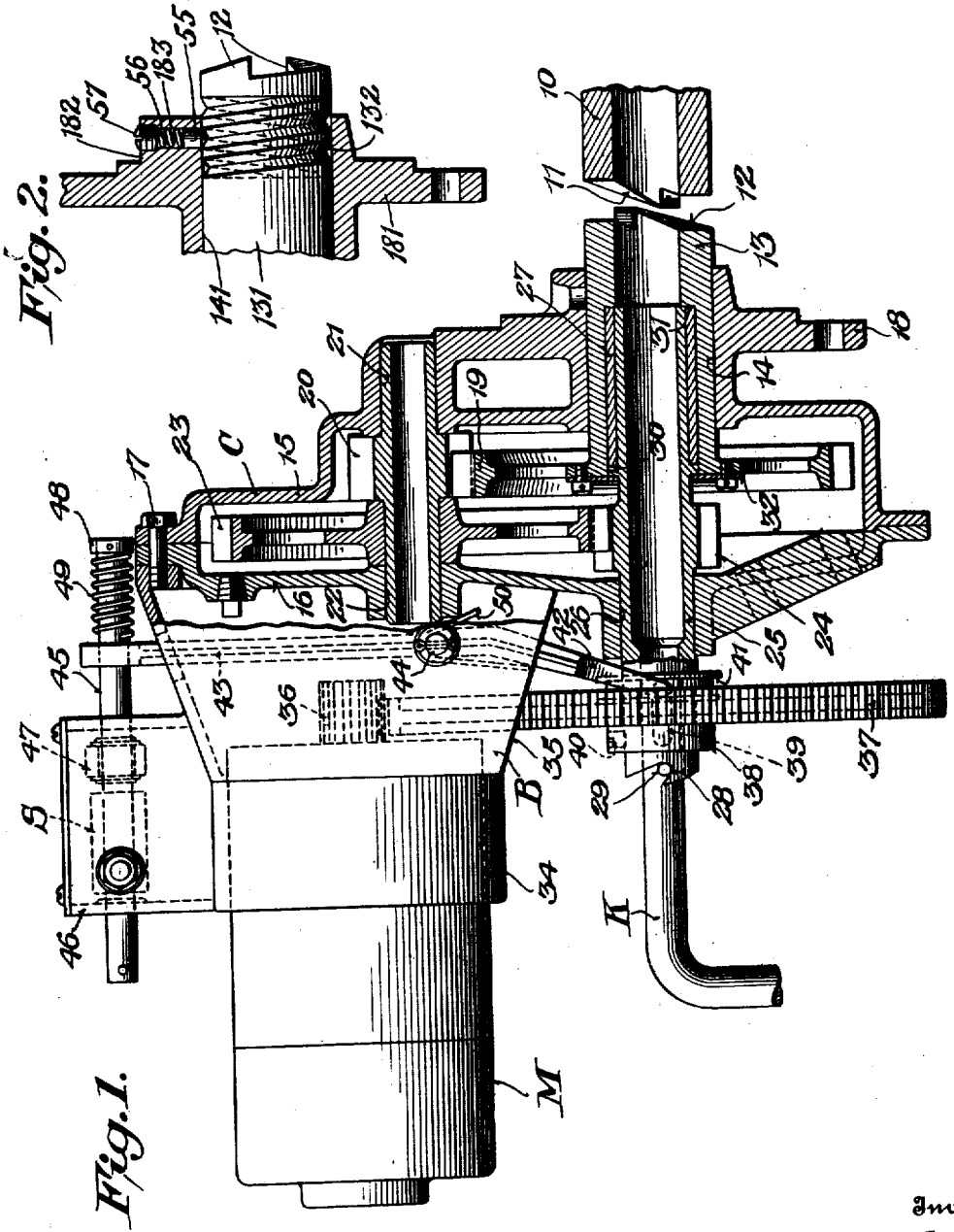
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ENGINE STARTING APPARATUS.

APPLICATION FILED SEPT. 28, 1918.

1,415,531. Patented May 9, 1922.



Witnesses.

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ENGINE-STARTING APPARATUS.

1,415,531. Specification of Letters Patent. Patented May 9, 1922.

Application filed September 28, 1918. Serial No. 256,126.

To all whom it may concern:

Be it known that I, JAMES K. DELANO, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Engine-Starting Apparatus; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

This invention relates to engine starting apparatus and has particular reference to apparatus for starting or cranking engines of large capacity, such as those employed for driving airplanes and trucks. Numerous features of the invention are not limited to such engines, however.

Usually an airplane engine is started by turning the propeller by hand. It is desirable to employ power operable starting mechanism in order to obtain a more reliable starting action and also to dispense with the labor required to start the engine manually. It is highly desirable that provision be also made whereby the occupant of the airplane may manually start the engine, so that the engine may be started by hand, should the power starting device fail to operate. To economize weight and obtain other advantages, the starting effort should be transmitted to the engine through gearing that is common to both starting devices. In a copending application, Serial No. 248,204, filed August 3, 1918, I have disclosed and claimed an engine starting apparatus broadly embodying the foregoing principles.

It is an object of the present invention to provide an engine starting apparatus embodying the same broad principles as the one shown in my application already filed, but involving a different arrangement of elements.

Another object of this invention is to combine a particularly desirable type of hand cranking mechanism with a starting motor in such manner that a slidable part common to both cranking devices may be actuated by either device to clutch the starting mechanism to the engine, whereby the motor and hand crank may be alternatively employed for starting the engine.

Another object of the invention is to provide a starting mechanism in which a power transmission mechanism embodying speed reduction gearing may be operatively connected to an engine by a novel means that also operates to close the circuit of the electric starting motor that is operatively connected to the power transmission mechanism.

Another object of the invention is to provide novel means whereby the starting mechanism may be connected to the engine automatically when starting power is applied to start the engine, and automatically disconnected from the engine shaft when the engine picks up and operates under its own power.

The above and other objects and novel features of the invention will be apparent from the following description taken in connection with the drawing in which—

Figure 1 is a view partly in section and partly in elevation illustrating an engine starting apparatus embodying my invention, and

Figure 2 is a detail view of a modification of a portion of the apparatus shown in Figure 1.

Referring to Figure 1, the end of the engine crank shaft or a part connected thereto is indicated at 10 and is provided with suitable clutch teeth 11, adapted to be engaged by the clutch teeth 12, on the clutch member 13 that is rotatably and slidably supported in a bearing 14 in one wall 15 of the gear case C. The other wall 16 of the gear case is secured to the wall 15 by bolts 17, the wall 15 being provided with a flange 18 having openings to receive bolts whereby the starting apparatus may be secured to the engine crank case or mounted in some other suitable position.

The inner end of the clutch member 13 carries a gear 19 which may be formed integral with the member 13 or secured thereto in some suitable manner. The gear 19 meshes with a pinion 20 which has elongated hub portions whereby it is mounted in bearings 21 and 22 in the walls 15 and 16, respectively. One hub of the pinion 20 carries a gear 23 that meshes with a pinion 24 carried by the starting shaft 25 that is slidably and rotatably mounted in the bearing 26 in the wall 16, and is rotatable in a bearing sleeve 27 in the clutch member 13.

The shaft 25 is hollow and extends out-

side the casing C, the outer end thereof being provided with a notch 28 to receive the pin 29 on a hand starting crank K, the inner end of which is adapted to fit into the shaft 25.

The shaft 25 and the clutch member 13 are in axial alignment, the former being provided with a collar 30 that is of larger diameter than the portion of the shaft 25 that rests in the bearing sleeve 27. The collar 30 abuts against one end of the bearing sleeve 27, the other end of the latter abutting against a shoulder 31 on the clutch member 13 so that an endwise movement of the shaft 25 toward the right in the drawing, will slide the clutch member 13 toward the right to engage the teeth 12 and 11 with one another. A ring 32 secured to the hub of the gear 19 is of smaller internal diameter than the external diameter of the shoulder or collar 30. The ring 32 and sleeve 27 engage opposite sides of the collar 30 and connect the shaft 25 to the clutch member 13 and gear 19 so that the said clutch member and gear will move longitudinally with the shaft 25 but will not rotate therewith. Accordingly, an endwise movement of the shaft 25 toward the left in the drawing will cause a disengagement of the clutch teeth 12 and 11, since the clutch member 13 moves axially with the shaft 25. The teeth of the pinions 20 and 24 are of sufficient length to constantly mesh with the teeth of the gears 19 and 23, respectively, in any position of the shaft 25 and clutch member 13.

In order to start the engine manually the crank K is connected to the end of the shaft 25, as shown, and by pushing inwardly the shaft 25 and the clutch member 13 are moved toward the right into position to engage the teeth 12 with the teeth 11 at the end of the engine member 10. Power will be transmitted at a reduced speed from the crank through the gear train 24, 23, 20 and 19, to the engine. After the engine has been started and the crank has been released, the shaft 25 and the elements connected to it will be returned to their normal position, in a manner to be described.

The wall 16 of the crank case carries a hollow bracket B which has a cylindrical part 34 forming a housing to receive the end of an electric motor M, and a hollow flaring part 35 which may be secured to the wall 16 in a suitable manner. The end of the motor armature shaft in the housing part 35 carries a pinion 36 that meshes with a gear 37 having a hub 38 whereby the gear is mounted on the shaft 25. The hub 38 and gear 37 are secured against rotative and longitudinal movement with respect to the shaft 25 by a key 39 and a set screw 40, respectively. The hub 38 is also provided with a groove 41 to receive the forked lower end 42 of a shifting lever 43 that is pivoted at 44 on the housing B. The upper end of the shifting lever 43 has an opening to receive the actuating rod 45, one end of which may be connected by suitable means to a point accessible to the operator. The rod 45 passes through a switch casing 46 and carries a switch member 47 that is arranged to close a switch S controlling the circuit of the motor M. The rod 45 carries a collar 48 and between the latter and the upper end of the shifting lever 43 there is a spring 49 that is adapted to yieldingly engage the lever 43 when the rod 45 is operated to shift the gear 37 and the shaft 25. The teeth of the pinion are of such length that they will be in constant mesh with the teeth of the gear 37 during all movements of the latter. The spring 49 also restores the rod 45 and the switch member 47 to normal position when the rod 45 is released, thereby breaking the motor circuit. A spring 50 that surrounds the pivot 44 of the lever 43, and has one end secured to said lever, serves to return the gear 37 and shaft 25 to their normal positions automatically when the operating rod 45 is released. When the engine is cranked by hand, the operator of course pushes inwardly on the crank, so that the gear 37, with the lever 43 connected to it, will slide axially a short distance to cause engagement of clutch teeth 11, 12, as before. Thus the spring 50 also automatically restores the parts to their normal position after the engine is cranked by hand.

It will be understood that a spring or other cushioning means (not shown) may be interposed at a suitable point in the gear train between the crank K or driving motor M and the engine crank shaft to cushion the initial turning force applied by the starter.

In Fig. 2, I have disclosed means whereby the clutch jaws of the starting apparatus may be automatically engaged and disengaged during the starting operation, so that the lever 43, collar 41, and other associated parts, shown in Fig. 1, may be eliminated if desired. The shaft 131, which corresponds to the shaft 13 of Fig. 1, is rotatably and slidably mounted in a bearing 141 in the housing member 181, corresponding respectively to the bearing 14 and housing 18 of Fig. 1. The shaft 131 has a coarse exterior thread 132 at a slight distance inwardly from the outer end thereof that carries the clutch teeth 12 which are adapted to interlock with corresponding clutch teeth 11 on an engine crank shaft 10.

A suitable cooperating means is provided for causing the threaded shaft 131 and the toothed part 12 carried thereby to move axially into engagement with the cooperating member on the engine crank shaft, and to permit said members to separate automatically after the engine has been started and has speeded up. A particularly simple and effective means for effecting this result is

shown in Fig. 2. The housing member 181 has a hub portion 182 that is provided with a recess or opening 183 which extends radially through the hub 182 and communicates with the bearing opening 141. A plunger or detent 55 fits in the opening 183 and has a tapering inner end that fits in the thread groove 132. A spring 56 in the recess 183 yieldingly presses the detent 55 into engagement with the threaded portion of the shaft 131, the said spring being held in place by a threaded cap 57 that closes the outer end of the recess 183. It will be understood that the structure disclosed in Fig. 2 may be applied to a starting apparatus such as the one shown in Fig. 1, but since such structure is intended to effect the automatic engagement and permit the automatic disengagement of the clutch teeth 11 and 12, the lever 43, pivot 44, collar 41, and spring 50, may be omitted. In such an arrangement the gear 37 is of course fast on the shaft 26 and the inner end of the spring 49 is arranged to bear against the end wall of the case of the switch S or some other suitable abutment to automatically open the switch S when the operator releases the rod 45.

The shaft 26, when rotated by hand or power, causes the rotation of the shaft 131, and the tracking of the detent 55 in the thread groove 132 causes the shaft 131 to move longitudinally as it is rotated and until the teeth 12 thereof engage the teeth 11 on the engine crank shaft 10, whereupon further longitudinal movement ceases and the engine shaft 10 is rotated by the shaft 131 to crank the engine. During the cranking operation the spring pressed detent 55 is alternately forced into its recess by the advancing thread and then dropped back into the thread groove, as the shaft 131 turns. When the engine operates under its own power and drives the shaft 10 faster than the shaft 131, the teeth 11 will ride upwardly on the teeth 12 and exert a powerful camming thrust on the shaft 131 in the reverse direction. The shaft 131, however, may still be rotating in the direction for starting, but the thrust exerted by the teeth 11 will be sufficient to force the spring pressed detent 55 back into the recess 183, allowing the shaft 131 to slide axially in the reverse direction regardless of whether it is rotating or stationary, the detent 55 merely ratcheting on the threads of the shaft 131.

What I claim is:

1. Engine starting apparatus comprising a shiftable shaft adapted for manual operation to start the engine, in combination with power operable means adapted to operate said shaft to start the engine, said shaft being alternatively operable manually or by said power means, and speed-changing mechanism for transmitting power from said shaft to the engine at a different speed from that applied to said shaft manually or by said power means.

2. Engine starting apparatus comprising the combination of a rotatable and axially movable shaft adapted for manipulation to operatively connect the same to an engine, power operable means adapted and arranged to rotate said shaft to start the engine and speed-reduction mechanism for transmitting power from said shaft to the engine at a reduced speed, said shaft and speed-reduction mechanism being alternatively rotatable manually or by said power operable means to start the engine.

3. Engine starting apparatus comprising a rotatable and shiftable shaft arranged for operative connection to an engine, in combination with power operable starting means for driving said shaft, manually operable means for controlling said power means and for effecting operative connection of said shaft and the engine, said shaft having provision whereby it is adapted to be rotated manually to start the engine, and speed-changing mechanism for transmitting power from said shaft to the engine at a different speed from that applied to said shaft manually or by such power means.

4. Engine starting apparatus comprising a rotatable and slidable shaft and speed-changing gearing arranged for operative connection to an engine, in combination with power operable means for driving said shaft and gearing to start the engine, said shaft having provision whereby the shaft and gearing may be manually driven to transmit power through said shaft and gearing to start the engine, said shaft being alternatively operable manually or by said power means.

5. The combination with power operable means, of a driven member, a shiftable driving member alternatively operable manually or by such power means, and speed-changing mechanism for operatively connecting such driving member and driven member.

6. Engine starting apparatus comprising the combination with power operable starting means, of a driven member adapted for operative connection to an engine, a shiftable driving member alternatively operable manually or by such power means, and speed-reduction mechanism for operatively connecting such driving member and driven member.

7. Engine starting apparatus comprising rotatable and shiftable shafts, one of which is arranged for operative connection to an engine, in combination with an electric starting motor operatively connected to the other of said shafts to drive the same, means including gearing for operatively connecting said shafts, and means for shifting said shafts and for closing the motor circuit, said

shafts being also adapted and arranged to be manually operated to connect the same to the engine to start the latter.

8. Engine starting apparatus comprising the combination with an electric starting motor, of a shiftable clutch member arranged for operative connection to an engine, a shiftable driving member alternatively operative manually or by said electric starting motor, means including gearing for operatively connecting such driving member and clutch member, and means for shifting said driving member and for closing the circuit of said motor.

9. Engine starting apparatus comprising the combination with power transmission mechanism including an axially movable clutch member, an axially movable starting and driving shaft, and means comprising a speed-reduction gearing operatively connecting said shaft and clutch member, of an electric starting motor operatively connected to said shaft, said shaft being provided with means whereby the same may be manually operated and means operable to connect the clutch member to an engine and to close the circuit of said motor.

10. Engine starting apparatus comprising an axially movable starting shaft having provision whereby the same may be manually operated, a power operable starting device arranged for operating said shaft, and means, including speed-changing gearing, associated with said shaft for transmitting power therefrom to an engine.

11. Engine starting apparatus comprising in combination, a rotatable shiftable shaft having provision whereby the same may be rotated manually to start an engine, means, including speed-reduction mechanism, for operatively connecting said shaft to the engine, power operable means arranged to drive said shaft to start the engine, means for controlling said power operable means, and means for returning said controlling means and shaft to normal position after the engine has been started.

12. Engine starting apparatus comprising the combination with co-axial shafts that are manually shiftable to operatively connect the same to an engine and manually rotatable to start the engine, of speed-changing mechanism operatively interposed between such shafts, an electric starting motor, means whereby said electric motor is operatively connected to one of said shafts to rotate it to start the engine, means for shifting said shaft and closing the circuit of said motor, and means whereby such shafts are automatically returned to their normal position after the engine has been started either manually or by said motor.

13. The combination of two coaxially arranged slidable and rotatable shafts, one of said shafts being arranged for alternative rotation manually or by power means, and speed-changing mechanism for mechanically connecting said shafts.

14. The combination with two telescopically arranged slidable and relatively rotatable shafts, the first of said shafts having provision whereby the same may alternatively be rotated manually or by power means, and speed-reduction, torque-multiplying mechanism interposed between said shafts and mechanically connecting them, whereby such first shaft is adapted to drive the other shaft at a reduced speed.

In testimony whereof I hereunto affix my signature.

JAMES KENDALL DELANO.