Feb. 14, 1933. N. E. WERNBERG 1,897,457

ENGINE STARTER

Filed Aug. 28, 1928 2 Sheets-Sheet 1

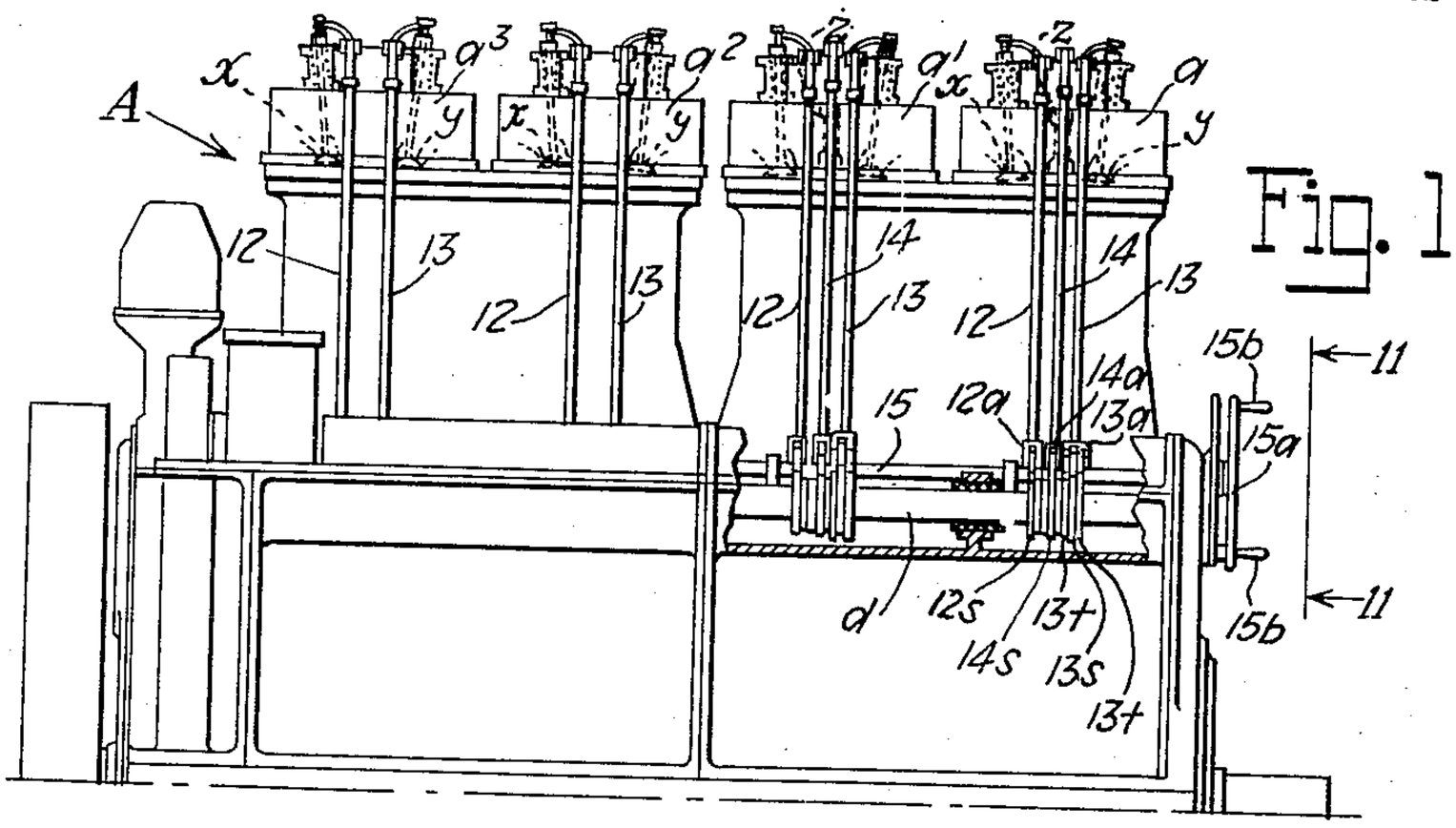


Fig. 1

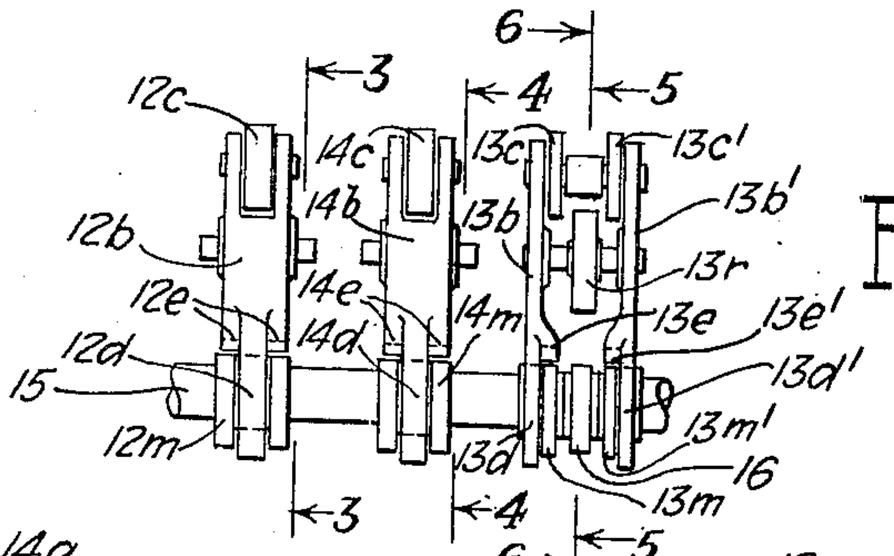
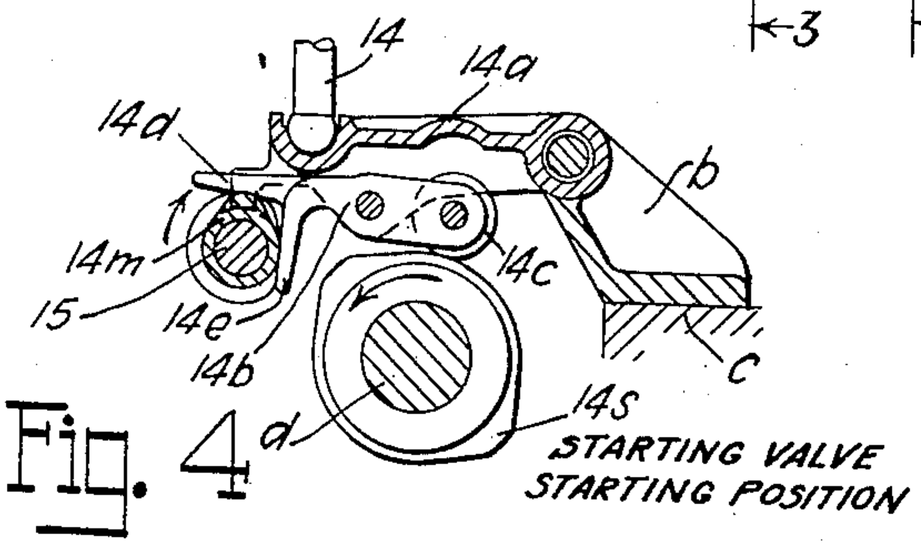
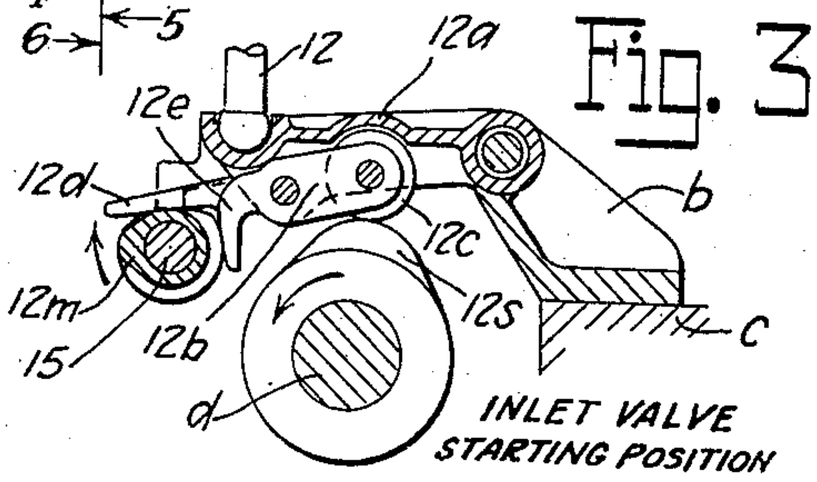


Fig. 2



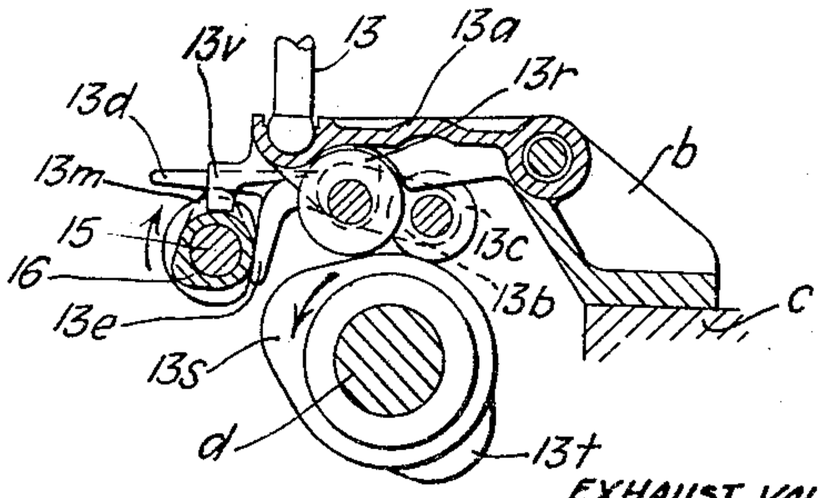
STARTING VALVE STARTING POSITION

Fig. 4



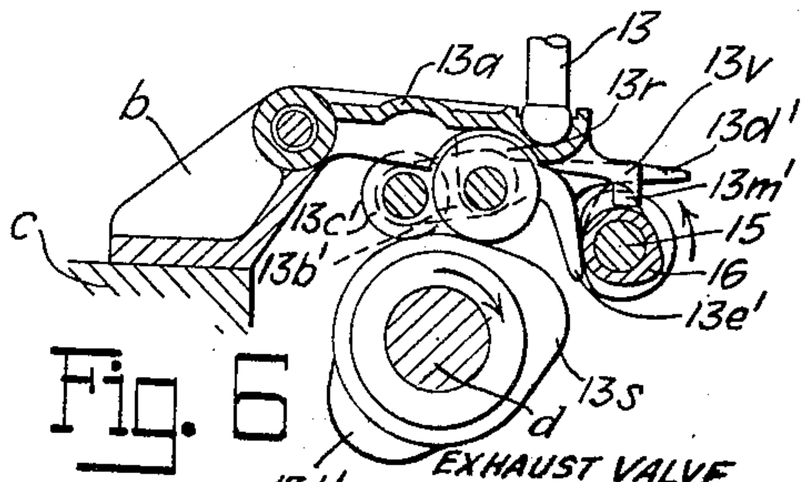
INLET VALVE STARTING POSITION

Fig. 3



EXHAUST VALVE STARTING POSITION.

Fig. 5



EXHAUST VALVE 13t STARTING POSITION.

Fig. 6

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ENGINE STARTER

Filed Aug. 28, 1928

1,897,457

2 Sheets-Sheet 2

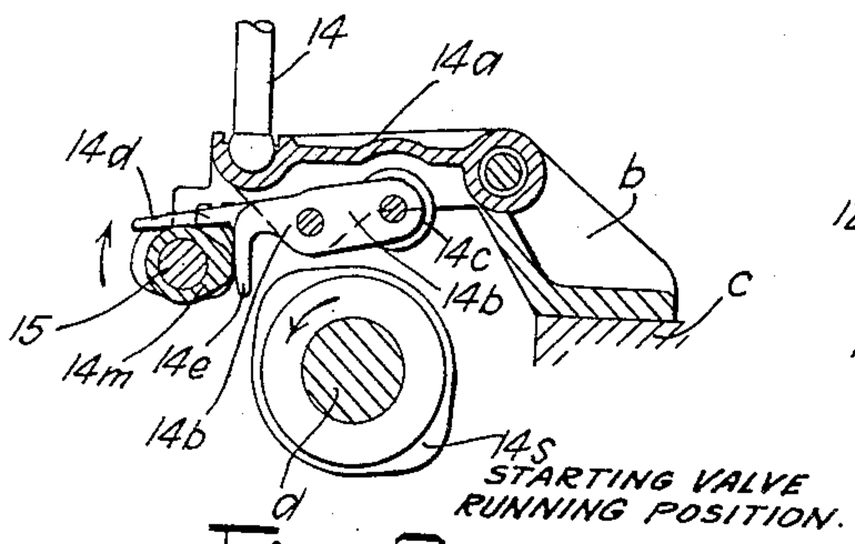

Fig. 8

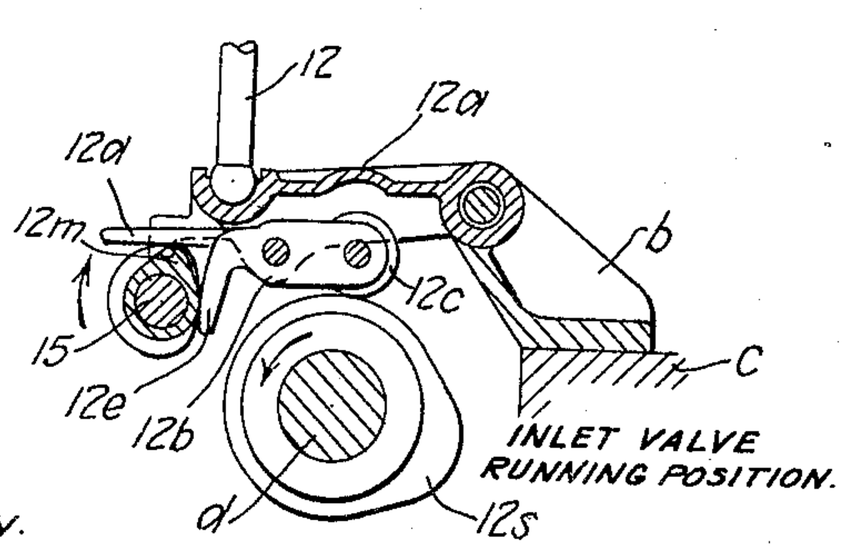

Fig. 7

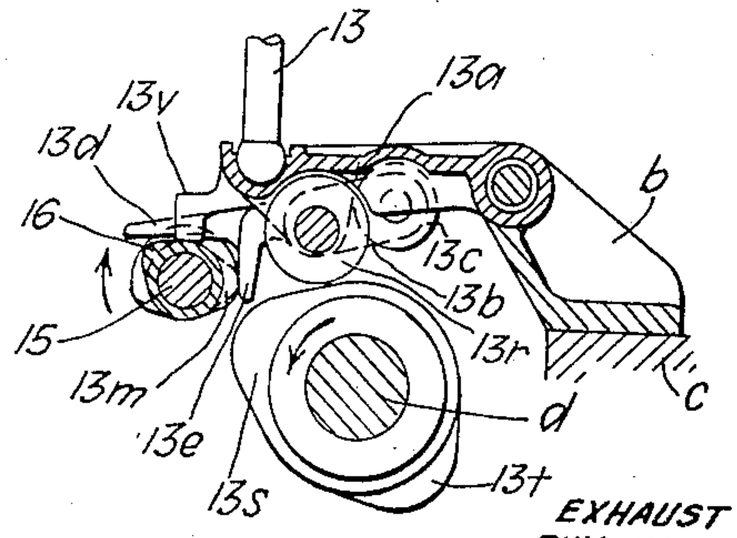

Fig. 9

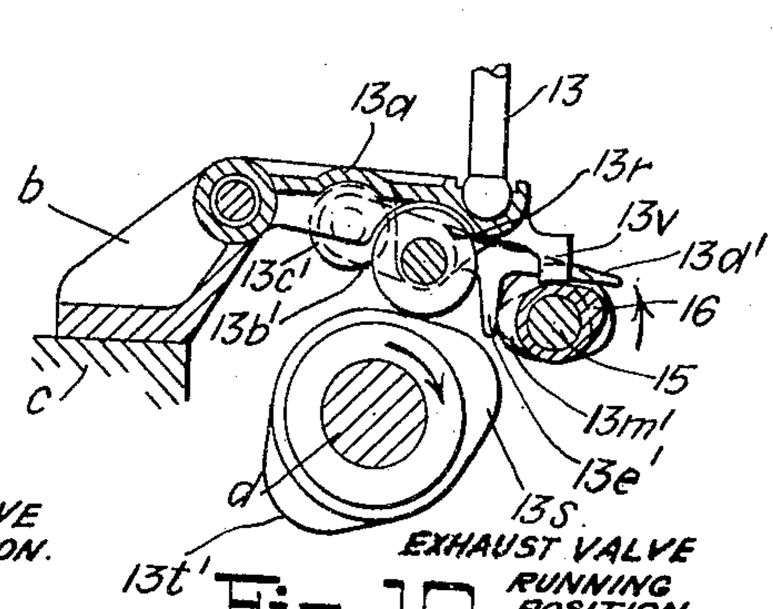

Fig. 10

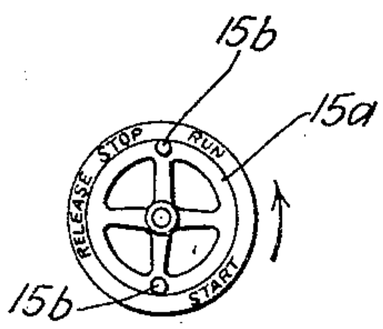

Fig. 11

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Patented Feb. 14, 1933 1,897,457

UNITED STATES PATENT OFFICE

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ENGINE STARTER

Application filed August 28, 1928. Serial No. 302,506.

This invention relates to internal combustion engines, especially those using the heavier hydrocarbon fuel oils and commonly known as Diesel or Diesel-type engines. More specifically it relates to apparatus for effecting starting of such engines.

One object of the invention is to arrange a four cycle Diesel engine to start on a two cycle basis. Another object is to facilitate the change from starting to combustion operation by providing for a part of the engine to operate on the combustion cycle during the starting period. Another object is to effect the change between starting and running control without moving the main cam shaft and without moving any of the cams on the said shaft. Still another object is to simplify, improve and cheapen the cost of starting apparatus without impairing its efficiency in order that more expeditious and convenient starting apparatus may be available. Further objects will be apparent from the detailed description which follows.

The invention provides for the utilization of only a part of a Diesel engine for starting while the remainder remains unchanged. Thus some of the cylinders may be adapted to use a starting fluid such as compressed air and to operate on the two-cycle principle while the remaining cylinders operate at all times as a combustion engine on the four-cycle principle. The control may be effected by means of cams on a separate control shaft acting upon special control levers mounted upon the usual valve mechanism. The control levers may be pivotally mounted upon the push rod cam levers and carry rollers arranged for operative engagement with and disengagement from additional cams on the cam shaft. Axial displacement of the cam shaft or of any cams thereon, which is the usual practice, is entirely avoided.

In order to illustrate the invention one concrete embodiment thereof is shown in the accompanying drawings, in which:

Fig. 1 is a side elevational view partly broken away of a Diesel engine;

Fig. 2 is a fragmentary top plan view on an enlarged scale of the control levers and cam rollers which are operated from the control shaft;

Fig. 3 is a detail sectional view substantially on the line 3—3 of Fig. 2 but disclosing the associated parts of the engine shown in Fig. 1;

Fig. 4 is a detail sectional view similar to Fig. 3 but taken substantially on the line 4—4 of Fig. 2;

Figs. 5 and 6 are detail sectional views similar to Figs. 3 and 4 but taken from opposite sides of the lines 5, 6—5, 6 of Fig. 2;

Figs. 7, 8, 9 and 10 are detail sectional views conforming to Figs. 3, 4, 5 and 6 respectively, but showing the position of the parts when the engine is running;

Fig. 11 is a fragmentary and elevational view of the manual operating handle of the control shaft, the view being taken substantially on the line 11—11 of Fig. 1.

The embodiment of the invention chosen for the purpose of illustration discloses in Fig. 1 a multi-cylinder internal-combustion engine A of the Diesel type. While the number of cylinders in the engine may be varied, the present engine has four cylinders a, a' a^2, and a^3. Each cylinder is provided with an inlet valve x and an exhaust valve y, and at least a part of the cylinders have air starting valves z. The valves of the engine are operated in accordance with the usual practice by push rods 12 for the inlet valves x, 13 for the exhaust valves y, and 14 for the air starting valves z.

The present engine has starting apparatus applied only to a portion of the cylinders, namely a and a', and in starting the engine these two cylinders are arranged to operate on the two-cycle principle while the engine in its running condition operates on four cycles. By arranging cylinders a and a' to operate on two cycles in starting, the same number of power impulses for turning the engine over are secured as if all four cylinders were used for starting on the four-cycle principle with the added advantage that cylinders a^2 and a^3, which are not equipped for air starting, operate at all times as internal combustion cylinders on the four-cycle principle. This facilitates the transition from starting to run-

ning condition since cylinders a^2 and a^3 are placed in running condition before cylinders a and a' are changed over from two cycle starting to four cycle running.

The manner of controlling the starting and running conditions of the engine will now be described, reference being had to the cut-away portion of Fig. 1 and to the enlarged detail views of Figs. 2–10 inclusive. Since the operation of engines of the Diesel type is well known, description in relation to cylinders a^2 and a^3 is entirely omitted and since the control of cylinders a and a' is the same, the detailed description and disclosure is confined to the control of but one of these cylinders. As is the usual practice the push rods 12, 13 and 14 are actuated by cam levers pivoted to brackets b on engine frame c, the cam levers for inlet valves x being indicated at 12a in Figs. 1, 3 and 7; the cam levers for exhaust valves y being indicated at 13a in Figs. 1, 5, 6, 9 and 10; the cam levers for starting rods 14, indicated at 14a, in Figs. 1, 4 and 8. Cams for operating the cam levers (as well as the control levers presently to be described) are mounted upon a cam shaft d (Figs. 1 and 3–10 inclusive). The exhaust cam levers have mounted directly thereon a roller 13r (Figs. 2, 5, 6, 9 and 10) which normally engages the exhaust cam 13s.

The cam lever for each push rod is provided with one or more control levers pivoted thereto, these control levers being disclosed in their relative positions apart from the cam levers in Fig. 2. Inlet cam lever 12a (Figs. 3 and 7) has a single control lever 12b having a roller 12c disposed beneath the central portion of the cam lever and having an axial extension 12d extending beyond the lever with angular arms 12e, the extension and the arms being arranged to engage the central cam portion and the side guide portions respectively, of a control cam 12m on manual control shaft 15. The position of control cam 12m determines whether roller 12c shall be in engagement or not with the inlet cam 12s on cam shaft d.

Starting cam lever 14a (Figs. 4 and 8) also has a single control lever 14b pivoted thereto and provided beneath the central portion of the cam lever with a roller 14c and at its opposite end with an extension 14d and two angular arms 14e, the extension and the arms being arranged to engage the control cam portions and the side guide portions respectively of a control cam 14m on manual control shaft 15. The position of the cam determines whether roller 14c shall engage starting cam 14s on cam shaft d.

Exhaust cam lever 13a, however, has two control levers 13b (Figs. 2, 5 and 9) and 13b' (Figs. 2, 6 and 10), these control levers utilizing the shaft of roller 13r on cam lever 13a as a pivot, as clearly indicated in Fig. 2. Control levers 13b and 13b' respectively have at the ends thereof and disposed beneath the central portion of the cam lever rollers 13c and 13c' and at their outer ends extensions 13d and 13d' with angular arms 13e and 13e', the extensions and the arms being arranged to engage the cam portions and the side guide portions respectively of control cams 13m and 13m' on control shaft 15, the positions of these cams determining whether or not rollers 13c and 13c' engage cooperating exhaust cams 13t and 13t' which flank the exhaust cam 13s on cam shaft d.

The guide portions of each of control cams 12m, 14m, 13m and 13m' on control shaft 15 act on the engaging angular arms 12e, 14e, 13e and 13e' respectively to maintain control levers 12b, 14b, 13b and 13b' in their inoperative positions but have flats in suitable relation (Figs. 3–10) to the cam portions to enable the latter to act on the extensions 12d, 14d, 13d and 13d' and move the control levers to their operative positions.

It is to be noted that the inlet valves operated by rods 12 are to be actuated only when the engine functions as an internal combustion engine on four cycles. Hence, the operating cam 12s on cam shaft d has but one lift since cam shaft d, in accordance with the usual practice, rotates at half the speed of the engine shaft. Similarly in the normal operation of the engine as an internal combustion engine, the exhaust valves are operated through the engagement of roller 13r with exhaust cam 13s, which also has a single lift for four-cycle operation. For two-cycle operation of cylinders a and a' in starting the air inlet valves operated by rods 14 need to be opened once during each revolution of the engine; hence, the air starting cam 14s (Figs. 4 and 8) has two lifts. It will also be necessary for two-cycle operation that the exhaust valves of cylinders a and a' be opened once during each revolution; hence, the additional exhaust cams 13t and 13t' on cam shaft d, which are in line to be simultaneously engaged by control lever rollers 13c and 13c' respectively. The angular position of cams 13t and 13t' relative to cam 13s conforms to the relative positions of rollers 13c and 13c' relative to roller 13r and is such as to make the lifts of the exhaust valve 180° apart. The purpose of the two exhaust control levers 13b and 13b' is to give a balanced thrust to exhaust lever 13a and to avoid any binding effect on the latter which might result from an offside thrust if only one control lever were used.

The manual operation of control shaft 15 is effected by turning a hand wheel 15a provided with handle 15b (Figs. 1 and 11). The direction of rotation of control shaft 15 from the start to stop position is indicated by the arrows adjacent thereto in Figs. 3 to 11 inclusive while the direction of rotation of cam shaft d is also indicated by the arrows adja-

cent thereto in Figs. 3–10 inclusive. On turning hand wheel 15*a* to the start position, the parts take the position shown in Figs. 3–6 inclusive wherein the inlet cam lever 12*a* is arranged to remain motionless through the action of cam 12*m* on the control shaft 15 engaging arm 12*e* of control lever 12*b* to move roller 12*c* out of operative relation with inlet cam 12*s* on cam shaft *d*. At the same time cam 14*m* on control shaft 15 operates to move and hold control lever 14*b* in the position shown in Fig. 4 with roller 14*c* in operative contact with cam 14*s* so that cam lever 14*a* is actuated to operate the starting valve twice during each revolution of cam shaft *d*. In a similar manner cams 13*m* and 13*m'* on cam shaft 15 engage extensions 13*d* and 13*d'* on control levers 13*b* and 13*b'* to hold the latter in operative engagement with cams 13*t* and 13*t'* as shown in Figs. 5 and 6 so that the exhaust valves on cylinders *a* and *a'* are actuated twice during each revolution of cam shaft *d* to cause these cylinders to operate on the two-cycle principle.

As soon as cylinders a^2 and a^3 have started to fire. hand wheel 15*a* is turned to the "run" position which brings the parts into the positions shown in Figs. 7–10 inclusive wherein cam 12*m* on control shaft 15 engages the extension 12*d* of control lever 12*b* in a manner to bring the same into operative engagement with inlet cam 12*s*. At the same time cam 14*m* operates to throw control lever 14*b* to inoperative position out of engagement with cam 14*s* so that the air starting valves are no longer operated. Similarly, cams 13*m* and 13*m'* operate to throw control levers 13*b* and 13*b'* to inoperative position, as indicated in Figs. 9 and 10, so that cam 13*s* alone of the three exhaust cams, 13*t*, 13*s* and 13*t'*, actuates cam lever 13*a* through roller 13*r* thereby effecting one opening of the exhaust valve in each revolution of the cam shaft which is four cycle operation. When hand wheel 15*a* is moved to stop position a cam 16 on control shaft 15 (Figs. 5, 6, 9–10) directly engages an extension 13*v* on exhaust cam lever 13*a* thereby holding open all the exhaust valves so the engine cannot operate.

From the above it will be apparent that the utilization of half the cylinders of a multi-cylinder four-cycle engine for air starting on the two-cycle principle gives the same number of power strokes and facilitates starting by enabling the four-cycle cylinders to start to run on fuel before the starting cylinders are thrown out of operation; that this arrangement makes a smoother change from air operation to fuel operation with the added advantage of an economical use of air to start the engine; that a lower starting air pressure may be utilized through the quicker starting of the engine on fuel; that this starting arrangement avoids the use of additional machine parts on the cylinders not used for starting thereby making the engine less expensive, and that the utilization of control levers on the cam levers permits engagement and disengagement of the rollers with the cams without shifting the cam shaft or moving the cams on the shaft, thereby producing a simpler and stronger construction.

While the invention has been herein disclosed in what is now considered to be a preferred form, it is to be understood that the invention is not limited to the specific details thereof, but covers all changes, modifications and adaptations within the scope of the appended claims.

I claim as my invention:

1. In combination, an internal-combustion engine having valves, a cam shaft, means interposed between said shaft and said valves for transmitting the cam impulses to said valves including cam levers, members movably mounted upon said levers for engagement with or disengagement from said shaft, angularly disposed arms in rigid fixed relation on each of said control levers, and a control shaft independent of said cam levers having cams for engaging said arms to hold said control levers in operative or in inoperative position relative to said cam shaft regardless of any normal movement of said cam levers.

2. In combination, an internal-combustion engine having valves, a cam shaft having cams for operating said valves both for starting and for running, connections to said valves including cam levers, members having cam engaging rollers movably mounted on said cam levers, and means apart from said cam shaft and independent of said cam levers for adjusting said members to dispose said rollers either in or out of engagement with the cams on said shaft thereby to control the operation of said engine, said members having angularly disposed arms remote from said rollers for engaging said means.

3. In combination an internal-combustion engine having valves, a cam shaft having cams for operating said valves both for starting and for running, connections to said valves including cam levers, members having cam engaging rollers movably mounted on said cam levers, and a control shaft wholly independent of said cam shaft for adjusting said members, each of said members having means engaging said control shaft tangentially at at least two angularly spaced points.

4. In combination, an internal combustion engine having valves, a cam shaft having cams for operating said valves both for starting and for running, connections to said valves including cam levers, members having cam engaging rollers movably mounted on said cam levers, and a control shaft apart from said cam shaft and said cam levers hav-

ing cams for adjusting the position of said members, each of said members having angularly disposed arms engaging said control shaft cams tangentially at spaced points.

5. In combination, an internal combustion engine having valves, a cam shaft having cams for operating said valves both for starting and for running, connections to said valves including cam levers pivotally mounted at one end, members pivotally mounted at substantially their central points on said cam levers and having at one end cam engaging rollers, and a control shaft apart from said cam levers and from the pivots of said levers and from said cam shaft but having means for adjusting the position of said members, each of said members having angularly disposed arms at the ends remote from said rollers for engaging said control shaft tangentially at spaced points.

6. In combination, an internal combustion engine having valves, a cam shaft having cams for operating said valves both for starting and for running, cam levers pivotally mounted at one end having valve operating means at the other end and intermediate means for engaging said cam shaft, said intermediate means comprising members pivotally mounted at substantially their central portions on said cam levers and having at one end rollers for engagement with said cam shaft, and a control shaft apart from said cam shaft and adjacent the free or valve actuating ends of said cam levers, said control shaft having cam and guide portions for adjusting the position of said members, each of said members having an extension at the ends remote from said rollers with angularly disposed arms engaging both the cam and guide portions of said control shaft.

7. In combination, an internal combustion engine having valves, a cam shaft having cams for operating said valves both for starting and for running, cam levers pivotally mounted at one end having valve operating means at the other end and intermediate means for engaging said cam shaft, said intermediate means comprising members pivotally mounted at substantially their central portions on said cam levers and having at one end rollers for engagement with said cam shaft, and a control shaft apart from said cam shaft and adjacent the free or valve actuating ends of said cam levers, said control shaft having cam portions and guide portions adjacent said cam portions with flats in a definite relation to the projections on said cam portions for adjusting the position of said members, each of said members having an extension at the ends remote from said rollers with angularly disposed arms corresponding to the angular relation of said flats and cam projections on said control shaft and engaging both the cam and guide portions of said control shaft.

Signed by me at Franklin, in the county of Venango and State of Penn. this 22d day of August, 1928.

NIELS E. WERNBERG.

CERTIFICATE OF CORRECTION.

Patent No. 1,897,457. February 14, 1933.

NIELS E. WERNBERG.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 1, line 85, after "apparatus" insert the words "including valves z; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 25th day of April, A. D. 1933.

M. J. Moore,
Acting Commissioner of Patents.

(Seal)