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R. L. LAMY
ELECTRIC IGNITION CONTROL IN STARTING
DEVICES FOR TURBO-ENGINES
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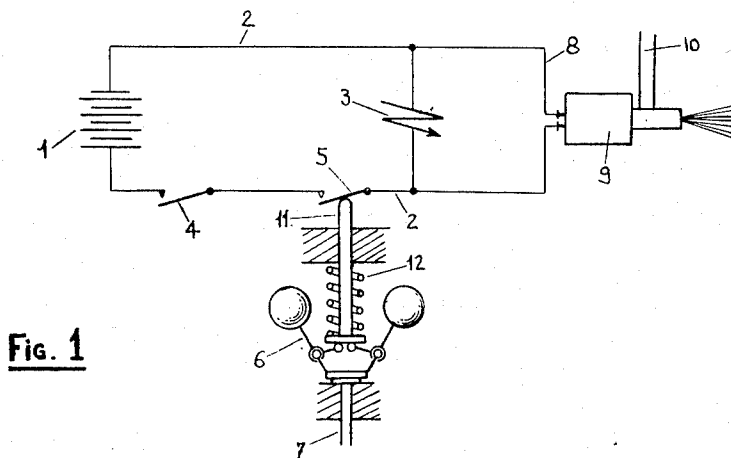


Fig. 1

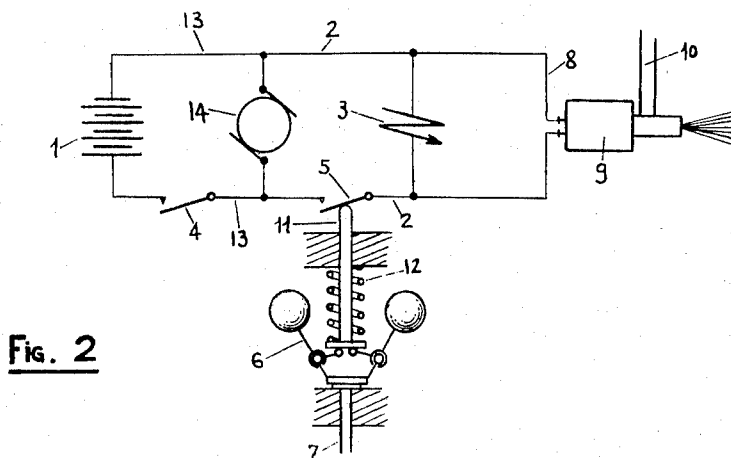


Fig. 2

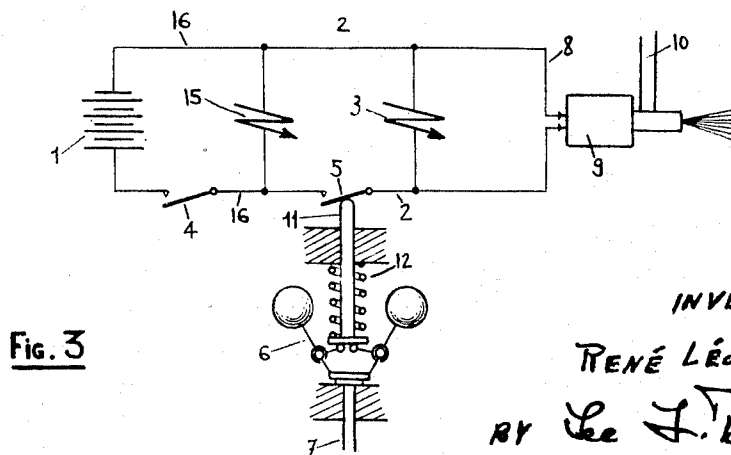


Fig. 3

INVENTOR
RENÉ LÉON LAMY
BY *Lee J. Burroughs*
ATTORNEY

1

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ELECTRIC IGNITION CONTROL IN STARTING DEVICES FOR TURBO-ENGINES

René Léon Lamy, Paris, France, assignor to Societe du Carburateur Zenith, Lyons, France

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8 Claims. (Cl. 60—39.14)

The present invention relates to starting devices of the kind in which, at the time of starting, the fuel mixture is ignited in one or more combustion chambers by means of an electric ignition device.

The invention is mainly applicable to starting devices for jet turbines of aircraft comprising an air compressor driven by the gas turbine of the jet turbine, but it is applicable, in a general way, to all types of turbo-engines, turbo-propellers or others, in which a gas turbine is operated by the combustion products of a mixture of fuel and air, the air being supplied by an air compressor driven by the said turbine.

At the time of starting a turbo-engine, it may happen that the speed at which the turbo-engine is driven by the starting motor does not attain the speed, starting from which the turbo-engine is able to turn by its own means, for various reasons: failure of the starting motor, bad state of the mechanical transmissions, or other reasons. When the starting motor is an electric motor supplied by an accumulator, this may, in particular, result from failure of the accumulator. The driving speed of the turbo-engine being insufficient, the supply of air from the air compressor of the turbo-engine is smaller than the supply which is normally necessary. If the electric ignition operates under such conditions, the fuel mixture is ignited, but the quantity of burnt gases formed is insufficient to drive the turbine of the turbo-engine and to enable this latter to turn by its own means. Thus, the turbine does not "catch up," that is to say that the speed does not increase, and overheating may be produced, which is liable to damage the turbo-engine and, in particular, the turbine blades.

An object of the invention is to eliminate the disadvantages which can result from an ignition of the fuel mixture at insufficient speed.

Other objects and advantages will be apparent to one skilled in the art from the following description taken in connection with the appended drawing given by way of example, in which:

Fig. 1 diagrammatically illustrates the circuit of one form of an electrical installation in conformity with the invention.

Fig. 2 diagrammatically illustrates a modification of the electrical installation circuit shown in Fig. 1, suitable for a turbo-engine the starting motor of which is an electric motor.

Fig. 3 diagrammatically illustrates another modification of the electrical installation circuit shown in Fig. 1, suitable for a turbo-engine the starting motor of which is an internal combustion engine having electric ignition.

In the drawing, the various parts have been indicated by conventional signs, without it being necessary to illustrate and describe the said parts in their practical constructional detail. These parts comprise apparatus in current use, which are well known to those skilled in the art.

In the various figures, the same parts have been denoted by the same reference numerals.

2

According to the invention, a switch, connected in the electric ignition circuit of the turbo-engine, is operated as a function of the speed of the said turbo-engine in such a way as to close the said circuit when the said speed reaches a given value.

By reason of this arrangement, the ignition is produced only when the turbo-engine, driven by the starting motor, has attained a speed which is sufficient to ensure that this ignition involves no danger for the parts of the turbo-engine, and that the latter can turn by its own devices. If, for any reason, the safety speed is not reached, ignition does not take place.

The speed responsive device actuating the said switch is not necessarily driven in a permanent manner by the turbo-engine, since it operates only during the starting period. It is sufficient to provide, between the said speed measuring device and the shaft of the turbo-engine, transmission which is active during the starting period. In practice, the said speed measuring device might be driven, either by the turbo-engine itself, or by the starting motor.

The said speed measuring device could consist of a centrifugal governor.

The electrical installation, the circuit of which is shown in Fig. 1, comprises a source of electric energy 1 such as, for example, an accumulator, supplying the circuit 2 of the electric ignition device of the turbo-engine. This electric ignition device has been denoted, as a whole, by the reference numeral 3, and it may comprise, as is customary, the usual parts, such as the coil, make and break, condenser, and one or more sparking plugs suitably arranged in one or more combustion chambers of the turbo-engine.

In the circuit 2 is connected a main switch 4 operated, in the usual way, by the pilot or by an automatic time-control. The operation of the switch 4, which does not form part of the invention, has not been shown.

In conformity with the invention, a switch 5, disposed in the electric ignition circuit 2, in series with the main switch 4, is operated by the sleeve 11 of a centrifugal governor 6 loaded by a spring 12. The spindle 7 of the centrifugal governor could be driven, either by the turbo-engine itself, or by the starting motor.

In practice, the switches 4 and 5 will generally be relay contactors.

In order to facilitate the starting of the turbo-engine, an electro-magnetically operated auxiliary starting injector is frequently used, closed during normal operation, and arranged in a combustion chamber in a manner favourable for the ignition of the flame. If such is the case, the electric circuit 8 operating the electro-magnetic injector 9 supplied with fuel by a pipe 10 might be connected in parallel with the ignition device 3. Said ignition device will itself comprise a plug suitably disposed relatively to the injector 9 to provide for easy ignition of the flame. The particular arrangement of the starting auxiliary injector and of the plug associated therewith does not form part of the invention and is not illustrated. The operation of the device is as follows:

The general switch 4 being closed, and the starting motor being started, the turbo-engine is driven by said starting motor, and the centrifugal governor 6, driven by the turbo-engine or by the starting motor, turns.

For such time as the speed of the turbo-engine has not reached a predetermined value for which the ignition of the flame may be effected without danger, the centrifugal governor 6 is unable to press back the sleeve 11 against the pressure of the spring 12 and the switch 5 remains open. The ignition device 3 does not operate and the electro-magnetic injector 9, if provided, does not supply.

When a suitable speed is reached, the centrifugal governor 6 presses back the sleeve 11 against the pressure of the spring 12 and closes the switch 5. The circuit 2—3 is

3

then closed, as also the circuit 8. The ignition device 3 comes into operation and the electro-magnetic injector 9 opens. The flame is ignited, the turbo-engine starts to turn by its own means and its speed increases, producing automatic disengagement of the coupling between the starting motor and the turbo-engine, which coupling may be of any suitably known type, saw-tooth clutch drive, electro-magnetic clutch, and the like.

The main switch 4 is then opened, either by the pilot, or by a time-switch mechanism brought into operation at the time of starting the turbo-engine. The circuit 2 being open, the ignition device 3 ceases to operate, as well as the electro-magnetic injector 9, if provided.

If the governor 6 is driven by the turbo-engine itself, this governor continues to turn during the whole operation of said turbo-engine and maintains the switch 5 closed, but the ignition is nevertheless interrupted, since the main switch 4 is open. If the centrifugal governor 6 is driven by the starting motor, the switch 5 opens when said starting motor stops, the two switches 4 and 5 being open during the normal operation of the turbo-engine.

If, for any reason, during the course of the starting period, the speed of the turbo-engine does not attain the value for which the centrifugal governor 6 closes the switch 5, the circuit 2 remains open, preventing the ignition from taking place and thus protecting the turbo-engine against the dangers of ignition at too slow a speed.

The electric installation, the circuit of which is illustrated in Fig. 2, suitable when using an electric motor as a starting motor, differs from the installation shown in Fig. 1, in that the ignition circuit 2—3 of the turbo-engine is connected in parallel with the electric circuit 13 supplying a starting electric motor 14. The main switch 4 is connected in the circuit 13.

The opening of the main switch 4, either by the pilot, or by a time-switch mechanism, has for result to open at the same time the supply circuit of the starting motor and the ignition circuit of the turbo-engine. Apart from this, the installation shown in Fig. 2 is identical with that shown in Fig. 1.

The electrical installation, the circuit of which is shown in Fig. 3, is suitable when an internal combustion engine with electric ignition is used as a starting motor. Said starting motor comprises an electric ignition device 15 connected in a circuit 16 connected to the source 1 of electric energy.

The installation shown in Fig. 3 differs from the installation shown in Fig. 1 in that the electric ignition device 3 of the turbo-engine is connected in parallel to the electric ignition device 15 of the starting motor. The main switch 4 is connected in the circuit 16.

The opening of the main switch 4, either by the pilot, or by a time-switch mechanism, has for effect to open at the same time the ignition circuit of the starting motor, thus producing the stoppage of said motor, and the ignition circuit of the turbo-engine. Apart from this, the two installations are identical.

If the starting motor includes magneto ignition, the source 1 of electric energy might be the magneto of the starting motor, on condition, as will be readily understood, that this magneto is sufficiently powerful for supplying the two ignition devices 15 and 3.

The invention is not limited to the constructional forms illustrated, which have been given mainly by way of example. In particular, it is not limited to a particular method of operating the switch connected in the ignition circuit of the turbo-engine as a function of the speed. In the drawing, a centrifugal governor is shown, but any other speed measuring device could be used.

In some known devices for supplying fuel to turbo-engines, there is used, in order to limit the supply of fuel as a function of the speed, the pressure difference, produced in the fuel by centrifugal force, between an axial space provided in the rotor of a fuel pump driven by the

4

turbo-engine and an annular space surrounding said rotor, said axial space and said annular space being connected by radial channels cut in said rotor. In combination with such a device, said pressure difference, which constitutes a measurement of the speed, could be used for operating the switch, connected, according to the invention, in the ignition circuit of the turbo-engine.

If, as described in connection with Fig. 3, the starting motor is an internal combustion engine having magneto ignition, the electromotive force of the magneto of the starting motor constitutes a measurement of the speed of said motor, and, in consequence, of the speed of the turbo-engine during the starting period, and said electromotive force could be used for operating the switch 5, which will then take the form of an electro-magnetically operated switch.

Some operating features of the turbo-engine itself are function of the speed. They may be used for the operation of the switch connected in the ignition circuit of the turbo-engine. There may be used to this end, for example, the super-pressure produced by the air compressor of the turbo-engine. This arrangement would be applicable mainly to turbo-engines operating on the ground, or the starting of which is effected only on the ground, the air pressure supplied to said compressor being then substantially constant.

In a general way, it is sufficient to those skilled in the art to know that, in order to carry out the invention, a switch, connected in the ignition circuit of the turbo-engine must be operated as a function of the speed of said turbo-engine and it will be for him to determine, in each particular case, the type of operation that is best adapted to the general construction of the turbo-engine and its accessories.

I claim:

1. In a starting device for a turbo-engine, an electric ignition circuit for said turbo-engine, a switch in said circuit, and means responsive to the speed of said turbo-engine during the starting period for closing said switch as said speed reaches a predetermined value for which said turbo-engine is able to run by its own means after ignition.

2. In a starting device for a turbo-engine, an electric ignition circuit for said turbo-engine, a switch in said circuit, tachometric means, a motion transmission between said tachometric means and said turbo-engine, operative during the starting period of said turbo-engine, and means operative by said tachometric means for closing said switch as the speed of said turbo-engine reaches a predetermined value for which said turbo-engine is able to run by its own means after ignition.

3. In a starting device for a turbo-engine, an electric ignition circuit for said turbo-engine, a switch in said circuit, tachometric means driven by said turbo-engine, and means operative by said tachometric means for closing said switch as the speed of said turbo-engine reaches a predetermined value for which said turbo-engine is able to run by its own means after ignition.

4. The invention claimed in claim 3, wherein said tachometric means is a centrifugal governor.

5. In a turbo-engine having a starting motor, an electric ignition circuit for said turbo-engine, a switch in said circuit, tachometric means driven by said starting motor, and means operative by said tachometric means for closing said switch as the speed of said starting motor reaches a predetermined value for which said turbo-engine is able to run by its own means after ignition.

6. The invention claimed in claim 5, wherein said tachometric means is a centrifugal governor.

7. In a starting device for a turbo-engine having an electric circuit and an electric starting motor in said circuit, an electric ignition circuit for said turbo-engine, connected in parallel with said motor, a switch in said ignition circuit, and means responsive to the speed of said turbo-engine during the starting period for closing

said switch as said speed reaches a predetermined value for which said turbo-engine is able to run by its own means after ignition.

8. In a turbo-engine having an internal combustion starting engine with electric ignition, an electric ignition circuit for said starting engine, an electric ignition circuit for said turbo-engine, connected in parallel with said first mentioned circuit, a switch in said second mentioned circuit, and means responsive to the speed of said turbo-engine during the starting period for closing said switch as said speed reaches a predetermined value for which said turbo-engine is able to run by its own means after ignition.

5

10

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