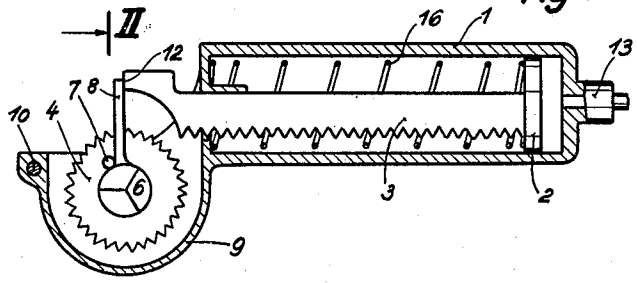
Aug. 17, 1937. A. CALLSEN 2,090,342

STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Filed March 23, 1936

Fig. 1



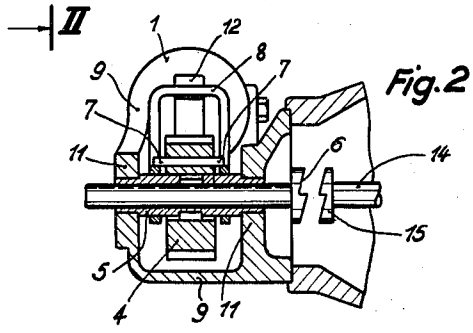


Fig. 2

Fig. 3

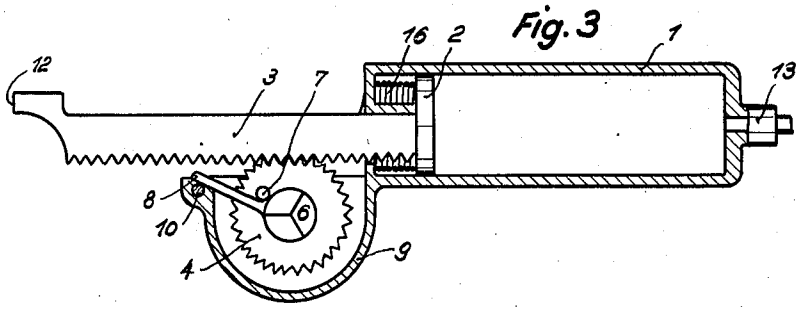
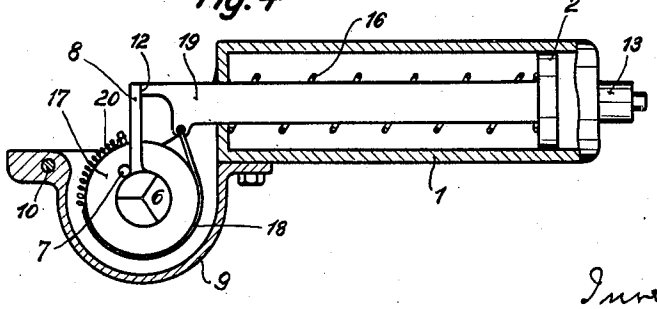


Fig. 4



Inventor
Albert Callsen
by Steward & McKay
his attorneys

Patented Aug. 17, 1937

2,090,342

UNITED STATES PATENT OFFICE

2,090,342

STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

Albert Callsen, Stuttgart, Germany, assignor to Robert Bosch Aktiengesellschaft, Stuttgart, Germany

Application March 23, 1936, Serial No. 70,466
In Germany April 5, 1935

4 Claims. (Cl. 121—37)

The present invention relates to starting apparatus for internal combustion engines, wherein the pressure produced in a cylinder by explosion gases acts on a piston, which rotates a driving member, for instance a dog or claw, which can be brought into engagement with a part of the engine to be started.

In apparatus of this kind the difficulty exists in that the thrust of the piston produced by the explosion gases, for instance, from a cartridge, is greatest directly after the explosion, whilst the acceleration of the masses, such as the crank-shaft and pistons, in the engine is greatest on being started from rest. Accordingly the torque required to be exerted by the driving member is greatest at the instant of starting. Too great a strain on the parts of the piston and driving member which transmit the pressure of the gases from the piston to the driving member can be avoided by making the lever arm, with which the piston acts on the driving member, large. This necessitates, however, a large piston stroke and thus a great increase in the cost of the apparatus and the driving medium. If the lever arm is made small, the power-transmitting parts such as a toothed pinion and rackbar or a traction cord, cannot withstand the stresses.

These drawbacks are avoided according to the invention, by varying the lever arm thrust of the piston on the driving member, the said lever arm thrust being greater at the beginning of the starting operation than in the succeeding rotary movement of the driving member.

Two examples of construction of the invention are diagrammatically shown in the drawing, in which:—

Figure 1 shows a starting apparatus partly in section.

Figure 2 is a section on the line 2—2 of Figure 1.

Figure 3 shows the apparatus in a special position.

Figure 4 shows a second form of construction.

The starting apparatus consists of a cylinder 1, in which is a piston 2, which is moved by compressed gases, that can be produced, for instance, by firing a cartridge. To the piston is connected a toothed rackbar 3 which on the forward stroke of the piston comes in engagement with a toothed pinion 4. This toothed pinion is keyed on a hollow shaft 5, which is mounted in bearings 11 in the gear-box 9, and in this hollow shaft a clutch-dog 6 is longitudinally movable but prevented from rotating. Stops 7 are provided on the toothed pinion, on which stops a driving member 8 can act, the said driving member being formed as a yoke, which is rotatably mounted on the hollow shaft 5, and engages over the pinion. An extension 12 provided at the free end of the rackbar acts on the yoke, and projects in the direction of movement of the rackbar so far beyond the teeth thereof that on the forward stroke of the piston the extension bears on the yoke before the teeth on the rackbar engage in the pinion. A stop 10 is provided on the gear-box 9 to limit the rotary movement of the yoke.

Means for firing a cartridge are provided on the part 13 of the cylinder, the powder gases producing the required working pressure. 14 is the crank-shaft of an engine, on which shaft is a clutch-dog 15, situated opposite the dog 6.

The apparatus works in the following way:—

To start the crank-shaft 14, the driver puts the dog 6 into engagement with the dog 15 of crank-shaft. He then explodes a cartridge, inserted in the chamber 13. The compressed gases evolved by firing the cartridge drive the piston 2 forward in the cylinder. On this movement of the piston, the extension 12 of the rackbar 3 first acts on the yoke 8, which by means of the stop 7 transmits the force exerted on it to the toothed pinion 4 and the dog 6 coupled thereto. After a rotation of the pinion and yoke, of say 60°, the teeth of the rackbar come into engagement with the pinion 4, while the extension 12 slides past over the yoke, and thus comes out of engagement with it, so that now the force of the piston is conveyed to the pinion only by the teeth of the rackbar. After the full stroke of the piston 2 (Figure 3), the pinion 4 has made a full rotation. The spring 16 arranged in the cylinder forces back the piston 2, and thus at the same time the pinion 4 and the yoke 8, into its initial position.

The maximum point of torque in the starting of an engine by compressed gases lies in the region of the first quarter revolution of the crank-shaft. In this region the piston acts on the dog 6 with the large lever arm of the yoke 8. After passing this point the torque quickly drops, because the acceleration of the masses in the engine slackens. This smaller torque can now be transmitted by the teeth of the rackbar and the toothed pinion without the strain on the teeth reaching an injurious degree.

In Figure 4 a second example of construction is shown. In this, instead of a toothed pinion, a drum 17 is employed round which a cord 18

is looped. One end of the cord is secured to the piston-rod 19, while the other end is connected to a spring 20, which is fixed on the drum. In starting the engine, the piston-rod acts on the lever 8. At the same time, a pull is also exerted on the cord 18, and the spring 20 stretched. When the piston-rod comes out of engagement with the lever 8, the whole thrust of the piston is transmitted only by the cord and the spring.

The advantage of the invention is that, without overloading the transmission members (teeth), the size of the cylinder can be kept small and thereby the starting apparatus can be made cheaply and is serviceable in practice.

I declare that what I claim is:

1. A starting apparatus for internal combustion engines comprising a pinion adapted for coupling to a moving part of the engine to be started, a lever, pin means on said pinion for engagement by said lever to couple said lever with said pinion, a cylinder, a piston displaceable in said cylinder for starting said engine, a rack bar carried by said piston and means projecting beyond the free end of said rack bar to engage with said lever at a part farther away from the axis of said pinion than the point of inter-engagement of the teeth of said rack bar with the teeth of said pinion.

2. A starting apparatus for internal combustion engines comprising a pinion adapted for coupling to a moving part of the engine to be started, a yoke shaped lever pivotally mounted about the axis of said pinion, pin means carried by said pinion and projecting beyond the ends thereof for engagement by the arms of said yoke shaped lever to rotate said pinion on angular displacement of said yoke shaped lever, a cylinder, a piston displaceable in said cylinder for starting said engine, a rack bar carried by said piston and means projecting beyond the free end of said rack bar to engage with said lever at a part farther away from the axis of said pinion than the point of inter-engagement of the teeth of said rack bar with the teeth of said pinion.

3. A starting apparatus for internal combustion engines comprising a toothed pinion adapted for coupling to a moving part of the engine to be started, a lever arm projecting radially beyond the periphery of said pinion, pin means carried by said pinion for engagement by said lever arm to couple said pinion therewith, a cylinder, a piston displaceable within said cylinder for starting said engine, a rack bar carried by said piston and an extension of said rack bar which projects forwardly beyond the free end of said rack bar in the direction of thrust of said piston and is located at a greater distance from the axis of said pinion than the teeth of said rack bar to provide a differential torque on said pinion when said extension engages with said lever at the commencement of movement of said piston than subsequently thereto when the rack bar of said piston engages with the teeth of said piston.

4. A starting apparatus as claimed in claim 3 wherein means are provided for limiting the angular displacement of said lever arm to substantially 60° and for limiting the total displacement of said pinion to one complete revolution during which the pin carried by said pinion travels from one side of said lever arm to the other.

ALBERT CALLSEN.