

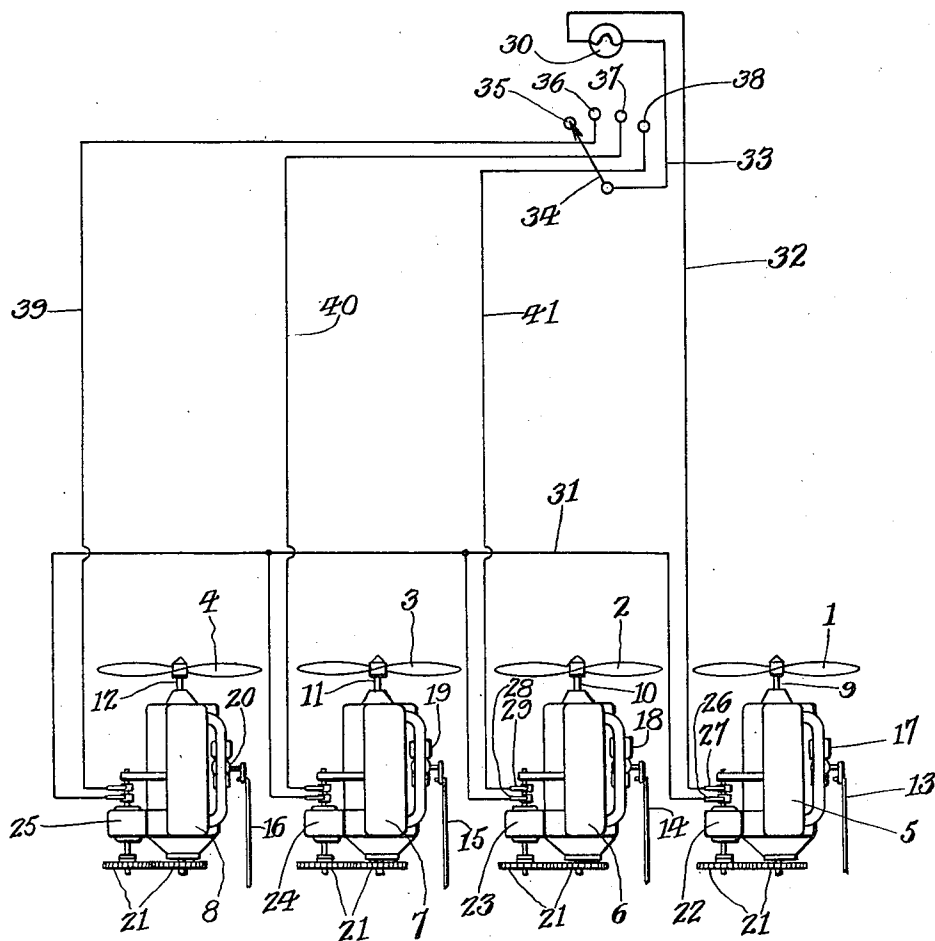
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AIRPLANE ENGINE SYNCHRONIZING DEVICE

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AIRPLANE ENGINE SYNCHRONIZING
DEVICE

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5 Claims. (Cl. 177—311)

This invention relates in general to airplanes and more particularly has reference to a means for eliminating disturbances due to differences in propeller speed of multi-propellered airships.

As is well known, airplanes of today are customarily driven by one or more propellers for each ship, each propeller ordinarily being independently driven by an internal combustion engine or the like. In those ships in which more than one independently driven propeller is employed it has been found that unless these propellers are revolving at exactly the same speed there will be produced a very disagreeable beat or drumming which is highly distracting to the nerves of most people and which is also very destructive to the structure of the airplane because of the vibration which it creates.

In ships where only two propellers are employed, it is a comparatively simple matter to eliminate this beat due to inequalities of speed by merely varying the speed of one of the driving motors until the beat disappears. However, when three, four or more propellers are employed it will readily be seen that the elimination of the beat due to inequalities of speed will become a highly complicated matter because of the fact that it is impossible to tell which propellers are causing the beat. Previously therefore this difficulty has proven a serious drawback to the use of airplanes having three or more independently driven propellers particularly for use in carrying passengers. The safety feature introduced by the greater number of independently driven propellers however is extremely desirable.

It is of course possible to set the engine speeds approximately the same by using a tachometer, but it is impossible with tachometers to set engines close enough to the same speed to eliminate the objectionable "beat" referred to above.

In view of the above, it is one of the objects of this invention to provide a means whereby all of the propellers of a multi-propellered airship may be easily and readily brought to exactly the same speed, and whereby it may be determined with the greatest facility which propeller or propellers may be causing a beat. It is an object of this invention also that this means shall be very simple and easy to operate and shall require only a very small amount of the pilot's time thereby leaving him free for attention to other and more important matters in connection with his ship.

Other objects and advantages of this invention will become apparent from the following description taken in connection with the accompanying

drawing, it being clearly understood that the same are by way of illustration and example only and are not to be taken as in any way limiting the spirit or scope of this invention. The spirit and scope of this invention is to be limited only by the prior art and by the terms of the appended claims.

Referring now more particularly to the drawing in which like numerals indicate corresponding parts throughout:

The single figure is a diagrammatic illustration setting forth one of the embodiments of this invention.

As illustrated in the drawing, this invention is shown as being applied to a propelling system consisting of four propellers 1, 2, 3 and 4 each independently driven by the internal combustion engines 5, 6, 7 and 8 respectively. These propellers are illustrated as being directly connected to the crank shafts 9, 10, 11 and 12 of the respective engines 5, 6, 7 and 8, and these engines are each provided with conventional throttle mechanisms 13, 14, 15 and 16, the said throttle mechanisms cooperating with the carbureters 17, 18, 19 and 20 to vary the speeds of the respective engines independently in the ordinary manner.

Directly and positively connected by means of gears 21 or the like to the rear end of each of the shafts 9, 10, 11 and 12 there is a small alternating current generator of conventional type, these being numbered 22 to 25 respectively. It is essential that these generators be positively geared or coupled to the propellers 1, 2, 3 and 4 respectively so that each generator will be operated at a speed directly proportional to the speed of the propeller to which it is connected. These generators 22, 23, 24 and 25 are electrically identical and are each provided with slip rings 26 and 27 contacted respectively by brushes 28 and 29 to which are connected the conductors leading from the respective generators. It will be seen from the above that each of the generators 22, 23, 24 and 25 will be caused to produce an alternating electro-motive force the frequency of which will vary in direct proportion with the speed of the propeller with which any particular generator is associated.

The generators are so designed that at the lowest operating speeds of the engines they will produce currents with sufficiently high frequencies to avoid noticeable flickering in an incandescent lamp lighted thereby.

A suitable means such as the electric incandescent bulb 30 is provided for indicating a flow of current and thus comparing the frequencies of

the electro-motive forces produced by any two of the alternating current generators 22, 23, 24 and 25. An arrangement of conductors is provided so as to enable one of these generators 22 which is associated with the propeller 1 and the engine 5 to be selectively connected to any one of the other generators 23, 24 or 25 and its frequency compared with the frequency of such other generator so as to determine any differences in speed between the speed of the propeller 1 and the engine 5 and the speed of any of the other propellers 2, 3 or 4. Any inequalities thus discovered may readily be compensated for by means of the throttles 14, 15 and 16 respectively as will be clearly apparent.

For the purpose of connecting the generator 22 to each of the other generators 23, 24 and 25 respectively for the purpose just set forth, the brushes 28 contacting with the slip rings 26 are permanently connected to each other by means of the conductor 31. The other brush 29 of the generator 22 is connected by a conductor 32 to one terminal of the lamp or bulb 30, and the opposite terminal of this bulb is connected by a conductor 33 to the switch arm 34 which is slidable to contact selectively with the switch points 35, 36, 37 and 38. The switch point 35 is a blank, and thus when the switch arm 34 is in contact therewith the generator 22 will not be connected to any of the other generators. The switch point 36 however is connected to the brush 29 of the generator 25 by means of the conductor 39. Likewise the switch point 37 is connected by means of the conductor 40 to the brush 29 on the generator 24 and the switch point 38 is connected by means of a conductor 41 to the brush 29 on the generator 23. Thus when the switch arm 34 is in contact with either of the points 36, 37 or 38, the generator 22 will be connected respectively to the generators 25, 24 or 23 through the bulb 30.

Now the pilot sets the propeller 1 by means of a tachometer or the like to the speed at which he desires to operate all of the propellers. He then moves the switch arm 34 so that it contacts with one of the switch points 36, 37 or 38 thus connecting the generator 22 through the bulb 30 to one of the other generators 25, 24 or 23 as the case may be. Now if the switch arm be connected to the switch point 36, and the propellers 1 and 4 be rotating at the same speed, the generators 22 and 25 will each be producing an alternating electro-motive force at exactly the same frequency. Thus, they will both either be pushing in the same direction at the same time thereby causing the bulb 30 to remain lighted, or else they will be pushing in an opposite direction at the same time thereby preventing any current from flowing and causing the bulb 30 to remain unlighted. If on the other hand the propeller 4 and its engine 8 are rotating at a slightly greater or slightly smaller speed than the propeller 1 and its engine 5, the electro-motive forces produced by the two generators 22 and 25 will be pushing in the same direction at one time, and a short time thereafter depending upon the differences in speed they will be pushing in opposite directions. This will cause the bulb 30 to flicker or fluctuate in its degree of intensity, the frequency of its fluctuation depending upon the difference in speed of the two generators 22 and 25. It is readily seen that the pilot may then manipulate the throttle 16 of the engine 8 so as to change the speed of this engine and the propeller 4 until the bulb 30 either remains at a constant intensity of illumination or goes out entirely. When this condition exists the two propellers 1 and 4 will be operating at exactly the

same speed and will be producing no beat between them.

After this has been accomplished the switch arm 34 may then be swung over to contact with the point 37 and the process repeated so as to bring the propeller 3 to exactly the same speed as the propeller 1. The propeller 2 is then brought up to the same speed as the propeller 1 in exactly the same manner.

If during the operation of the ship there is some variation either in the resistance offered to one of the propellers or its engine or if the quality of fuel varies slightly or for some other cause a beat appears, it is a simple matter for the pilot to move the switch arm 34 in turn to the switch points 36, 37 and 38 and to determine which one of the propellers or engines is out of cadence with the engine 5. It is not necessary for him to guess which propeller is out of cadence and run the risk of disturbing the adjustment of another one of the engines thus making matters worse than before, but he can find out with very little trouble and practically no loss of time just which motor is causing the beat and correct the trouble.

It will thus be seen that a problem has been ingeniously solved in a very satisfactory manner and that a very material advance in the airplane art has been effected thereby. This is a problem the solution of which has long been sought, and which it will readily be seen has been very satisfactorily solved by the invention above described.

While alternating current generators have been referred to above for the purpose of illustration, it is within the purview of this invention to utilize any other type of means for producing a pulsating current with a frequency directly proportional to the speed of the engine to which it is connected, whether such pulsating current be alternating or otherwise.

What I claim is:—

1. In an airship having a plurality of independently driven propellers, one of which is adapted to serve as a master, means for eliminating disturbance due to inequalities in the speeds of the respective propellers, said means comprising a plurality of alternating current generators, said generators being positively connected with said propellers respectively to be driven therewith for producing alternately electromotive forces having frequencies exactly proportional to the speeds of said propellers, an electric incandescent bulb, means for selectively connecting the generator connected with the master propeller to any one of the other generators in series with said bulb, whereby said bulb will be caused to flicker by any difference in speed of the two propellers, and means for selectively changing the speed of each of the other propellers to exactly that of the master propeller.

2. In an airship having a plurality of independently driven propellers one of which is adapted to serve as a master, means for eliminating disturbance due to inequalities in the speeds of the respective propellers, said means comprising a plurality of devices for producing pulsating electro-motive forces, one of said devices being associated with each of said propellers to produce pulsating electro-motive forces with frequencies directly proportional to the speeds of said propellers, means for indicating a flow of current, means for selectively opposing the electro-motive force of the device associated with the master propeller to that of each of the other devices through said indicating means, whereby said in-

dicating means will selectively indicate any variation in flow of current between said devices due to differences in frequency of said electro-motive forces caused by differences in speed between the master propeller and any one of the other propellers, and means for selectively changing the speed of each of said other propellers to exactly that of the master propeller.

3. In an airship having a series of independently operated propellers, an alternating current generator operated from each propeller, said generators being electrically identical and one serving as a master, a series of normally open indicating circuits, each circuit including the master generator and one of said other generators, a normally inactive speed comparison lamp common to the said several circuits, and means common to the said several circuits for selectively closing them to interpose the lamp in the closed circuit to provide for the latter indicating frequency differences between said master generator and one of said other generators.

4. In an airship having a plurality of independently driven propellers one of which is adapted to serve as a master, means for eliminating disturbance due to inequalities in the speeds of the respective propellers, said means comprising a plurality of devices for producing alternating electro-motive forces, one of said devices being associated with each of said propellers to produce alternating electro-motive forces with frequencies directly proportional to the speeds of said propellers, means for indicating a flow of current, means for selectively opposing the elec-

tro-motive force of the device associated with the master propeller to that of each of the other devices through said indicating means, whereby said indicating means will selectively indicate any variation in flow of current between said devices due to differences in frequency of said electro-motive forces caused by differences in speed between the master propeller and any one of the other propellers, and means for selectively changing the speed of each of said other propellers to exactly that of the master propeller.

5. In an airplane having two independently driven propellers one of which is adapted to serve as a master, means for eliminating disturbance due to inequalities in the speeds of the respective propellers, said means comprising two devices for producing pulsating electro-motive forces, one of said devices being associated with each of said propellers to produce pulsating electro-motive forces with frequencies directly proportional to the speeds of said propellers, means for indicating a flow of current, means for opposing the electro-motive force of the device associated with the master propeller to that of the other of said devices through said indicating means, whereby said indicating means will indicate any variation in flow of current between said devices due to differences in frequency of said electro-motive forces caused by differences in speed between the master propeller and the other of said propellers, and means for changing the speed of said other propeller to exactly that of the master propeller.

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