April 4, 1939. C. R. WASEIGE 2,152,675

ENGINE STARTING MECHANISM

Filed June 29, 1935 2 Sheets-Sheet 1

Fig. 1

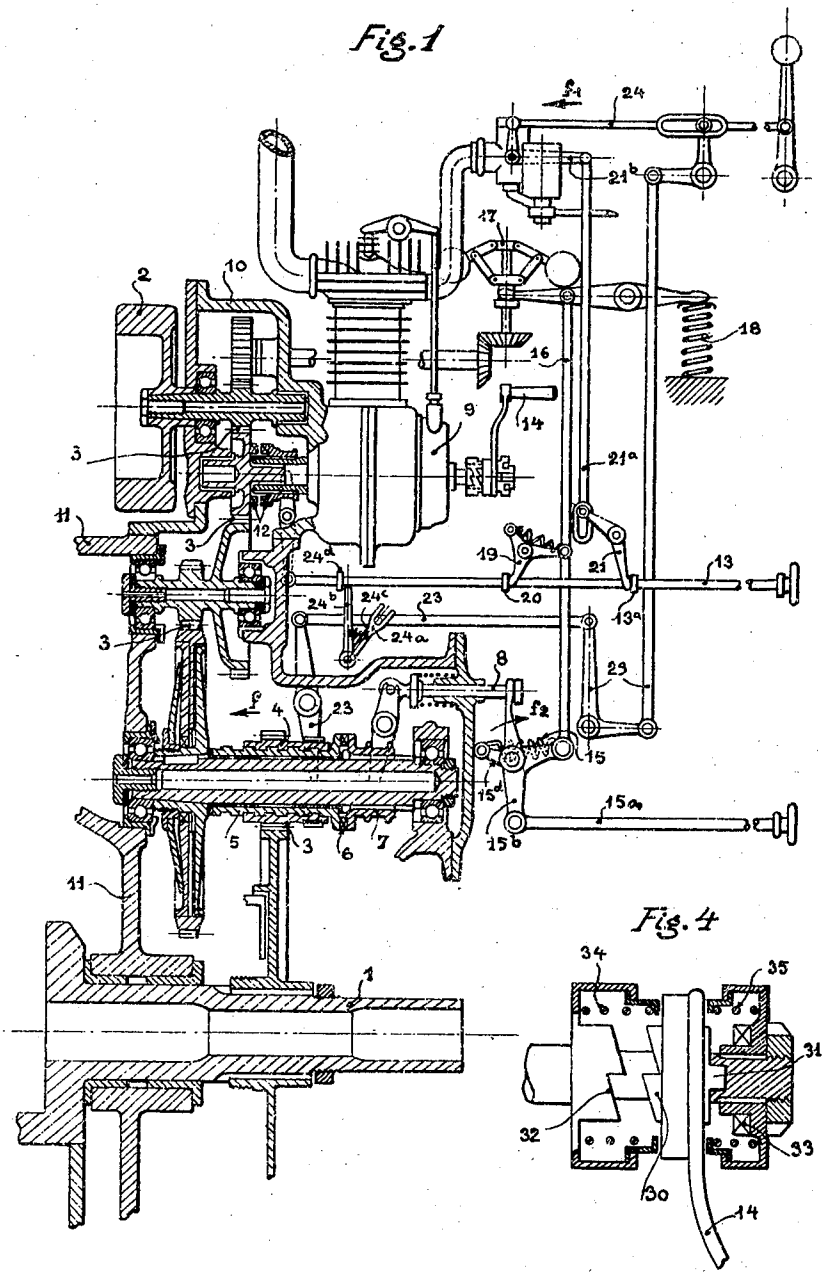


Fig. 4

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Filed June 29, 1935 2 Sheets-Sheet 2

Fig. 2

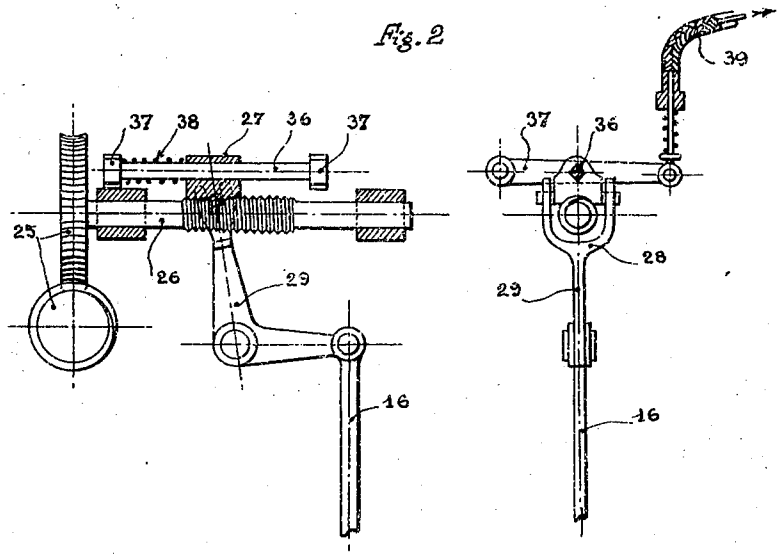
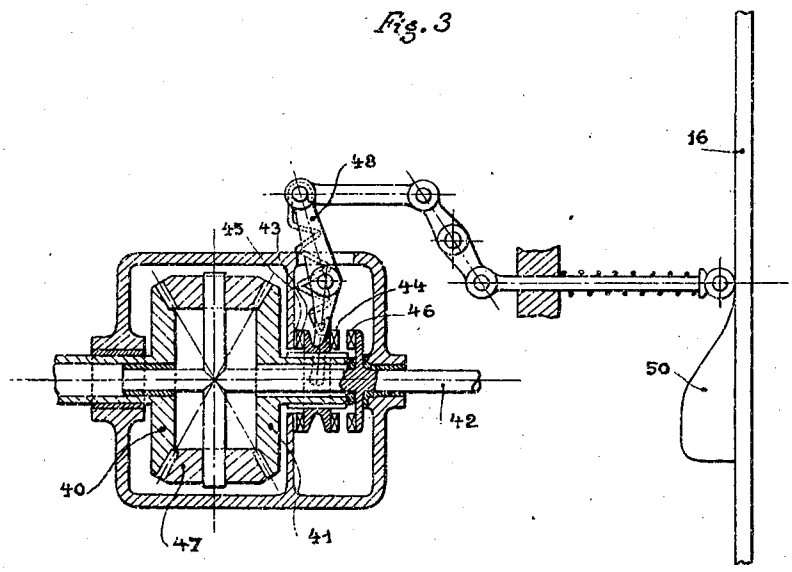


Fig. 3



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ENGINE STARTING MECHANISM

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In France July 24, 1934

2 Claims. (Cl. 123—179)

This invention relates to engine starting mechanism and more particularly, through not exclusively, to starting apparatus of the inertia type.

The starting of explosion engines, and particularly the engines of aeroplanes, requires either, in the first place, that an important muscular effort be developed to turn the engine over by hand, or to rotate at a sufficient speed a fly wheel the live force or energy of which will be subsequently utilized to turn the engine, or, in the second place, requires the provision of important sources of energy either of the electric or of the compressed fluid form. Now it must be borne in mind that the last solutions envisaged are accompanied with a large dead weight, demand a periodic recharging, and, in the case of batteries, it is necessary, in order that their proper functioning be assured, that the utilization thereof be not interrupted for long periods of time. These requirements are not easily fulfilled when it is a question of private aeroplanes, and as concerns military aeroplanes, the fulfilment of these requirements necessitates the maintenance on hand of a large reserve of material.

The present invention relates to apparatus for the starting of the engines by inertia and has for object the improvement of these devices for the purpose of eliminating the drawbacks hereinbefore set forth. To this end, and this constitutes one of the principal, but not the only important characteristic of the present invention, the auxiliary source of energy for rotating the flywheel or inertia element is provided by a small explosion or internal combustion motor, preferably, but not necessarily carried by the housing of the engine to be started. The advanced state of the present technical development easily permits the realization of a small motor of this type developing in the neighbourhood of 2 H. P., having a high angular speed and at the same time now weighing more than 3 or 4 kgs.

Taking into consideration the small power of such a motor, it is obvious that it is easily started by hand and for this reason numerous advantages as to weight, space-takeup and facility of utilization are provided.

According to another characteristic of the invention, the organ that couples the flywheel to the engine to be started is automatically controlled so as to effect the coupling at the moment desired through the intermediary of a quick release mechanism actuated either by a centrifugal regulator connected for rotation to the flywheel or to the motor, or by a pawl-ratchet device or any similar step by step or progressive advance mechanism which operates as a function of the number of turns effected by the flywheel or the motor. In any event the starting motor may be left in gear in order that the couple developed thereby may support and bolster up the energy engendered in the flywheel or contrarily a liaison may be provided between a coupling disposed between the flywheel and the source of starting energy and between the automatic clutch mechanism connecting the engine to be started to the flywheel in such a way that the starting motor is automatically disengaged, a disposition which constitutes another characteristic of the present invention.

In the last mentioned case, it is advantageous to provide automatic ignition interrupting means or mechanism controlling automatically the throttle of the starting motor in order that, after the starting of the engine, the starting motor may be automatically stopped or brought to idling speed. In the last case envisaged the starting motor continues to rotate slowly with just sufficient energy to overcome the cylinder compression and is only stopped definitely when the engine has effectively started and when it is determined that it will be no longer necessary to rebuild up energy in the flywheel.

For the purpose of more rapidly bringing the flywheel to its desired speed for starting the engine, it may be advantageous to provide a speed change mechanism between the flywheel and the starting motor. This speed change mechanism may be actuated automatically by the centrifugal regulator hereinabove mentioned or by a device which operates as a function of the number of turns effected by the starting motor.

For the event in which the starting attempt has been unsuccessful, it is necessary to be able to liberate the coupling between the starting motor and the engine to be started for the purpose of rendering possible a new rotation and building up of energy in the flywheel. In the case where the coupling takes place by the axial displacement of a pinion, a helicoidal member or the like, it is absolutely necessary to disengage this pinion. To effect this end, means are provided to permit turning by hand of the helicoidal member in a sense inverse to that communicated to it by the starting motor.

In one embodiment for the realization of this end, utilization is made of a three-position crank for the rotation of the starting motor, the crank permitting the rotation thereof in either direc-

tion. If desired, a hand operated control of the clutch between the starting mechanism and the engine to be started may be provided, the latter permitting the rotation of the engine to be started by hand, by means of the crank which effects the rotation of the starting motor. This arrangement of the elements may be advantageous for the purpose of verifying and regulating the motor to be started.

For the purpose of a clearer understanding of the subject matter of the present invention, reference is had to the accompanying drawings, wherein:

Figure 1 is a view in elevation of the starting mechanism;

Figure 2 shows an automatic control for the clutch that is adapted to connect the starting motor to the engine to be started when the former has effected a predetermined number of turns.

Figure 3 is a change speed mechanism between the starting motor and the flywheel.

Figure 4 is a plan view in large scale of a device for the starting of the starting motor.

1 indicates, in Figure 1, the crankshaft of the motor to be started. 2 is the inertia flywheel which is adapted to be rotated at a high rate of speed in order that sufficient live force may be built up therein to effect the turning over of the motor to be started. The flywheel may be mechanically connected to the crankshaft 1 through the intermediary of a set of reduction gearing indicated in general by the reference numeral 3. The transmission between the flywheel and the crankshaft 1 comprises a screw pinion 4 carried by a screw 5 freely mounted on an axis of the said transmission, but capable of being connected to that axis by a dog clutch 6, for example, comprising a dog 7 splined to but longitudinally slidable upon the axis. The dog may be displaced upon the axis by means of a pull mechanism 8 provided with a spring.

According to the invention, the rotation of the flywheel 2 is assured by a small explosion or internal combustion motor 9 carried conveniently, for example, directly by the housing 10 which encloses the transmission 3, the housing 10 being fixed to the housing 11 of the engine to be started. The starting motor 9 may be of any suitable type, but should be as light as possible and should be able to develop a high angular speed. This solution permits a more rapid rotation of the flywheel than the devices heretofore provided, thus requiring a less important gear train between the starting motor and the flywheel. In the present instance, the connection between the motor 9 and the flywheel comprises a clutch 12 hand operated through the intermediary of a pull member 13 and the motor is started by the hand crank 14 represented as being disposed on the motor itself. It is obvious, however, that through the utilization of an appropriate transmission, the hand crank may be provided at any convenient point. The presence of the clutch 12 is not indispensable, but it is nevertheless an advantage in that it permits an easier starting of the motor 9 which, by reason thereof, may be completely isolated from the transmission 3.

For the purpose of effecting the automatic coupling of the starting mechanism with the crankshaft 1 of the engine to be started, in other words to bring about automatically at the desired moment the manoeuvre of the pull member 8, utilisation is made of a device 15 providing a sudden release, the device being controlled by a rod 16. Referring to Figure 1, it can be noted that this rod is actuated by a centrifugal regulator 17 motivated from one of the organs that the starting motor rotates. As indicated, the regulator may be conveniently operated from one of the transmission gears between the flywheel and the shaft 1. The displacement of the rod 16 in the sense corresponding to the engagement is effected against the action of a spring 18. It will be readily understood that when the motor 9—flywheel 2 organization has reached a predetermined speed, the rod 16 has taken a position in which the quick release bell crank 15 is on the point of coming into operation to effect a single pull on the pull member 8, the displacement of which is communicated to the jaw 7. This jaw comes into engagement with the screw 5 and as a consequence thereof the shaft 1 is thereby brought into rotation by the flywheel 2.

For the case in which it is desired to isolate automatically the starting motor 9, one can, as indicated by the Figure 1, utilize for this purpose the displacement of the rod 16. The rod in its displacement causes operation of a rapid release bell crank 19 similar to 15, the rapid release device 19 coming into operation against a shoulder 20 of the rod 13 so as to produce a rapid disengagement at 12, simultaneously with, or slightly after the device 15 has effected, as hereinbefore indicated, the connection between the starting motor and the shaft 1 of the engine to be started.

The idling, and eventually the stopping, of the starting motor in the case of the declutching of the latter is assured automatically by a connection between the throttle of the motor 9 and the clutch mechanism 12. To this end the rod 13 carries a shoulder 13*a* which, in the disengaged position, rests upon a swinging lever 21 that is connected by rodding 21*a* to a lever 21*b* connected to the throttle.

The connection comprises a certain amount of plates disposed in such manner that the throttle can be opened to its maximum extent without affecting the rod 13. One can thus assure the causing of the motor to idle by means of a rapid release device acting on the lever 21*b* and controlled by the rod 16.

In any event the shaft 1 turns so long as the live force of the flywheel 2 is not exhausted. If the engine starts, the screw pinion 4 displaces itself automatically in the direction of the arrow *f* along the screw 5 and the mechanical connection between the starting mechanism and the engine is interrupted. All that remains necessary is to stop the starting motor either by hand or automatically. For the realization of this end in the embodiment illustrated in Figure 1, the screw pinion 4 in displacing itself in the sense of the arrow *f*, causes the lever 22 to swing which, through the intermediary of a linkage 23 and an appropriate mechanism actuates the rod 24 in the direction f_1 whereby the throttle of the starting motor is closed and the motor stops.

If the engine does not start, the rod 16 returns to its original position under the action of the spring 18 according as the element which effects rotation of the regulator 17 slows down. Through the effect of this return movement of the rod 16 the device 15 swings suddenly at a given moment in the direction opposite to the arrow f_2 and permits the spring of the pull member 8 to interrupt the connection between the nut 7 and the screw 5. The mechanism now lends itself to a new starting attempt, but as the screw

pinion 4 has remained in gear with the engine to be started, any failure of the gearing elements to slip with sufficient freedom might cause a breaking of gear teeth. As a further, although not absolutely rigid and unyielding safeguard against such breakage, a blocking of the control mechanism of the coupling 12 is provided, to yieldably oppose the engagement of the coupling as long as the screw pinion 4 is engaged with the motor to be started.

For this purpose there is provided a swinging lever 24a the extremity of which in the form of a fork engages with a trunnion of the rod 23. Coaxially to the lever 24a is mounted another lever 24b drawn toward lever 24a by a spring 24c. The arrangement is such that when the rod 23 is in the position for which the pinion 4 is disengaged, the extremity of the lever 24b is not situated on the trajectory of a shoulder 24d of the rod 13, but for the position that the rod 23 occupies when the pinion 4 is engaged, the said extremity of the lever 24b comes into position on this trajectory between the positions of the shoulder 24d corresponding to the engagement and to the disengagement of the coupling 12. Furthermore, the trajectory of the extremity of the lever 24b does not encounter the shoulder 24d for the position of disengagement of the rod 13. It results therefore, as in the position indicated in Fig. 1, that the lever 24b opposes itself to the engagement of the coupling 12, but before this occurs the rod 13 is allowed to come back to its position corresponding to disengagement against the effort of the spring 24c and as a result of the push of the shoulder 24d in the course of the disengagement of the coupling 12.

For the purpose of absolutely disengaging the screw pinion 4 recourse may be had to a three-position crank (Fig. 4) for the starting of the motor 9, one neutral position being provided and two other positions permitting the motor to be turned in opposite directions. The hand crank 14 carries on its opposite faces the toothings 30 and 31 cooperating respectively with two other toothings 32—33 fixed to or forming part of the motor shaft, the hand crank being normally maintained in its medium neutral position by the opposed springs 34—35. All that is necessary to disengage the pinion 4 and permit a new attempt of starting is to turn the engine in its non-normal sense.

For the purpose of permitting the rotation at will and by hand of the engine to be started in utilizing the hand crank 14, there is here provided a link 15a articulated on a lever 15b angularly fixed with respect to levers 15c and 15d of the quick release device 15 which controls the clutching of the engine to be started to the inertia flywheel. This clutch can be thus controlled at will and by hand independently of the automatic control provided therefor.

Figure 2 shows another form of embodiment of automatic control of the rod 16 in function of the number of turns effected by the starting motor 9 or of the flywheel 1. In this embodiment the shaft of the starting motor 9 or the transmission to the flywheel motivates, through the intermediary of a reduction gearing 25, here illustrated as of the worm type, a threaded shaft 26 that is axially fixed and along which may displace a half screw 27 guided in such a way that it cannot turn. Two trunnions carried by this screw 27 are engaged by a fork 28 provided at the extremity of one arm of a two-armed lever of which the other arm is articulated on the rod 16. It will be understood that at the end of a definite or determined number of turns the rod 16 comes into the position for which take place automatically the operations hereinabove set forth for the control by the centrifugal regulator.

The guide bar 36 of the screw 27 is carried at its extremity by two levers 37 that are arranged to pivot about the same axis in order to permit the disengagement of the screw 27 from the threaded shaft 26 and a spring 38 is provided which continually urges the screw 27 in the sense contrary to the displacement which results from the action of the motor 9 thereon. It is obvious that when the connection between the screw 27 and the threaded shaft 26 is interrupted by the raising of the screw, the latter is returned along the bar 36 by the spring 38 and comes back into its initial position bringing with it the rod 16 through the intermediary of the lever 29. The raising of the screw 27 is obtained in this embodiment through any desired mechanism as for instance through the intermediary of a Bowden cable, but it is to be understood that the operation may be effected by any other mechanism adapted to the conditions imposed.

Referring to Figure 3, there is provided an embodiment of an automatic change speed disposed between the starting motor and the flywheel. In this embodiment a planetary gear train is utilized of which one of the planetaries 40 is connected to rotate with the flywheel 2 while the other planetary 41 may be immobilized or connected for rotation to the shaft 42 of the starting motor 9 through the intermediary, for example, of a jaw clutch of which one of the jaws is displaceable and splined to the tail of the planetary 41. The movable jaw carries two opposite toothings 43 and 44 adapted to be brought respectively into engagement with two toothings 45 and 46, the one 45 fixed to the housing and the other 46 carried by a plate of the shaft 42. The satellites 47 are always set in motion directly by the shaft 42 of the starting motor.

The engagement in one sense or in the other is controlled by a quick release device 48 that is actuated automatically by a cam 50 motivated by the mechanism which controls the rod 16. In the embodiment represented this cam 50 is carried by the rod 16. It is obvious that when toothings 43 and 45 are in engagement, the shaft of the flywheel is rotated with a certain reduction by the shaft 42 whilst, when the toothings 44 and 46 are in engagement, a direct coupling between the shaft 42 and the flywheel 2 results. The first position corresponds to the getting under way of the motor 9 and of the flywheel 2. Then, when the flywheel and the motor have acquired a certain predetermined speed or effected a number of turns chosen in advance, the cam 50 actuates the mechanism 48 which releases and brings into engagement the toothings 44 and 46 effecting thus the direct connection between the driving shaft and the driven shaft.

It is to be clearly understood that the invention is not limited to the mechanical embodiments and details of realization represented and described, which, by the way, have been suggested merely as exemplary, the scope of the present invention being defined only by the claims hereto appended.

What I claim is:

1. A starting mechanism for aircraft engines, comprising a flywheel, a driving motor, means including a clutch for drivably connecting said motor to said flywheel, an engine engaging mem-

ber, means including a gear train for drivably connecting the flywheel to the engine engaging member, and means controlling the operation of said clutch, said controlling means including a clutch shifting member engageable with said clutch, means for yieldably opposing movement of said clutch shifting member, and means shiftable with said engine engaging member for withdrawing said opposing means from the opposing position.

2. A starting mechanism for aircraft engines comprising a flywheel and power means for actuating said flywheel, means including a clutch and a self engageable and disengageable pinion to cause operative connection of the fly-wheel with the engine to be started so that the latter may be turned over by said fly-wheel, and means responsive to the position of the pinion to yieldably oppose reoperation of the starting mechanism.

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