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D. FERGUSSON.

STARTING MEANS FOR GAS ENGINES.

APPLICATION FILED MAY 8, 1906.

Fig. 1.

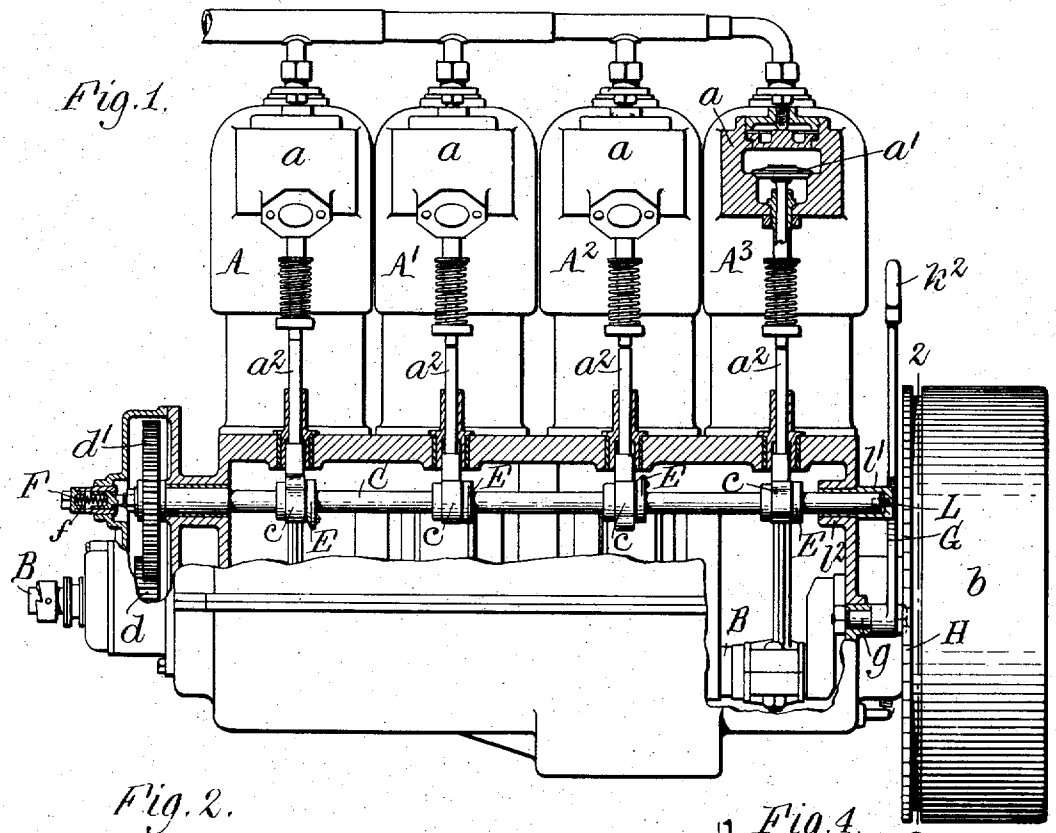


Fig. 2.

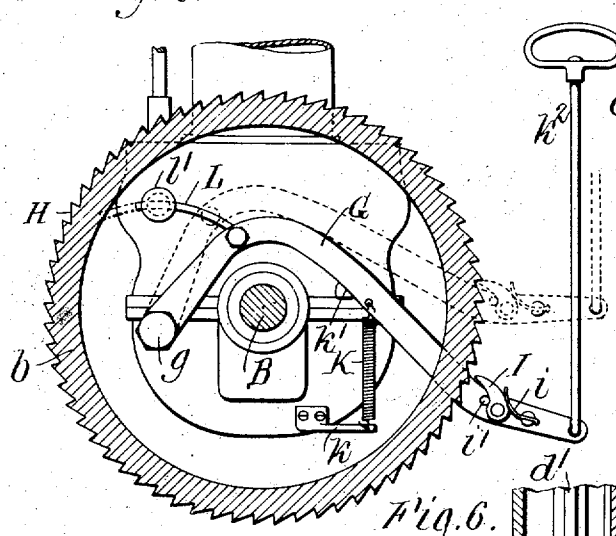


Fig. 4.

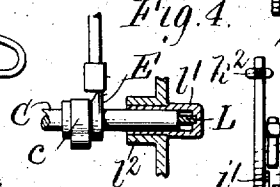


Fig. 3.

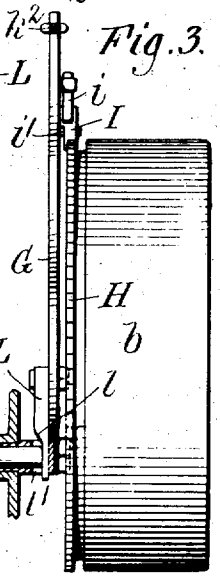


Fig. 5.

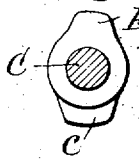
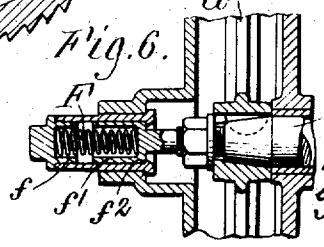


Fig. 6.



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STARTING MEANS FOR GAS-ENGINES.

No. 888,794. Specification of Letters Patent. Patented May 26, 1908.

Application filed May 8, 1906. Serial No. 315,787.

To all whom it may concern:

Be it known that I, DAVID FERGUSSON, a subject of the King of Great Britain, residing at Buffalo, in the county of Erie and State of New York, have invented a new and useful Improvement in Starting Means for Gas-Engines, of which the following is a specification.

In starting internal combustion or explosive gas engines it is ordinarily necessary to turn the crank shaft by hand to draw a charge of fuel into the engine cylinder and compress it preparatory to the automatic operation of the engine. If the normal compression is not relieved in the cylinder during the compression stroke of the piston, great exertion is required to turn the crank shaft by hand and the operator is liable to be injured in the event of premature firing of the fuel charge and consequent sudden and violent backward rotation of the engine shaft. It has heretofore been customary to open the exhaust valve to relieve the compression when starting the engine, but this has usually been accomplished by actuating some device before turning the engine shaft and as a separate or distinct operation from turning the shaft.

The primary object of this invention is to provide means of very simple, desirable and efficient construction, capable of easy operation, for both relieving the compression and turning the engine shaft by the movement of a single starting lever or device.

Other objects of the invention are the provision of simple means which will connect or couple the starting device to the engine shaft when the former is moved in the operative direction and will automatically release the engine shaft upon the return of the starting device to the initial position to prevent noise and wear of the parts during the running of the engine, and also to prevent possible injury to the operator or to the starting mechanism in the event of the back firing of the engine; to especially adapt the starting device to multiple cylinder engines with a view to making the device of the minimum number of parts and of very simple and inexpensive construction.

Still another object of the invention is to provide means for the purpose stated of the desirable construction hereinafter described and set forth in the claims.

In the accompanying drawings: Figure 1 is a side elevation, partly in section, of an engine equipped with starting means embodying the invention. Fig. 2 is a fragmentary sectional elevation thereof in line 2—2, Fig. 1. Fig. 3 is a plan view, partly in section, of the starting device and associated parts. Fig. 4 is a fragmentary sectional elevation of the cams for one exhaust valve, the cam shaft and shaft shifting device, showing the parts in the shifted position. Fig. 5 is a transverse sectional elevation of the cam shaft and one pair of cams. Fig. 6 is a detail sectional elevation, on an enlarged scale, of the spring device for returning the cam shaft to normal position after it has been shifted by the starting means.

The starting means forming the subject matter of this invention is shown in the drawings and will be hereinafter described as applied to an explosive gas engine of the four-cycle type having four cylinders and pistons, one of which pistons produces a working stroke for each half revolution of the engine shaft. Each cylinder has an exhaust valve and the several exhaust valves are actuated by a corresponding number of cams or operating devices driven by the engine. Beside each exhaust cam is a second or relief cam or operating device which is driven by the engine but is normally in an inoperative relation to the exhaust valve. By shifting the cams or devices the relief cams or operating devices are brought into operative relation to the exhaust valves, so that when the engine shaft is turned the valves will be opened in the proper sequence to relieve the compression in the cylinders in the compression strokes of the pistons. A starting lever or device is provided and means which, when the lever is moved in one direction, couple or connect the lever to the engine shaft and turn said shaft, said means automatically releasing the shaft when the starting lever or device is released or returned to its normal position. When the starting lever or device is moved to turn the engine shaft it actuates means for shifting the valve operating cams or devices to place the relief cams or devices in operative relation to the exhaust valves during the first portion of the operative movement of the starting lever and before the engine shaft is turned, so that the ex-

haust valves will be opened and the compression in the cylinder or cylinders relieved before the pistons commence their compression strokes. The invention is not necessarily restricted in application to a multiple cylinder four-cycle engine such as described.

Like letters of reference refer to like parts in the several figures.

A A^1 A^2 A^3 represent the four cylinders of the engine, *a* the casings of the exhaust valves therefor, one of which exhaust valves is shown at a^1, and a^2 the rods or parts for lifting the exhaust valves, B the engine or crank shaft provided at one end with the usual fly-wheel *b*, and C the cam shaft provided with exhaust cams or operating devices arranged respectively in operative relation to the lifting rods or parts for the exhaust valves of the respective cylinders A A^1 A^2 A^3. The cams *c* are differently positioned on the cam shaft and the latter is driven in any suitable manner, for instance, by gear wheels *d* d^1, from the engine shaft B at the proper speed to operate the several exhaust valves in the proper sequence. These parts of the engine may be of any usual or suitable construction. Their operation is well known. The other parts of the engine which are not necessary to an understanding of the invention are not shown or described.

The cam shaft C is preferably journaled so as to be capable of sliding endwise and is provided beside the several exhaust cams with relief cams or operating devices E for the exhaust valves. The exhaust and relief cams *c* and E can be separate parts separately secured to the cam shaft, or they can be formed by properly shaped portions on a single integral part. In the normal position of the cam shaft, shown in Fig. 1, the exhaust cams are in operative relation to, or opposite to, the lifting rods for the exhaust valves, and the relief cams are held in an inoperative position to one side of the valve lifting rods so as to turn past the same without actuating them. By shifting the cam shaft endwise slightly, the relief cams are placed in operative position opposite to the valve lifting rods without moving the exhaust cams out of operative position, see Fig. 4, so that the exhaust cams will open the valves for the exhaust strokes and the relief cams will open the valves for the compression strokes of the pistons.

Any suitable means may be employed for holding the exhaust cam shaft in its normal position and returning it to this position after it has been shifted to place the relief cams in operative position. The means shown in the drawings, see Figs. 1 and 6, consist of a coil spring F arranged in a spring pocket *f* secured to the engine casing opposite one end of the exhaust cam shaft, and bearing at one end against a plunger f^1 which is confined in the spring pocket and has a projecting portion bearing against the adjacent end of the cam shaft. The plunger preferably has a chamber to receive and confine the spring F and the spring pocket preferably has a lip or flange adapted to engage a shoulder f^2 on the plunger to limit the outward movement thereof. The cam shaft is shifted lengthwise against the action of the spring F by the starting mechanism, as will be presently described.

G represents the starting device, preferably, though not necessarily, consisting of a lever fulcrumed on a stud or pivot *g* secured to the engine casing eccentrically with reference to the engine shaft. Secured to the engine shaft adjacent to the starting lever is a wheel, preferably a ratchet wheel formed by integral teeth on the fly-wheel *b* of the engine. A pawl or clutch device I is carried by the starting lever and is adapted in the movement of said lever in one direction to engage the teeth of the ratchet wheel H to turn said wheel and the engine shaft. The pawl shown is pivoted to the starting lever and is pressed toward the ratchet wheel by a spring *i* secured at one end to the starting lever and bearing at the free end against the pawl, and the movement of the pawl toward the ratchet wheel is limited by a stop stud or projection i^1 on the starting lever. In the normal position of the starting lever, shown by full lines in Fig. 2, the pawl is held by its stop *i* out of engagement with the teeth of the ratchet wheel. As the starting lever is fulcrumed eccentrically with reference to the engine shaft, when it is moved in the forward or operative direction, that is, upwardly in Fig. 2, the pawl will approach the wheel and come in contact with one of the teeth thereof, as indicated by dotted lines in said Fig. 2. In the continued movement of the starting lever the pawl will yield against the action of its spring and will be held by said spring in engagement with a tooth of the ratchet wheel, so that the latter will be turned by the lever. In the return movement of the starting lever the pawl will be held by its spring against the teeth of the ratchet wheel until it strikes its stop *i* and is thereby caused to recede from the teeth of the ratchet wheel in the remainder of the return movement of the starting lever. Thus by one or more quick forward movements of the starting lever the ratchet wheel will be engaged and turned sufficiently to start the engine, and upon each return movement of the lever the pawl will be automatically moved out of engagement with the ratchet wheel so as to permit the latter to turn forwardly with the engine shaft by reason of its momentum, or the automatic operation of the engine. In the event of the back firing of the engine the pawl will leave the ratchet wheel and free the starting lever therefrom before it reaches the limit of its return movement, and thus

injury to the starting mechanism or to the operator is prevented. The starting lever is preferably returned to the initial position by a spring K connected to the lever and to any suitable stationary part k of the engine, and is arrested in the initial position by striking any suitable stop or part k^1 on the engine. The lever is also preferably provided with a handle or operating device k^2 of any convenient or desired form which may extend to any convenient point for operation, for instance, to the vicinity of the seat of an automobile, where the starting device is applied to the engine on an automobile.

The starting means are above described as comprising a lever fulcrumed eccentrically with reference to the engine shaft and provided with a pawl for coöperation with a ratchet wheel secured to the engine shaft, but manifestly the operating device or lever could be differently arranged and provided with different means for releasably coupling, clutching or connecting it with a different sort of wheel or part secured or connected to the engine shaft, so that the wheel or part will be engaged and actuated to turn the engine shaft when the starting device is moved in one direction and to release or free the wheel or part when the operating device is moved in the opposite direction, and the invention is not limited to the particular coupling or connecting means for the starting device and engine shaft above described.

The cam shaft is shifted lengthwise to place the relief cams in operative relation to the valve lifting rods by a part or device actuated by the starting lever or device during the first portion of the operative movement thereof. Different devices may be employed for this purpose. The device shown in the drawings consists of a bar or wedge L pivoted to the starting lever and having an inclined or cam face l, see Figs. 3 and 4, adapted to engage the end of the cam shaft C. When the starting lever is moved in the forward or operative direction, this cam face slides against the end of the cam shaft and shifts the latter endwise in its bearings against the action of its returning spring F. The shifting bar is preferably curved concentrically with the pivot of the starting lever and passes through a slotted guide l^1 by which it is held opposite to the end of the cam shaft. The guide l^1 shown consists of a hollow cap or bushing surrounding the end of the cam shaft and secured in the bearing boss or lug l^2 on the casing for the cam shaft. The parts of the starting mechanism are so proportioned and related that the inclined face of the shifting bar will engage and shift the cam shaft to place the relief cams in operative relation to the exhaust valve lifting rods before the pawl or clutch device engages and turns the starting wheel and engine shaft, so that the exhaust valves will be opened and the compression relieved in the cylinders before the pistons are moved in their compression strokes.

In starting the engine it is only necessary for the operator to pull the handle of the starting lever G up one or more times. During the first portion of the movement of the starting lever, the cam shaft C will be shifted and the relief cams E placed in operative relation to the exhaust valve lifting rods and thereafter during the same movement of the handle and lever the starting wheel H will be engaged and the engine shaft turned. When the engine starts the handle is released and the parts of the starting mechanism permitted to return to their inactive or rest position.

I claim as my invention:

1. The combination with an engine having a relief valve, of a rotatable operating device for said relief valve which is driven by the engine and is normally in an inoperative relation to said relief valve, means for starting the engine, and a device which is connected to said starting means and is moved thereby transversely with respect to said operating device for moving the same axially into operative relation to said relief valve, substantially as set forth.

2. The combination with an engine having a relief valve, of a rotary operating cam for said relief valve which is driven by the engine and is normally in an inoperative relation to said relief valve, means for starting the engine, and means moved by said starting means transversely with respect to the axis of said cam for shifting the cam axially into operative relation to said relief valve, substantially as set forth.

3. The combination with an engine having an exhaust valve, a rotary cam for actuating the same in the normal operation of the engine, of a part on said cam which is normally in an inoperative relation to the valve, means for starting the engine, and a wedge moved transversely of the axis of said cam by said starting means for shifting said cam axially to place said part thereof into operative relation to said valve, substantially as set forth.

4. The combination with an engine having an exhaust valve, of two rotary operating devices for said valve one of which is normally in an operative relation and the other normally in an inoperative relation to said exhaust valve, means for starting the engine, and a wedge which is moved by said starting means transversely of the axis of said rotary devices for shifting said second operating device axially into operative relation to said valve, substantially as set forth.

5. The combination with an engine having an exhaust valve, of two rotating cams driven by the engine and one of which is normally in an inoperative relation to said ex-

haust valve, means for starting the engine, and a wedge moved transversely of the axis of said cams by said starting means for shifting the inoperative cam axially into operative relation to said valve, substantially as set forth.

6. The combination with an engine having an exhaust valve, of a cam shaft, two cams on said shaft, one of which is normally in an inoperative relation to said valve, means for starting the engine, and a wedge which is moved transversely of said cam shaft by said starting means for shifting said cam shaft endwise to place said inoperative cam into operative relation to said valve, substantially as set forth.

7. The combination with an engine having an exhaust valve, of an endwise movable cam shaft, means for yieldingly holding said shaft in the normal position, two cams on said shaft, one of which is normally in an inoperative relation to the exhaust valve, means for starting the engine, and a wedge moved transversely of said cam shaft by said starting means for shifting said shaft endwise to place said inoperative cam into operative relation to the exhaust valve, substantially as set forth.

8. In a multiple cylinder engine having an exhaust valve for each cylinder, the combination of a cam shaft, a pair of cams on said shaft for each of said valves, one of the cams for each valve being normally in an inoperative relation to its valve, means for starting the engine, and a wedge which is moved transversely of said cam shaft by said starting means for shifting said shaft endwise to place said inoperative cams into operative relation to the several exhaust valves, substantially as set forth.

9. The combination with an engine having an exhaust valve, of a cam shaft, two cams on said shaft for operating said exhaust valve, one of said cams being normally in an inoperative relation to said valve, means for starting the engine, and a bar having an inclined face which is moved with said starting means for shifting said cam shaft to move said inoperative cam into operative relation with said exhaust valve, substantially as set forth.

10. The combination with an engine having a relief valve, of an operating device for said relief valve which is driven by the engine and is normally in an inoperative relation to said relief valve, a starting lever for the engine which swings toward and from said valve-operating device, and a device which moves with said lever and shifts said operating device in a direction transversely of the plane of movement of said lever to place the operating device in operative relation to said relief valve, substantially as set forth.

11. The combination with an engine having a shaft and a relief valve, of a cam which is driven by said engine and is normally in an inoperative relation to said relief valve, a starting lever pivoted to swing transversely of said engine shaft, clutch mechanism operated by said lever for turning said engine shaft, and a wedge connected to and operated by said starting lever for shifting said cam into operative relation to said relief valve, substantially as set forth.

12. In an engine, the combination of a starting wheel, a starting lever fulcrumed eccentrically with reference to said wheel, a clutching device which is carried by said lever and is moved by said lever into engagement with said wheel, and a stop on said lever for limiting the movement of said clutch device toward said wheel and for moving said clutch device out of engagement with said wheel when said lever is moved in one direction, substantially as set forth.

13. In an engine, the combination of a starting ratchet wheel, a starting lever fulcrumed eccentrically with reference to said ratchet wheel, a pawl carried by said lever and pressed toward said ratchet wheel, and a stop on said lever for limiting the movement of said pawl toward said ratchet wheel and for moving said pawl out of engagement with said ratchet wheel when the lever is moved in one direction, substantially as set forth.

Witness my hand this 5th day of May, 1906.

DAVID FERGUSSON.

Witnesses:
CHARLES W. PARKER,
C. B. HORNBECK.