provision of means to prevent functioning of an electric starting motor until the load reducing means
15 has come into operation, thereby preventing injury to the starting motor incident to subjecting it to sudden loads.

Other objects and advantages of the invention will become apparent as the description proceeds, reference being had to the accompanying drawings in which a preferred embodiment of the invention is shown, and in which—

Figure 1 is a diagrammatic elevation of an engine, with parts broken away, to show the installation of a device comprising the present invention; Fig. 2 is an enlarged diagrammatic end view of the engine, with parts broken away; Fig. 3 is a fragmentary side view of the control parts shown in Fig. 2; Fig. 4 is an enlarged partial section on line 4—4 in Fig. 1; Fig. 5 is a view similar to Fig. 2 with the parts in another position; Fig. 6 is an enlarged detail of the control handle and associated mechanism, and Fig. 7 is an enlarged section on line 7—7 of Fig. 4.

Referring to the drawings, the present invention is disclosed as associated with an internal combustion engine 1, having a fly-wheel 2, as is the usual practice. An electric starting motor 3 has a pinion 4 adapted to mesh with a gear
40 5 carried by the fly-wheel.

In starting compression ignition engines, or other engines which require a considerable torque from the starting motor to overcome the compression pressure of the engine, it is necessary to providing a starting motor of relatively great capacity. This requires that an equally large source of electric power be carried in the form of a number of large storage batteries. Obviously, these devices are only a dead load once the engine has started, and since their cost is high, some means should be devised to eliminate them to the greatest possible extent and keep the size of the starting motor down to a minimum.

The present invention permits the use of a
55 small starting motor by reducing the initial load

which it is called upon to carry. Briefly, the present invention contemplates using a small motor to turn the engine while compression is released by opening one of the valves in each cylinder, and, after the engine is rotating at a
5 speed sufficient for the purpose, closing the valves and utilizing the dynamic energy of the rotating parts to supplement the torque of the starting motor in cranking the engine. The combined torque of the starting motor and of the rapidly
10 rotating engine are usually sufficient to accomplish the cranking or starting operation.

The control apparatus shown includes means to lift one of the valves in each engine cylinder, and is so constructed that the starting motor
15 circuit cannot be closed unless the valve lifting parts have functioned. While the apparatus is disclosed as mounted adjacent the engine, it will be appreciated that in practice the control handle may be remote from the engine and may function
20 similar to a marine "telegraph" device.

In the form shown, the control means comprises a handle 10 fixed on an arm 12 which is, in turn, fixed on a shaft 14 so that the latter turns in response to movement of the handle. The
25 shaft 14 may be connected to the governor of the engine, so that the speed may be controlled by the handle 10. For purposes of the present description, however, the governor connections will be omitted, as their function is important only
30 after the engine has started.

The valve lifting mechanism preferably includes a cam 16 carried by the shaft 14 and adapted to engage and move a lever-arm 18 fixed to an end of a shaft 20. The shaft 20 extends
35 alongside the engine adjacent the tappet rods which actuate the valves, designated by V. The shaft is normally held in inoperative position by a spring 21.

As shown in Fig. 7, the tappet assembly comprises an outer, cup-shaped cam follower 22 adapted to ride on the surface of a cam 24 driven by the engine. An inner cup member 26 is seated in the follower 22 and is adapted to be moved by the follower during normal running of the engine.
45 A tappet rod 28 is seated in the inner cup member so as to be actuated thereby. A spring 30 is disposed between guide shoulders 32 carried by the cup member 26 and the inner bottom surface of the follower 22 so as to urge the follower against
50 the cam 24, and to act as a cushioning means for the parts when in valve opening position. At its upper end, or at any suitable point in its length, the cup member 26 is provided with a lateral projection, in the present instance in the form of an
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annular flange 34. It will be seen that if the inner cup member 26 is lifted by a lever acting on the annular surface 34, the associated valve will be opened regardless of the position of the cam 24. The lifting agency is associated with the operating shaft 20 and is shown as comprising flat surfaces 36 formed on the shaft, one adjacent each of the valve mechanisms, which are to be moved. Thus, the flat surfaces 36 and arm 18, together with the shaft 20, constitute, in effect, a lever mechanism to move the valves V.

The control for the electric starting motor 3 includes a switch 37 interposed in a line 39 and mounted in the handle 10 and adapted to be closed by axial movement of a push button 40. The button has an enlarged head for a purpose which will presently become apparent.

It will be seen from Fig. 5 that a counterclockwise movement of the handle 10 moves the valves to open position through the above-described lever mechanism. Inasmuch as the starting motor is not of sufficient capacity to crank the engine alone with the valves closed, the present invention provides means to prevent closing of the starting motor switch 37 until the valves have been opened to release compression. Such means preferably includes a latch member 42 in the form of an elongated stem guided for vertical reciprocatory movements in the arm 12 of the control handle, and urged behind the enlarged head of the push button 40 by a spring 44 abutting at one end a collar fixed on the latch member 42. It will be seen that so long as the stem 42 is in its upper position, as shown in Fig. 6, the starting motor switch 37 cannot be closed because the head of the push button will strike the stem 42 before sufficient axial movement of the button has occurred. The stem 42 is, however, withdrawn from the path of the head 40 by a cam 46 carried by a handle guide plate 48. The cam 46 is equidistantly disposed from the operating center of the shaft 14, except for a portion of predetermined length at one end corresponding to the "compression release" position of the control mechanism, where it is formed on the locus of a decreasing radius. A head 50 carried by the stem 42 engages the underside of the cam 46 so that the stem will be pulled from the path of the push button as the handle is moved to the starting or "compression release" position shown in Fig. 5.

A spring pressed friction member 52 is provided to engage the handle guide plate 48 and retain the handle 10 in any set position. The tension of the spring, and hence the frictional resistance to movement of the handle may be adjusted by a screw 54.

The operation of the device may be followed in Figs. 2 and 5. When it is desired to start the engine, the handle 10 is moved to the starting position shown in Fig. 5. The valves are thus opened through the mechanism including cam 16, lever 18 and the flat surfaces 36 of the shaft 20. As the handle is moved to this position, the cam 46 has withdrawn the latch stem 42 from the path of the push button 40. The push button is then pressed to close switch 37 and allow the starting motor 3 to rotate the engine crankshaft. Since the compression of the engine is released by holding one of the valves in each cylinder open, the torque required to turn the engine is reduced, so that the work can be done by a relatively small starting motor. The parts are held in this position until the engine is spinning rapidly, at, for example, 400 R. P. M. At this speed, considerable inertia exists in the rotating system, par-

ticularly in the fly-wheel 2. With the engine turning at this speed, the operator moves the handle 10 to slow speed running position shown in Fig. 2, keeping the starter circuit closed. This movement of the handle allows the valves to seat regularly and the engine to build up compression in each cylinder. The inertia of the engine added to the torque of the starting motor is sufficient to spin the engine rapidly with the valves closed until firing takes place in the cylinders. The engine is then operated under the usual governor control.

If the engine fails to start at the first attempt, the push button 40 is released. The latch stem 42 snaps behind the button so that the starting motor circuit cannot be closed until the handle is moved to "compression release" position and the above cycle of operations repeated.

It will thus be seen that I have provided a device to facilitate starting of an engine of the compression ignition type with a relatively small starting motor. While numerous modifications and changes may be made in the valve lifting mechanism as well as in the form and disposition of the other parts, it should be expressly understood that such changes may be made without departing from the invention as defined in the appended claims.

What I claim is—

1. In a device for starting a multi-cylinder internal combustion engine, an electric starting motor, a control handle carried by a stub shaft, a switch for said starting motor carried by said handle, a push button carried by said handle and adapted to be manually closed by the operator, means to release the compression in the engine including a shaft, means carried by said shaft to open a valve in each cylinder of said engine, a lever carried by said shaft at an end thereof, a cam carried by said stub shaft and adapted to be turned by said handle to move said lever and actuate said valve opening means, a latch member adapted to prevent movement of said push button, and means to withdraw said latch member when said handle is moved to compression releasing position.

2. The combination with an internal combustion engine and an electric starting motor therefor, of manually operable means to release the engine compression and having starting and running positions, a switch for said motor having a control part carried by a movable part of said means, and means coacting with said control part and preventing the closing of said switch when said first means is in running position and permitting such closing when said first means is in starting position.

3. The combination with an internal combustion engine and an electric starting motor therefor, of means operable to release the engine compression, a manual control for said means having running and compression releasing positions, a normally open switch for said motor carried by said control, and means normally locking said switch against closing when said control is in running position and automatically operable to release the switch to permit closing when the control is in compression releasing position.

4. The combination with an internal combustion engine and an electric starting motor therefor, of a lever means operable to coact with parts of the engine to release the compression in one or more of its cylinders, an arcuately movable control having a running position and

a starting position and operable when moved from one position to another to coact with said lever means and actuate it to release the compression, a switch for said motor having a control part carried by said arcuately movable control, and means for permitting a closing movement of said switch control part only when said arcuately movable control is at a predetermined point in its movement.

5. The combination with an internal combustion engine and an electric starting motor therefor, said engine having cylinder-valve operating parts and a control means operable to engage said valve operating parts and hold them in compression releasing position, a switch for said motor carried by said control means, a stem normally locking said switch against closing movement, and means coacting with said stem and operable to release it from switch locking position when the control means is moved to and while at compression releasing position, said stem being prevented from returning to locking engagement with the switch until the switch has opened and when the control means is in other than compression releasing position.

6. The combination with an internal combustion engine and an electric starting motor therefor, of a shaft, a cam and a control handle carried by said shaft, the latter for imparting predetermined rocking movements thereto, means actuated by said cam upon a predetermined movement of the control handle to effect a predetermined release of the engine compression, a normally open switch for said motor carried by said control handle, a stem normally engaged with said switch to prevent the closing movement thereof, and cam means for moving said stem to release the switch when the control handle has been moved to and is in compression releasing position, said stem when released being prevented from again having locking engagement with the switch while the switch is closed irrespective of the position of said control means.

7. The combination with an internal combustion engine and an electric starting motor therefor, of means operable to release the engine

compression, a control for said means having running and compression releasing positions, a normally open switch for said motor, and means normally locking said switch against closing when said control is in running position and automatically operable to release the switch to permit closing when the control is in compression releasing position.

8. The combination with an internal combustion engine and an electric starting motor therefor, of means operable to release the engine compression, a manual control for said means having running and compression releasing positions, a normally open switch for said starting motor operable only when said compression release means has functioned and thereby cause the starting motor to rotate the moving parts of the engine rapidly without combustion, said switch being adapted to be maintained manually in closed position to continue operation of said starting motor after said compression release means has ceased to function, and means normally locking said switch against closing when said control is in running position and automatically operable to release the switch to permit closing when the control is in compression releasing position.

9. The combination with a multi-cylinder internal combustion engine and an electric starting motor therefor, of means to release the compression in one or more cylinders, a manually operable normally open switch to energize said starting motor operable only when said compression release means has functioned, and thereby cause the starting motor to rotate the moving parts of the engine rapidly without combustion, said switch being adapted to be maintained manually in closed position to continue operation of said starting motor after said compression release means has ceased to function and until said switch is released from its manually closed position, whereby the torque of the starting motor is added to the inertia of the moving engine parts and utilized to turn the engine with the parts in operating position to start the same.

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