

L. M. WOLFFSOHN (NOW BY JUDICIAL CHANGE OF NAME L. M. WOOLSON).
ELECTRICAL SYSTEM FOR AEROPLANES AND THE LIKE.

APPLICATION FILED MAR. 13, 1917.

1,362,380.

Patented Dec. 14, 1920.

2 SHEETS—SHEET 1.

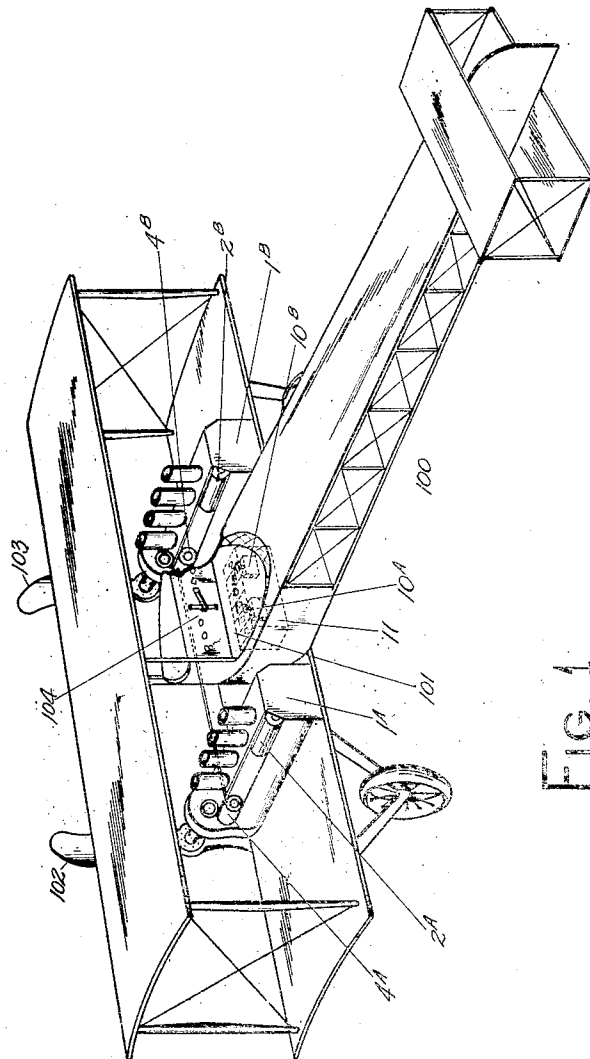


FIG. 1

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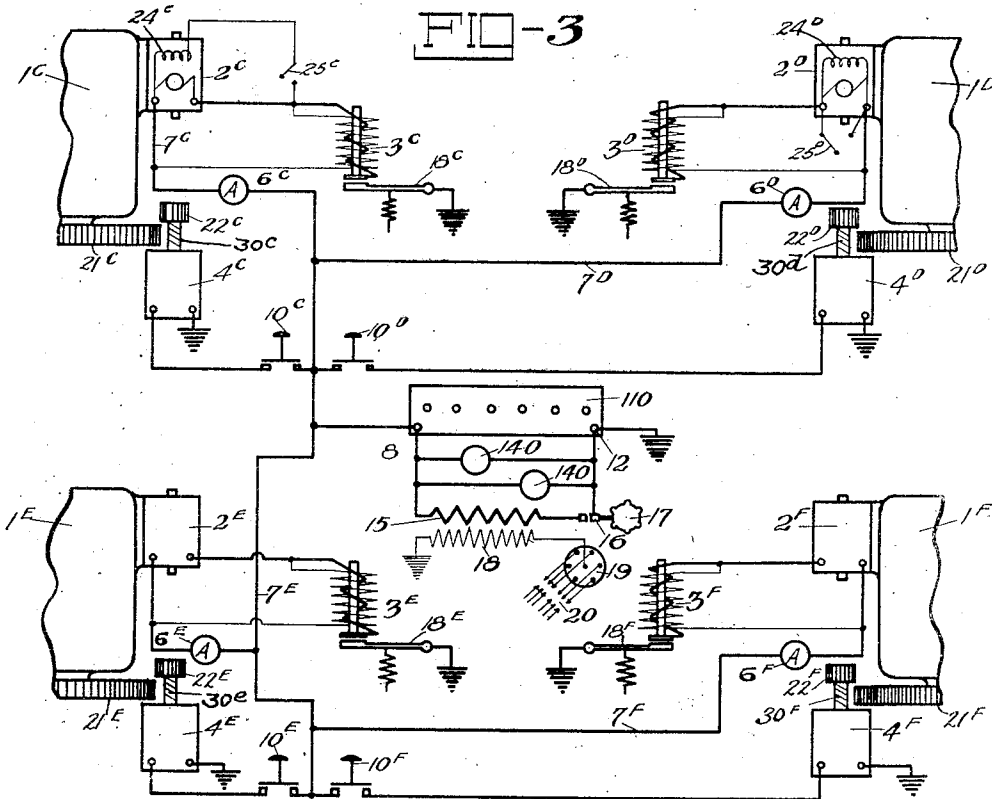
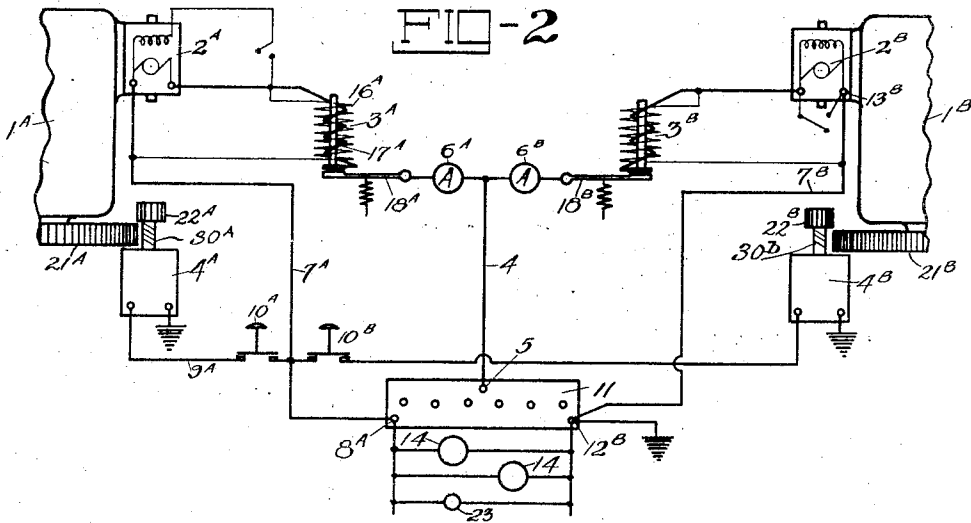
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INVENTOR

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UNITED STATES PATENT OFFICE.

LIONEL M. WOLFFSOHN, (NOW BY JUDICIAL CHANGE OF NAME LIONEL M. WOOLSON,) OF WEEHAWKEN, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO BIJUR MOTOR APPLIANCE COMPANY, A CORPORATION OF DELAWARE.

ELECTRICAL SYSTEM FOR AEROPLANES AND THE LIKE.

1,362,380.

Specification of Letters Patent.

Patented Dec. 14, 1920.

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To all whom it may concern:

Be it known that I, LIONEL M. WOLFFSOHN, a citizen of the United States, and a resident of Weehawken, in Hudson county, State of New Jersey, have invented an Improvement in Electrical Systems for Aeroplanes and the like, of which the following is a specification.

This invention relates to aeroplanes and with respect to its more specific features, to the electrical equipment thereof.

One of the objects thereof is to provide a practical aeroplane in which the engines are reliably and conveniently started and electric current rendered available with a minimum of complication and weight of the parts.

Another object is to provide an electrical system for aeroplanes and the like of reliable action, the apparatus for which shall have a relatively small weight.

Another object is to provide an efficient and economical method of generating and distributing electric power, particularly in connection with systems employing a plurality of gas engines.

Another object is to provide a simple and reliable method necessitating apparatus of relatively small weight, for operating electrical equipment of vehicles, more particularly of aeroplanes having a plurality of gas engines.

Other objects will be in part obvious, and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, steps of the method and arrangement of parts which will be exemplified in the construction hereinafter set forth and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings wherein are shown one or more of various possible embodiments of the several features of this invention, Figure 1 is a perspective view of an aeroplane, showing the location of apparatus, circuits not being indicated. Fig. 2 is a diagrammatic view showing the electrical equipment used in Fig. 1, and Fig. 3 is a diagrammatic view similar to Fig. 2 of a modified arrangement of electrical equipment.

Similar reference characters refer to similar parts throughout the different views of the drawings.

As conducive to an understanding of this invention it may be noted that on aeroplanes where driving power of relatively high value is employed, it is frequently advisable to divide this power between two or more engines, instead of concentrating it all in one engine. Power starters are particularly desirable with aeroplane engines which are frequently of a size where they are difficult to start by manual power, yet, on the other hand, excessive weight of an electrical self-starter or electrical apparatus is very objectionable and lightness in weight and simplicity are of corresponding importance.

Referring now to Fig. 1 of the drawings, there is shown an aeroplane 100, the construction of which is not part of this invention and need not be described. Separate internal combustion engines 1^A and 1^B are equidistant from opposite sides of the pilot's compartment 101, and they drive propellers 102 and 103 respectively. Mounted on engine 1^A, in the usual relation are the generator 2^A and the starting motor 4^A and to engine 1^B the generator 2^B and starting motor 4^B are attached. A single storage battery 11 for coöperation with the electrical appliances of the aeroplane in a manner to be described below, is located in an accessible place preferably under the pilot's seat. The motor starting switches 10^A and 10^B are shown in the pilot's compartment, and the remaining electrical control switches to be described below are shown on the switch board 104, all readily accessible to the pilot.

If a separate battery were located near each of the engines, and arranged to be controlled from the pilot's compartment, not only would such batteries be relatively inaccessible, but the much greater weight of the pair and the greater length and consequently weight of connecting cables, would decrease the usefulness of the aeroplane.

Referring now to Fig. 2 of the drawings, which shows the general arrangement of the electrical equipment in Fig. 1, there is shown associated with engine 1^A and adapted to be driven thereby by mechanism not shown, preferably a 6 volt generator 2^A. Main 4 connects one terminal of generator 2^A with terminal 5 of storage battery 11 through a main switch 3^A of well known type, comprising a voltage coil 16^A and a series coil 17^A so wound and connected as to attract and close contact member 18^A, upon the volt-

age reaching a value suitable for charging said battery. The construction and operation of the main switch 3^A need not be described in greater detail as the invention does not reside therein. Any desired form of voltage regulating means may be employed in connection with the generator, but as this forms no part of my invention it is neither shown nor described. The usual ammeter 6^A is disposed between the main switch and the battery and main 7^A connects the other terminal of the generator 2^A with terminal 8^A of the battery. Starting motor 4^A is preferably grounded and has its other terminal connected by lead 9^A through starting switch 10^A to terminal 8^A of storage battery 11. The usual flywheel 21^A, and the pinion 22^A of an automatic drive are also indicated. By preference the drive is of the type including a screw shaft 30^A conventionally shown, which automatically causes a movement of the pinion 22^A into mesh with the gear 21^A upon starting of the electric motor. The disposition of parts just described is substantially duplicated, parts corresponding to those described above having the same reference numerals with exponent B instead of A. The generator 2^B associated with and adapted to be driven by engine 1^B is, as shown, connected between terminal 5 and grounded terminal 12^B of storage battery 11. The term "grounded" as applied to aeroplanes and other forms of vehicles to which my invention may be applicable, designates connection to a frame or a metallic structure of the machine. Translating devices, such as lamps 14 and pilot lamp 23 are preferably connected across terminal 8^A and 12^B of the storage battery 11 and are controlled from the pilot's seat by switches, indicated on switch board 104 in Fig. 1.

In this arrangement it is seen that the usual electrical equipments on two separate and distinct gas engine power plants cooperate with but a single storage battery, the starting motors 4^A and 4^B being of a relatively high voltage and connected across the entire battery, to develop relatively high torque so that they may start relatively heavy engines, and having a common return, and the generators 2^A and 2^B in this embodiment being shown to generate each but one-half the voltage of the battery and being each connected to charge one-half of the cells thereof whereby both weight and expense are saved as compared with generators of higher voltage.

To cause the propellers 102 and 103 to turn in opposite direction, the motors are preferably disposed as shown to turn in opposite directions, and the same is preferably true of the generators, whereby both a static and dynamic balance of the parts is effectively brought about.

The modified form of the invention shown in Fig. 3, which is particularly adapted for an aeroplane having four engines, differs from that shown in Fig. 1 in the use of generators of the same voltage as the motors, all machines being connected across terminals 8 and 12 of a battery 110, said terminal 12 and one of the terminals of each of the machines being shown grounded, that is, they are connected to a metallic structure of the machine. The modification is furthermore a development of the form shown in Fig. 1 in so far as it shows the application of my idea to four power plants associated with but a single storage battery. In this form furthermore, one ignition circuit is shown by way of example deriving its current from the terminals of the storage battery 110. There being no invention in the ignition circuit *per se*, it is shown of conventional form, primary coil 15 being connected across the battery terminals and interrupter 16 being operated by cam 17, alternately opening and closing the primary circuit. Secondary coil 18 is shown grounded at one end and connected to the distributor 19 at the other, from which the secondary current is led in succession to the spark plugs 20. Ignition apparatus similar to that shown and similarly operated from the battery may be associated with a plurality or with all the engines. In this form, it is seen that all the electrical machines of the system preferably have a common return resulting in economy of weight and material. Also, as in the other embodiment described above, a static and dynamic balance is preferably brought about by causing half of the engines, propellers, generators, and motors to turn in one direction and half in the other. In this modification, parts corresponding to those shown in Fig. 2 have the same reference numerals with exponents C, D, E and F respectively for the four power plants.

If a separate battery were located near each of the power plants shown in Fig. 3 and the cables were led to switches in the pilot's compartment, the larger weight of the plurality as opposed to the single battery and the greater length of cable would decrease in particular the usefulness of an aeroplane of which the system might be a part.

If a separate battery be employed for each of the power plants shown in Fig. 2, not only would the objections described with reference to Fig. 3 be present but the problem of operating from a battery, a motor of a voltage higher than the charging generator would demand a practical solution.

As compared with the battery used in the relatively simple automobile system containing but one engine, one generator, one motor and other translating devices, it may

be apparent that a single battery employed for the larger electrical equipments shown in Figs. 2 and 3, would have to be of greater capacity, and that the battery in Fig. 3, would have to be of greater capacity than that in Fig. 2, to secure proper operation.

After investigation, I discovered that this is not the case, but that, particularly in aeroplanes a single battery of a capacity no larger than and of a construction closely resembling the usual automobile battery will operate reliably in association with all the electrical equipment of the relatively complex systems shown in Figs. 2 and 3, such battery being preferably of somewhat lighter construction than in automobiles. Such single battery, I have further discovered, will have substantially the same life, as those of like capacity used in relatively simple automobile systems. By the use of such single battery, I further effect saving in cost and a lessening of weight particularly beneficial in aeroplane operation.

In each of the embodiments of the invention shown, I therefore employ a single storage battery substantially of the capacity and preferably of lighter construction than in automobiles.

To account for this capability of successful electrical operation, particularly on aeroplanes, of two or more power plants associated with a storage battery of a capacity no larger than that needed for a single such power plant, I have the following explanation which, it is to be understood, is merely tentative and subject to modification.

The minimum size of the battery necessary to successfully start an engine under conditions of cold weather appears to be one which will furnish the needed current for the short interval required to start the engine without permitting its voltage to fall to an undesirable extent. In other words, the battery must be at least large enough to furnish the necessary current without excessive voltage loss. Since the time during which the engine is cranked under electric power before it starts firing is short, the total ampere hours taken out are small even though the current be high. For this reason the ampere hour capacity of even the minimum size battery is not greatly lessened after each start and the same battery is capable of making a number of further successive starts under conditions approximately the same as for the first start. Thus, when the size of the battery is determined by its ability to once start a single engine successfully its electrical capacity suffices for successively starting a plurality of such engines.

There appears to be also a second reason, which contributes to the successful operation of the electrical equipments of two or more power plants in association with a single

apparently relatively small battery. Since unlike vehicles intended to be operated primarily on land or water, aircraft, such as aeroplanes, cannot remain at rest in their medium, but must move at a relatively high speed, it is clear that at least one, and normally all of the engines, and therefore at least one and normally all of the generators more particularly in the species of Fig. 3 will, while the vehicle is in the air, be in effective operation to maintain the storage battery in charged condition. Throughout the operation of translating devices such as lamps 14, ignition apparatus, etc., connected with the battery as shown in the two figures of the drawings, it is thus clear that the single battery will receive current from at least one generator, to replenish its output to the translating devices, as distinguished from the case of an automobile where it is frequently desirable as is well known, to supply current from the battery to the lights for hours at a time, while the engine is not running, thereby greatly depleting the battery. In aeroplane operation the storage battery would thus be called upon without effective connection of charging generators, merely to provide the current necessary to operate the starting motors, and if desired to also furnish a small amount of current for a pilot lamp 23 to be used when the machine is stored at night. It thus appears that in this case no great number of ampere hours is used up without replenishing the source of current.

In the system shown in Fig. 3 it may at times be undesirable to charge the battery with all four generators on account of the liability to overcharge. On the other hand, it would be undesirable to dispense entirely with all but one of the generators, since, if a single generator were relied on and this went out of order accidentally, there would be no means of replenishing the battery. To effectively provide against this overcharge, I arrange so that the pilot of the machine can render one or more of the generators inoperative and get his current supply from the remaining generator, or generators.

I have shown applied to generators 2^c and 2^d by way of example, two different methods of carrying out this object. In series with the field 24^c of generator 2^c, I have shown a hand switch 25^c which when open, will render the generator inoperative. My second method for rendering a machine inoperative is illustrated in association with generator 2^d, which has connected across its terminals a hand switch 25^d which when in closed position short circuits both armature and field. It is to be understood that either the short-circuiting or the field-circuit opening form of switch may be effective.

tively employed in connection with each of the generators, or both types may be used conjointly on different generators of the system. The field-circuit opening type of switch is the preferred form, but it is to be understood that there are peculiarly advantageous features to the other embodiment. The switches just described are preferably located on the switch board 104 with the other control switches.

By way of illustration I have shown the two methods just described for rendering the generators inoperative, applied one to each of the generators in Fig. 2.

Having reference to the figures of the drawings, the ignition switches and throttles, (not shown), being assumed adjusted, the operation is substantially as follows:—For starting, the switches 10^A and 10^B or 10^C, 10^D, 10^E and 10^F are depressed successively in any order whereby each starting motor is set in operation by the battery and is preferably automatically placed into co-operation with the engine. The engines are thus started successively, the starting apparatus being preferably constructed to automatically go out of operative relation with the engines, after they are started, said automatic meshing and unmeshing being effected preferably by a construction of the type above referred to. The generators which are driven from the engines will now send current to the storage battery while the main switches are closed, and ignition circuits and lights may in turn derive current from the battery, when their controlling switches are closed. If there be danger of overcharging the battery in the system shown in Fig. 3, either switch 25^C is opened or 25^D closed to place the corresponding generator out of action, or both machines may be rendered inoperative.

Though the systems shown in Figs. 1 and 2 find their special utility in the application to aeroplanes as fully described above, it is to be understood that these systems may be used to good effect for other purposes. On some occasions, it may be desirable to operate less than the full number of power plants or to alternate in the use of the power plants, sometimes operating on less than the full equipment. In this case, of course, only selected starting switches would be depressed. It is, also, obvious that though the invention has been shown as applied to two engines in Fig. 2 and to four engines in Fig. 3, that it may

be applied advantageously to a system having a different number of engines.

It will thus be seen that there is herein described apparatus and methods of operation in which the several features of this invention are embodied, which apparatus in its action, and which method in its execution, attain the various objects of the invention and are well suited to meet the requirements of practical use.

As many changes could be made in the above construction and method and many apparently widely different embodiments of this invention could be made or executed without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an electrical system for aeroplanes and the like, in combination, two gas engines, a separate generator associated with each said engine, and adapted to be driven thereby, a single secondary battery, one of said generators being connected across one-half the cells of said battery, the other generator across the other half of said battery, a separate starting motor for each engine, each adapted to be connected to both terminals of said battery, a separate starting switch for each said motor for effecting said connection, and additional translating devices adapted to be connected across said battery.

2. In an electrical system for aeroplanes and the like, in combination, two gas engines, a separate substantially 6 volt generator associated with each said engine, and adapted to be driven thereby, a single substantially 12 volt battery, each said generator being connected to charge one-half the cells of said battery, a separate substantially 12 volt starting motor for each engine, each adapted to be connected to both terminals of said battery, a separate starting switch for each said motor for effecting said connection and a lighting and an ignition circuit adapted to be fed from said battery.

In testimony whereof, I have signed my name to this specification this 9th day of March, 1917.

LIONEL M. WOLFFSOHN.