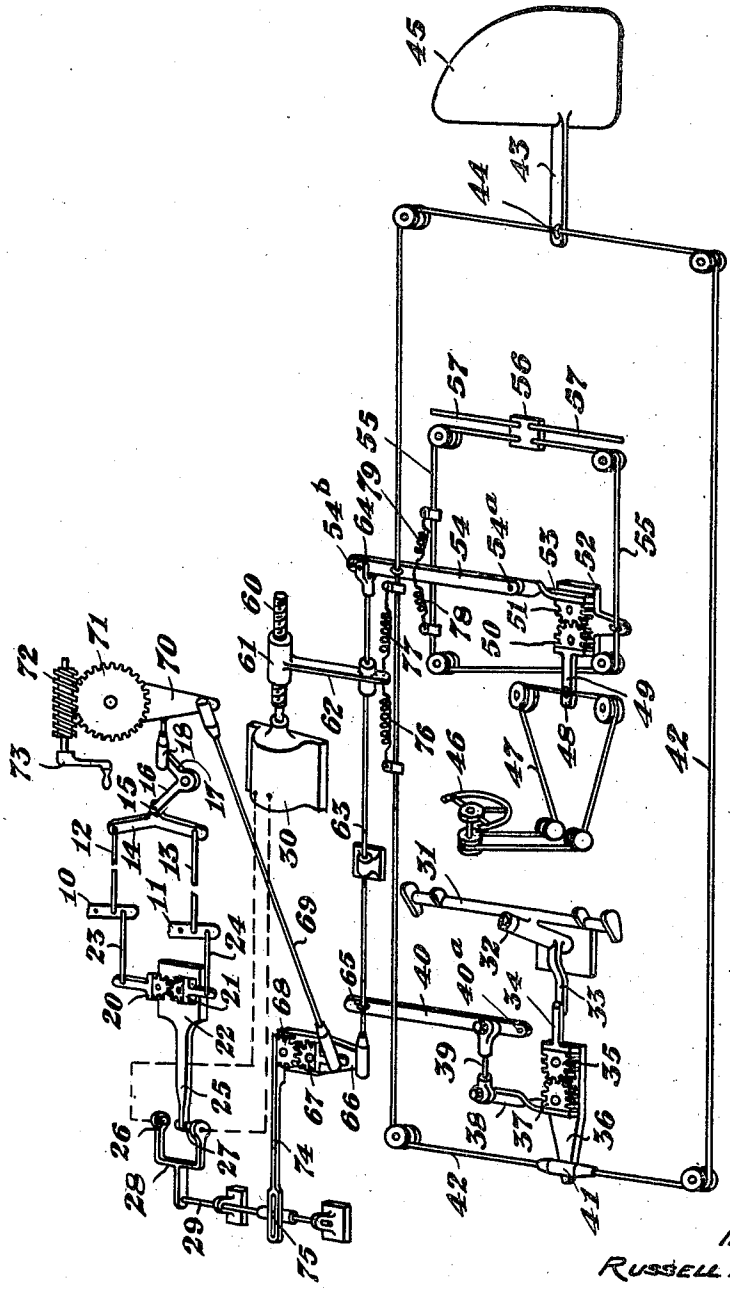
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TRAINER FOR TEACHING AIRPLANE CONTROLS

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INVENTOR,
RUSSELL L. WEST.

Smart & Biggar.

BY

ATTORNEYS.

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TRAINER FOR TEACHING AIRPLANE CONTROLS

Russell L. West, Montreal, Quebec, Canada, assignor to West Aeronautical Devices, Inc., Montreal, Quebec, Canada, a corporation

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The present invention relates to aeronautics and is particularly concerned with the controls of single engine planes. The invention provides for the simulation by a single motor plane of certain behaviours of a multi-motor plane. It is characteristic of multi-motor planes that should the power of one motor be reduced in comparison with that of the other motor the plane will turn and bank, the air speed over one wing being diminished thus reducing the lift on that wing, and reduction of power of one motor causing the other motor to tend to turn the plane by driving in advance of the other motor. Such a turning and banking effect may be overcome by manipulation of the controls to apply the opposite rudder and an opposite bank. Obviously such turning and banking reaches a maximum when one motor stalls or otherwise goes dead while the plane is in flight. In the training of pilots it is important that they should become familiar with this characteristic of operation of a multi-motor plane and the proper responsive manipulation of the controls.

The cost of multi-motor planes and of their operation are very considerably greater than the cost of single motor planes and their operation. It is, therefore, among the prime objects of the present invention to provide a single motor airplane having means therein for simulating the performance of a multi-motor plane.

A more specific object is to provide a single motor plane with multi-motor controls and to provide for simulation of multi-motor plane behaviour through manipulation of such controls. A further and general object of the invention is to provide means in a single motor plane for the training of pilots in the control of multi-motor planes.

More specifically it is among the objects to provide a single motor plane which will train a pilot in the reactions of a multi-motor plane when one motor has ceased to function. A still further and specific object of the invention is to provide a single motor plane with multi-motor controls whereby a pilot by manipulation of the multi-motor controls can experience the reaction of a multi-motor plane.

Numerous other objects and features of the present invention will be apparent from consideration of the following specification taken in connection with the drawing.

The invention is readily applicable to various types of single motor planes. As herein shown and described the invention is applied to a single seated single motor plane. It may, however, be readily applied to multiple seated planes such as trainer planes of either dual side by side control or tandem seating arrangements.

In general terms the invention comprises an arm movable in response to movement of one of a pair of throttle levers with respect to the other, these levers simulating the pair of throttle levers with which a twin-motor airplane would be provided but both controlling the single motor. The arm in turn actuates (preferably through an electric motor) the rudder and ailerons of the plane to cause the plane to bank and turn when one throttle is moved in simulation of the reducing or cutting out of the power of one motor of a twin-motor plane. The rudder and ailerons are, however, also under the control of the pilot who may compensate for such movement thereof by manually applying opposite rudder and opposite aileron movement, thereby righting the plane and keeping it on its course. The invention also provides a trimmer which indirectly controls the rudder and aileron setting so that, when they have been set to correct the turn and bank by manipulation of the pilot, the electric motor may be operated reversely to return the rudder and ailerons to their normal position without resetting the throttle lever. The invention further provides for controlling the actual power of the motor when either of the throttle levers are moved or when they are moved together so as to simulate the power output of a twin-motor plane when the throttles are adjusted.

The figure of the drawing is a diagrammatical illustration of one embodiment of the present invention.

In the drawing the numerals 10 and 11 represent the starboard and port throttle simulating levers. Links 12 and 13 extend therefrom to the opposite arms of a rock arm 14 which is pivotally connected at its centre 15 to one arm 16 of a bell crank. The end of the other arm 17 of this crank is directly connected with a throttle link 18 which directly controls the speed of the motor of the plane.

This arrangement provides for a full movement of the link 18 upon full simultaneous movement of both throttle levers 10 and 11. Movement of one throttle lever independently of a movement of the other lever will cause the rock arm to pivot using the opposite stationary end as a fulcrum and thus impart only partial movement to the link 18 when only one lever is operated. Thus the motor power will be reduced only partially, thereby to simulate the drop in power of a twin-

motor plane when one motor reduces power or is completely shut off.

For causing the plane to turn and bank in response to the movement of one throttle lever with respect to the other, a differential is provided including a starboard sector 20 meshing with a port sector 21. These sectors are semicircular gears whose teeth intermesh, and they are each rotatably mounted on a master arm 22 which in turn is pivotally mounted at a point intermediate the pivotal points of the sectors; the latter are connected by suitable links 23 and 24 to the levers 10 and 11 respectively.

The specific type of differential here shown is used throughout the present control arrangement and provides for both differential action and a lost motion connection. It will be seen that when one of the sectors remains stationary while the other is pivotally moved, the one pivotally moved will by enmeshment with the teeth of the companion sector move with planetary motion about the pivot point of the master arm as the centre. Thus, should the handle of the throttle lever 10 be moved backwards, the connection 23 will move forwards, rocking the arm of the sector 20 in a counter-clockwise direction on its own pivot. The sector 21 being stationary, such movement will cause counter-clockwise planetary motion of the centre of the sector 20. Since the latter 20 is pivoted at its centre upon the master arm 22, which in turn is pivoted to a fixed base intermediate the centres of the sectors 20 and 21, the arm 22 will be rocked on its centre in a counter-clockwise direction. Similarly, should the throttle lever 10 be retained stationary, and with it the throttle sector 20, while the arm of the throttle sector 21 is rocked in clockwise direction, the master arm 22 will be moved in clockwise direction around its pivotal point. It will also be noted in considering the actions of this type of differential that should the sectors 20 and 21 be equally moved in opposite directions, that is should the handles of both throttle levers be moved together in the same direction, there will be no responsive movement of the arm 22, and likewise should the sector 20 be rocked to impart a predetermined motion to the arm 22, an equal and opposite rocking of the sector 21 will return the arm 22 to its original position. While, in the normal operation of the present invention, one throttle sector will not be used to offset or compensate motion imparted to the arm 22 by rocking of the other throttle sector, this action of the differential is here referred to since in other places in the structure such compensating action will be the normal mode of operation of similar differentials.

The end of the master arm 22 is provided with a flexible contactor 25 which is mounted between a pair of oppositely disposed contact arms 26 and 27 carried by a bracket 28 mounted upon a reciprocating rod 29. The invention provides a reversible electrical motor 30, the energization of which is directly controlled by the contacts, the current being supplied through the contactor 25. The contact arm 26 provides for energization of the motor in a positive direction when current is supplied through the contacts thereto, while when the contactor supplies energy through the contact arm 27 the motor will be energized in a reverse or negative direction. The electrical connections between the motor and the contact arms may be of a conventional type and are consequently merely diagrammatically shown by means of dotted lines.

The motor is adapted to have a controlling effect on the setting of the aileron and rudder in a manner hereinafter described.

As in conventional planes a rudder bar 31 is provided which is adapted to be swung from side to side by the feet of the pilot, the rudder bar being pivotally mounted as at 32 and provided with a rudder arm 33 which in turn engages the arm 34 of a sector member 35. This sector is pivotally mounted on the master arm 36 and meshes with a companion sector 37, the arm 38 of which is engaged by link 39 which is movable by a lever 40 pivoted at 40a. It will be seen that this arrangement is such that with the lever 40 stationary and thus the sector 37 held against movement, pivotal movement of the rudder bar will rock sector 35 which, through its enmeshment with sector 37, will rock the master arm 36. Likewise with the rudder bar held stationary and the lever arm 40 moved, movement will be imparted to the master arm 36. The arrangement of the quadrants here referred to is similar to that of the quadrants associated with the throttle levers, and it will thus be seen that should the master arm 36 be moved by the lever arm 40 such movement can be reversed by a movement of the rudder arm 31 and vice versa. The end of the master arm 36 is attached as at 41 to the rudder control cable 42 which passes over suitable pulleys and is connected with a rudder arm 43 as at 44 thus to manipulate the rudder 45.

In a similar manner the ailerons for controlling the banking of the plane are manually controlled by the pilot through a wheel, stick or the like 46, hereafter referred to as a wheel, which operates cable 47 secured as at 48 to the arm 49 of the sector 50 which meshes with a similar sector 51, both of which are pivotally mounted on a master arm 52. The sector 51 is provided with an arm 53 pivoted at 54a to an arm 54 which is fulcrumed at 54b and connected at 64 to the link 63 to be operated with the arm 40 in a manner hereinafter disclosed. The arrangement here is similar to the arrangement provided for the rudder control, in that manipulation of the wheel 46 will rock the sector 50. Assuming the sector 51 to be held stationary by the arm 54, the master arm will turn and its connection with the cable 55 will move the block 56 which is connected to the ailerons in a conventional way through aileron operating cables 57. Likewise movement of the lever arm 54 while the sector 50 remains stationary will cause like movement of the block 56. Thus the aileron operating cables are responsive to the movement of either the arm 54 or the wheel 46. Should the ailerons be moved by the arm 54 their movement can be reversed by manipulation of the wheel 46.

The movements of the arms 54 and 40 are under the direct control of the motor 30, the motor shaft of which is provided with a worm 60 on which travels an internally threaded nut 61 carrying an arm 62. The arm 62 is secured to a reciprocating link 63 which engages the arm 54 as at 64 and the arm 40 as at 65. Thus, when the motor is energized the worm 60 will turn, and the nut 61 will move on the worm to move the link 63. Since the motor is reversible the link 63 may be reciprocated in response to the opposite energization of the motor. Thus it will be seen that when the port throttle is moved with respect to the starboard throttle the master arm 22 will be moved in a clockwise direction, the positive contact 26 will be engaged by the contactor 25 and the motor will move energized in a

positive direction. The threaded relation of the worm 60 and nut 61 provides, in this event for the movement of the nut to the right in the figure, thus moving the arms 40 and 54 and their respective sectors 37 and 51. In normal operation such movement will be accomplished with the rudder bar and the wheel remaining stationary, and thus the master arms 36 and 52 will move the rudder and ailerons to cause the plane to tilt to the left and turn to the left in simulation of a reduction or cessation of power by the port motor of a multi-motor plane. When the plane thus banks and turns the pilot may apply opposite rudder and opposite bank by manipulation of the rudder bar and wheel; the rudder bar sector 35 and wheel sector 50 will thus act upon their master arms to restore the setting of the rudder and the aileron cables. It will be seen, however, that the link 63 is connected to the rudder control cable 42 by springs 76 and 77 and to the aileron control cable 55 by springs 78 and 79 fastened to the arm 54. These springs, as can be seen, assist movement of the cables 42 and 55 when the motor operates and the link 63 moves, but resiliently oppose movement of these cables caused by movement of the rudder bar 31 or wheel 46. The result of this arrangement is that to maintain the restored setting referred to, whereby the plane is righted and retained on its original course, the rudder bar and wheel must be held in their new setting until a trimmer is operated to hold the new setting and relieve the pilot from manual strain, as is the case in actual operation of a multi-motor airplane.

While the trimming is accomplished in a normal plane by a rotary mechanism directly engaging the control cables, it is accomplished in the present device through manipulation of the arm 29 carrying the contact arms 26 and 27 and the arrangement also works through a device which provides for de-energizing the motor after a predetermined movement thereof has set the aileron and rudder in a newly adjusted position. The arrangement includes the coupling of the link 63 with a master arm 66 which supports a trimmer sector 67 and a companion sector 68. The arm of the trimmer sector 67 is connected by a link 69 to an arm 70 mounted upon a wheel 71 which may be manually rotated by the turning of a worm 72 through manipulation of a handle 73. The companion sector 68 is provided with an arm 74 engaging through a lost motion connection 75 the link 29. By this arrangement it will be seen that when the motor is energized in a positive direction the master arm 66 will rock in counter-clockwise direction thus rocking the arm 74 in clockwise direction to move the link 29 upwardly causing a disengagement between contactor 25 and the positive contact 26 and breaking the circuit to the motor. Since the contactor 25 is flexible it will be seen that the amount of movement of one throttle lever with respect to the other will control the movement of the arm 22 and will determine the length of time the contactor engages one of the contacts, since it will be necessary for the motor to continue energization until the arm 74 has moved the contact arm completely away from the contactor 25. Thus adjustment of the throttle may simulate a partial reduction of power of one of the motors of a twin-motor plane or may simulate the complete shutting off of a motor.

Through the trimming mechanism, including the handle 73, worm 72 and wheel 71, there is provided means for re-setting the rudder and aileron to normal position after the pilot has attained such position through manipulation of the rudder arm 31 and wheel 46. Thus after a turning and banking movement is imparted to the plane by the adjustment of one throttle lever with respect to the other, and compensation for such turning and banking has been effected by manipulation of the rudder bar 31 and wheel 46, the trimmer handle 73 may be moved so as to impart motion to the sector 67. This rocks the companion sector 68 and moves the arm 74 to engage the opposite contact arm with the contactor 25. The motor will thus be energized in opposite direction and will continue such energization until the link 63 acts upon the master arm 66 to compensate for the position of the sector 67. The sector 68 will thus be moved to move the arm 74 to re-set the bracket 29 and the contact arms 26 and 27 to a midway position on opposite sides of the contactor 25; the aileron and rudder cables will at the same time be moved to re-set the aileron and rudder to normal flight position.

From consideration of the foregoing it will be seen that a plane equipped with the present invention will properly simulate the turning and banking effect which would follow from the reduction or cessation of power of one motor of a twin-motor plane. As in a twin-motor plane such turning and banking may be offset by proper manipulation of the rudder bar and wheel, and after such adjustment the plane may be retained in its normal course of flight by an adjustment of the trimmer mechanism which will relieve the pilot from the necessity of physically holding the rudder bar and wheel in their newly adjusted position. It will also be noted that the amount of turn and bank applied in response to an adjustment of the throttle is proportionate to the difference in the throttle adjustment, the arrangement providing for a maximum turning and banking in response to the maximum difference in the setting of the throttle levers. However, a difference in throttle setting of only a fraction of the maximum difference will impart only a fractional banking and turning effect to the plane. The arrangement also provides for the reduction in the actual power of the plane in consequence of a difference in the throttle setting or in consequence of a change in the setting of the throttle levers with respect to each other. Thus the plane may be slowed down by moving both the throttle levers or it may be slowed down in consequence of one throttle lever being moved with respect to the other, thus simulating the reduction in total power of a twin-motor plane should the power of one motor be reduced with respect to that of the other motor.

I claim:

1. A single motor airplane, comprising throttle means for the motor, a pair of controls for said throttle means, and means operated by movement of one of said controls with respect to the other for turning and banking the airplane.

2. A single motor airplane, comprising throttle means for the motor, a pair of controls for said throttle means, means operated by movement of one of said controls with respect to the other for turning and banking the airplane, and manually controlled devices operable independently of said throttle control operated means for turning and banking the airplane in the opposite direction in order to restore it to a normal flight position.

3. A single motor airplane according to claim 2,

comprising means for retaining the airplane in normal flight position after operation of the throttle control operated means and of the manually controlled devices, in spite of the fact that neither the last mentioned means nor said devices are at their normal setting for a normal flight position of the airplane.

4. In a single motor airplane having throttle means for the motor and a rudder and ailerons controlled respectively from a rudder bar and wheel, a pair of controls for said throttle means, and means operated by movement of one of said controls with respect to the other to move both said rudder and ailerons without moving said rudder bar and wheel.

5. A single motor airplane comprising throttle means for the motor, a pair of controls for said throttle means, and means for actuating said throttle means to a different extent upon movement of one of said controls than upon the same amount of movement of both said controls.

6. A single motor airplane according to claim 5, in which the means for actuating the throttle means include a yoke pivoted for movement by either of the controls and bodily movable upon simultaneous movement of said controls.

7. A single motor airplane according to claim 5, comprising a differential device operated by movement of one of said controls with respect to the other to move the ailerons and rudder of the airplane.

8. A single motor airplane according to claim 5, comprising a differential device operated by movement of one of the controls with respect to the other, a switch operated upon movement of said differential device, and a motor controlled from said switch and operable to cause movement of the ailerons and rudder of the airplane.

9. A single motor airplane according to claim 5, comprising a differential device operated by movement of one of the controls with respect to the other, a switch operated upon movement of said differential device, a motor controlled from said switch and operable to cause movement of the ailerons and rudder of the airplane, and independent means for controlling said motor.

10. A single motor airplane according to claim 5, comprising a differential device operated by movement of one of the controls with respect to the other, a switch operated upon movement of said differential device, a motor controlled from said switch and operable to cause movement of the ailerons and rudder of the airplane, and means operated upon energization of said motor to interrupt the circuit of the motor after a predetermined period.

RUSSELL L. WEST.