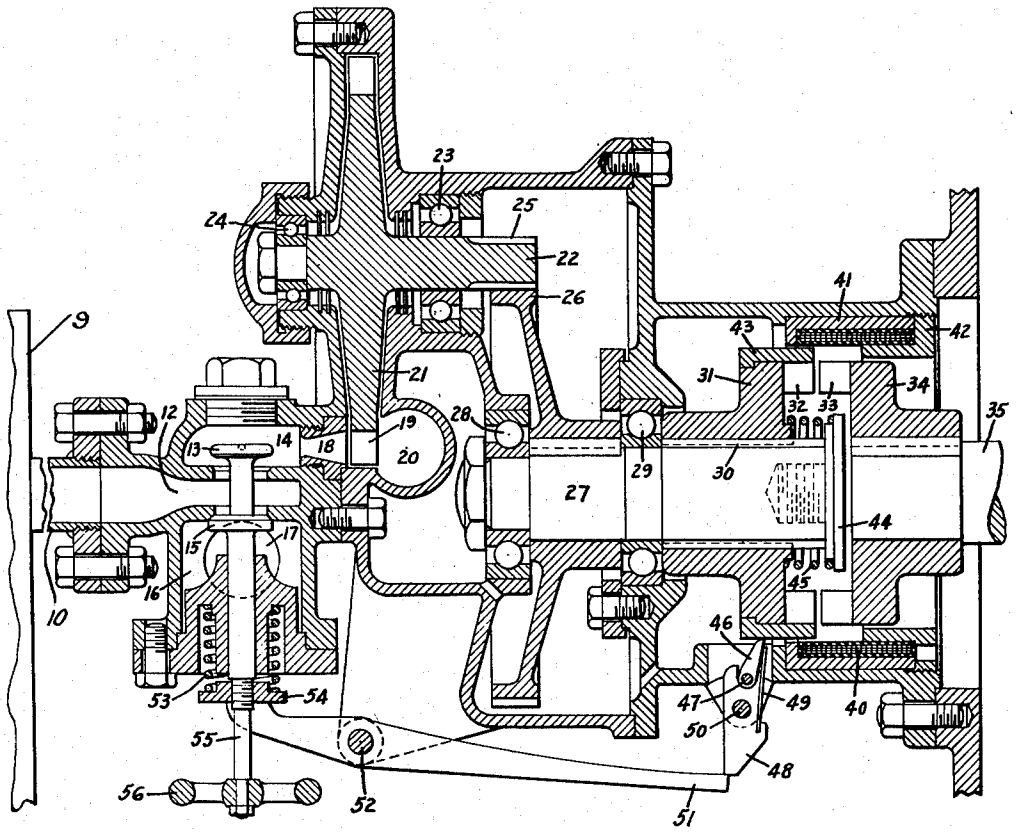
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STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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STARTING APPARATUS FOR INTERNAL COMBUSTION ENGINES

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This invention relates to apparatus for starting internal combustion engines, more particularly, it relates to starting apparatus by means of which gases under pressure generated by igniting a cartridge containing an explosive material or a stored fluid, such as compressed air, are utilized for starting an engine. The gases under pressure may be expanded in an air or gas turbine which is connected by suitable gearing and through a coupling to the engine shaft.

Starters of this type, being light in weight, are particularly adaptable for use with aircraft engines of the internal combustion type. The starter motor or turbine may be relatively small and of simple construction having but a single stage rotor. The coupling or clutch is generally arranged for automatic engagement upon the firing of the cartridge or the release of the compressed air and also for automatic disengagement upon the firing of the engine. If the engine fires and runs up to speed disconnecting the clutch to the starter motor before all the energy in the cartridge has been consumed, the remaining energy would be expended in the disconnected starter motor and increase its speed to a dangerously high value.

It is an object of this invention to provide a new and improved arrangement for precluding overspeeding of a starter motor of the type described upon its disengagement from the engine shaft.

It is a further object of this invention to provide a new and improved control system for the operating fluid in starting apparatus of the type described which is simple, efficient and automatically operable in accordance with an operating condition of the engine associated therewith.

In the illustrated embodiment of the invention, a new and improved control arrangement is provided for a starter motor adapted to be energized upon the release of a fixed quantity of stored energy or operating fluid whereby upon the disengagement of the engine coupling suitable valves are actuated shutting off the supply of energy or operating fluid to the starter motor and exhausting that remaining to atmosphere.

For a consideration of what we believe to be novel and our invention, attention is directed to the following description and the claims appended thereto taken in connection with the accompanying drawing.

The single figure of the drawing is a cross-sectional view through the starting apparatus illustrating one embodiment of the invention.

Referring to the drawing, gases under pressure are supplied from a suitable container or from a cartridge of explosives 9, through the pipe 10 to the valve chamber 12. The valve chamber communicates through valve 13 with the turbine inlet chamber 14 and, through valve 15, with the exhaust chamber 16 having exhaust openings 17. The valves, which are rigidly connected, are illustrated in the starting position, with the valve 13 to the turbine inlet chamber open, and the valve 14 to the exhaust chamber closed. From the turbine inlet chamber, the gases expand through the turbine nozzle 18 and pass through the turbine blades 19 to the turbine exhaust 20. The turbine disk 21 is solid with the shaft 22 which is suitably supported, as in ball bearings 23 and 24.

Through gear teeth 25 on the overhanging part of the shaft 22 the torque is transmitted to the gear wheel 26 which is keyed to the shaft 27 which in turn is supported in ball bearings 28 and 29. The shaft 27 has an overhanging end provided with splines 30 on which slides the driving coupling half 31. This coupling half is provided with dogs 32 for engaging dogs 33 of the driven coupling half 34 which is keyed onto the shaft 35 of the internal combustion engine.

The driving faces of the dogs 32 and 33 may slope forward slightly so as to keep them in engagement when driving. The rear surfaces of the dogs preferably have a large slope in order to facilitate the disengagement of the coupling when the engine fires and the shaft 35 increases its speed of revolution above that of the shaft 27.

For causing the engagement of the coupling, a solenoid 40 mounted around the coupling and coaxial with the shafts 27 and 35 may be used. The solenoid may be electrically connected in series or in parallel with the heater plug (not shown) which fires the cartridge used for starting, or other means for releasing the fixed quantity of stored energy to the starter motor. The solenoid is provided with iron shrouds 41 and 42, preferably of good magnetic material, in order to increase the pull on the plunger which is in the form of a ring 43 carried on the driving coupling half 31.

Between a disk 44 at the end of the shaft 27 and the hub of the coupling 31 is fitted a spring 45, which keeps the coupling dogs 32 well clear of the coupling dogs 33 when the engine runs normally and further serves the purpose of absorbing the shock at the end of the travel of the coupling 31 when engaged. In order to further reduce the shock, the airgap between the parts 42 and 43 is made so large that there remains

an appreciable gap when the coupling is engaged. The increase in pull of the solenoid, as the ring 43 and the coupling hub 31 are pulled in, can then be kept moderate, say within 50% or less. As the force of the spring 45, which resists the pull, also increases as the coupling is pulled in, it is possible to obtain a low force at the end of the travel by selecting the spring characteristic to suit.

In order to prevent undue overspeeding of the turbine in the event that the engine fires and runs up to speed before all the energy in the cartridge has been expended, a trip device operated by the coupling hub 31 may be provided. One form may consist of a trigger 46 pivoted at 47 on the lever 48 and held against the ring 43 by means of a leaf spring 49. The lever 48 which can swing about the fulcrum 50 rests at the end of another lever 51 which can swing about the fulcrum 52. A spring 53 holds the washer 54 against the other end of the lever 51. The washer 54 is threaded on the spindle 55 carrying the valves 13 and 14. By means of the handwheel 56 the valve 15 can be set tight.

Upon starting, the solenoid circuit is closed and the coupling half 31 is pulled into engagement. The ring 43 is moved to the right clear of the end of the trigger 46 which will be forced to the upright or set position by the spring 49. When the engine fires and runs up to speed and the coupling half 31 is pushed out of engagement, the ring 43 will hit the trigger 46 and pivot the lever 48 about fulcrum 50 so that the lever 51 becomes free. The spring 53 will then close the valve 13 and open valve 15 so that the flow of gases from the cartridge will be divertd from the turbine to the exhaust 17 via the chamber 16.

Having described the principle of operation of our invention together with the apparatus which we now consider to represent the best embodiment thereof, we desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a starting apparatus for an internal combustion engine, a starter motor, a fixed quantity of stored energy adapted to be released for driving said motor, means for controlling the supply of energy to said starter motor, a coupling between said motor and said engine arranged for automatic disengagement upon the firing of said engine, and means responsive to the disengagement of said coupling for operating said control means to shut off the supply of energy to said starter motor and to dissipate the remainder of said quantity of energy.

2. In combination an internal combustion engine, a starter motor, a coupling between said starter motor and said engine, a fixed quantity of stored energy adapted to be released for driving said starter motor, means for controlling the supply of said stored energy to said starter motor, means for effecting the engagement of said coupling simultaneously with the release of said stored energy to said motor, means for effecting the disengagement of said coupling upon the firing of said engine, means responsive to the disengagement of said coupling for operating said control means to the closed position and means operable upon the closure of said control means for dissipating the remainder of said stored energy.

3. In combination, an internal combustion engine, a starter motor, a source of a predetermined quantity of operating fluid adapted to be released for driving said starter motor, a coupling between said starter motor and said engine, means for effecting the engagement of said coupling upon the release of said operating fluid, means for effecting the disengagement of said coupling upon the firing of said engine, and valve means responsive to the disengagement of said coupling for shutting off the supply of operating fluid to said starter motor and by-passing the remainder of said quantity of operating fluid to atmosphere.

4. In a starting apparatus for an internal combustion engine, a starter motor, a coupling for connecting said motor to the engine, a fixed quantity of operating fluid for driving said starter motor, electro-magnetic means for effecting the engagement of said coupling upon the release of said operating fluid to said motor, means for automatically causing the disengagement of said coupling upon the starting of the engine and valve means responsive to the disengagement of said coupling for shutting off the supply of operating fluid to said starter motor and by-passing the remainder of said operating fluid to atmosphere.

5. In a starting appartus for an internal combustion engine, a starter motor, a coupling adapted to connect said starter motor to the engine, an electro-magnetic means for effecting the engagement of said coupling, means responsive to the starting of the engine for effecting the disengagement of said coupling, a fixed source of operating fluid for said starter motor, normally open valve means for controlling the admission of operating fluid to said starter motor, normally closed valve means for by-passing said operating fluid with respect to said motor, and means responsive to the disengagement of said coupling for closing said admission controlling valve and opening said by-passing valve.

6. In a starting apparatus for an interni combustion engine, a rotary elastic fluid starter motor, a coupling for connecting said starter motor to the engine, means for effecting the engagement of said coupling, means for effecting the disengagement of said coupling upon the starting of the engine, a relatively fixed source of operating fluid for said starter motor, a normally open valve for controlling the admission of operating fluid to said starter motor, a normally closed valve for by-passing the operating fluid with respect to said starter motor, a trigger adapted to be tripped by said coupling upon the disengagement thereof, and spring means releasable upon the tripping of said trigger for closing said admission controlling valve and opening said fluid by-passing valve.

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