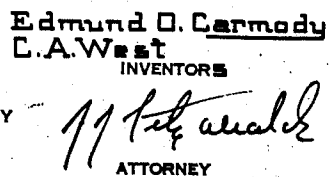


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TORQUE DEVICE FOR COORDINATOR TRAINERS

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TORQUE DEVICE FOR COORDINATOR
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This invention pertains to an educational arrangement for practicing properly coordinated manipulation of airplane controls. The purpose of this arrangement is to familiarize the student with the necessity of coordinating his throttle advance to a high power position with the corresponding rudder or aileron operation for overcoming the effect of the resulting increased engine torque, so as to maintain the plane on a straight course during a power climb particularly at low flying speed. By acquiring the habit of coordinating these controls, the new pilot will not be taken by surprise, when actually executing a power climb, to suddenly find himself making an unintentional bank and turn to the left. A further purpose is to afford the student practice in the process of checking the engine operation of an engine equipped with dual ignition prior to taking off.

The primary object of this invention is, therefore, to construct a set of controls simulating the actual controls in a airplane cockpit, including the stick, dual-ignition switch, rudder pedals, tachometer and throttle, so interconnected with each other and with a buzzer or other signal system and with means for effecting the tachometer readings as to make the engine speed indicated on the tachometer dependent not only on the position to which the throttle is moved, but also on means selectively controlled by the instructor to indicate trouble in either or both ignition systems when tested by the student by operation of the ignition switch. The buzzer is so connected as to operate whenever the manipulations of the controls are not properly coordinated to overcome the effect of increased torque with increased speed of engine operation.

These and other more specific objects will become more apparent as the detailed description of my apparatus proceeds. The construction of an illustrative form of my invention is shown in the accompanying drawing wherein;

Fig. 1 shows the general layout of my apparatus in perspective view,

Fig. 2 is a wiring diagram of the buzzer or other electric signal system tied up with the connections in a regular ignition switch for a dual magneto ignition system, and with the operation of the several electro-magnets, and,

Fig. 3 is a phantom perspective view of the tachometer.

Similar parts in the several views of the drawing are designated by the same numerals. The general arrangement of the controls and their relative positions in the present device is the same

as may be found in the cockpit of an airplane. The stick 1 is mounted on a transverse pivot 2 fastened to the axially rotatable shaft 3 and is normally maintained in a position for level flight by the bungee cables 4 and 5 fastened as shown.

The axial shaft represents the aileron control shaft. It has an arm 6 to the end of which is pivotally connected one end of contact bar 7 having contact bands 8, 8 with a strip of insulation 9 between them. An end 10 of a slidable contact spring 11 slides over these bands and strip, the other end of the spring being fastened through insulation 12 to a rod 13 slidably mounted within an axial bore 14 in the end of contact bar 7. The outer end of this rod 13 is pivotally connected to lever 15, one end of which is pivotally connected to link 16, which in turn is pivotally connected to the end of arm 17 rigidly mounted on rotatable shaft 18 to which arm 19 is also rigidly connected. Arm 19 is biased by bungee 20 but is limited in its oscillation in the direction of this bias by a line 21. The throttle 22 is connected by a lost-motion connection 23 to the arm 19 to move it against the bias after the throttle is advanced beyond a certain position. The throttle is also connected by line 24 passing over pulley 25, 26 and 27 to a drum 28 mounted on shaft 29 in the tachometer 30 and biased by spring 31 to move the pointer 32 attached thereto toward the maximum R. P. M. reading on the tachometer scale 33.

The other end of lever 15 is pivotally connected to the arm 34 rigidly mounted on rotatable shaft 35 on which also rigidly mounted are rudder pedal plate 36 and opposed arms 37, 38. A similar rudder pedal plate 39 for the left pedal is rotatably mounted at the left end of shaft 35. The rudder pedals 40 and 41 are mounted on pedal arms 42 and 43 both mounted to freely rotate on shaft 35 and having pins 44 and 45 to lock them in any suitably adjusted position to the plates 36 and 39 respectively. The movement of one of the rudder pedals forward is caused to move the other pedal rearward by a pair of lines 46 and 47 running around pulleys between the forward ends of the plates and the rear ends thereof as shown.

Bungees 48 and 49 are provided as shown to maintain the rudder pedals normally in neutral position and to furnish a torque to the displacement of the rudder pedals similar to that normally transmitted thereto by the air pressure against the rudder surface in actual flight.

The circuit through the contact mechanism 8, 9, 10 is completed as shown in Fig. 2 by a transformer 50 which operates a buzzer 51 or other signal when power is supplied and spring end

10 comes in contact with either of the bands 8. Thus, it will be seen that if, as the throttle is advanced to full power position, the right rudder pedal is pushed forward or the stick moved to the right a corresponding amount, or both rudder and stick movement combined to maintain contact 10 on the insulated strip, no signal will be obtained. However, if these controls are not simultaneously operated, or coordinated, contact 10 will slide to either one or the other of the bands 8 and will complete the buzzer or other signal circuit to indicate the absence of proper coordination. By practicing manipulation of these controls, good coordination thereof is quickly acquired by the aid of this signal circuit.

Besides the drum shaft and spring in the tachometer casing, there are two arms 52 and 53 hinged on the shaft 29 and having overlapping ends as shown of magnetic material, spaced respectively from two electro-magnets 54 and 55 when the throttle is fully advanced so that lug 56 on drum 23 strikes against arm 53 and carries both arms along with it, against the force of a light spring 57, because the force of spring 31 produces a greater torque on these arms through the lug 56 than the opposing torque of spring 57. The clearance between the longer arm 52 and the electro-magnet 54, under these conditions, is such that when this electro-magnet is operated and attracts the arm the pointer 32 is moved back approximately 25 R. P. M., but the clearance between the shorter arm 53 and electro-magnet 55 is still not taken up until the latter magnet is operated, which reduces the R. P. M. indicated by an additional 50 R. P. M. more or less. The electro-magnets are mounted on a bracket 58 extending across the inside of the tachometer casing.

A third electro-magnet 59 is mounted as shown in Fig. 1 to actuate a bell crank 60 against the force of the light spring 61 which normally holds the bell crank against the stop 62. In this position the line 63 tied between the lower end of arm 64 and the line 24 does not interfere with the movement of the latter line in response to throttle operation. The arrangement is such, however, that when the electro-magnet 59 is operated while the throttle is in full power position, line 24 is drawn out of the tachometer to the extent that the indicator pointer drops all the way down to zero.

The wiring diagram in Fig. 2 shows how the electro-magnets are controlled to give the desired results in connection with simulated ignition tests to be performed by the student for practice purposes. The switches 65, 66 and 67 are under the control of the instructor. 68 is a regular ignition switch for a dual-ignition power plant. By properly setting the switches 65, 66 and 67 the instructor may cause the tachometer to respond to simulate either normal ignition operation by opening switch 65 and moving switches 66 and 67 into their lowest positions as viewed in Fig. 2 or any one of the following abnormal ignition operating conditions.

By swinging either switch 66 or 67 upwardly to its highest position the corresponding ignition system will appear to be dead, since, when the ignition switch is turned to the corresponding magneto (L or R) by the student, electro-magnet 59 will operate to immediately bring the tachometer reading to zero indicating engine stopping.

With either of the switches 66 and 67 in lowest position, the other being in its middle position and the switch 65 closed, the tachometer reading

will drop about 75 R. P. M. when the ignition switch is moved to the corresponding magneto, indicating some fault in the corresponding ignition system; while a normal tachometer drop of about 25 R. P. M. will be obtained when the ignition switch is moved to the other magneto position, since that point is connected to a second winding on electro-magnet 54, the two coils having a common terminal at one end as shown in the diagram. With the ignition switch on B (both magnetos), no noticeable drop in R. P. M. will ordinarily be noticed when the fault is slight in only one of the ignition systems. Such faults should, however, be corrected before taking off, because they indicate the possibilities of more trouble being in the offing.

With both switches 66 and 67 in their lowest positions and switch 65 closed, trouble will be indicated in each ignition system, yet appreciably no drop in R. P. M. might be observed with both systems operating.

Thus, a series of different conditions in engine operation may be simulated to test the student's ability and give him practice in the determination of whether the condition of his power plant justifies him taking off or if he is to report his trouble so that it may be corrected.

The devices herein disclosed are illustrative of one specific form in which our invention may be built. However, it is understood that they may be modified in shape and arrangement in many ways without departing from the scope of our invention which is defined in the appended claims.

This invention may be made and used by or for the Government of the United States for governmental purposes without the payment to us of any royalties thereon or therefor.

What is claimed is:

1. In a flight training apparatus in combination with a simulated cockpit with the normal controls such as stick, rudder controls, throttle, dual-ignition switch, and tachometer, a connection between the throttle and the tachometer for operating the latter in response to the position of the former, a lever system including a floating lever pivoted at three points one of which is connected to move in response to movement of the rudder controls, another in response to movement of the throttle in the high power range and the third is connected to move one of a pair of relatively slidable contact members in a signal circuit, the other contact member being connected to move in response to movement of the aileron controls, the contact surface of one of the members being normally positioned on an insulated portion between two adjoining contact surfaces of the other member, these connections and leverage being arranged so that, with normal movement of the rudder and/or aileron controls corresponding to the advance of the throttle to the high power range to overcome the effect of high engine torque and maintain a straight course in flight, the contact members will maintain normal out-of-contact relative positions, but if the control coordination is not properly executed the contact surface of said one contact member will move over one of the adjoining contact surfaces of said other contact member to complete the signal circuit and cause a warning signal indicating an improper coordination of the controls.

2. In a flight control coordination trainer, in combination with the usual airplane controls, a floating lever one point of which is connected to

move in response to throttle movement in the high power range, a second point of which is connected to move in response to movement of the rudder controls and a third point of which is connected to one of a pair of relatively slidable members the other of which is connected to move in response to the aileron controls, an insulated spring contact fastened to one of said members and slidable over the surface of the other member, said surface having an insulated strip between two conducting contact portions, the three points on the floating lever being so selected and arranged that the spring contact will remain on the insulated strip while the throttle is advanced from idling to full power as long as the rudder and/or aileron controls are simultaneously moved in a manner to overcome the effect of the corresponding increase in engine torque which would ordinarily result from the increased power applied in a power climb.

3. In a flight control coordination trainer, in combination with the usual airplane controls, a floating lever one point of which is connected to move in response to throttle movement in the high power range, a second point of which is connected to move in response to movement of the rudder controls and a third point of which is connected to one of a pair of relatively slidable members the other of which is connected to move in response to the aileron controls, an insulated spring contact fastened to one of said members and slidable over the surface of the other member, said surface having an insulated strip between two conducting contact portions, the three points on the floating lever being so selected and arranged that the spring contact will remain on the insulated strip while the throttle is advanced from idling to full power as long as the rudder and/or aileron controls are simultaneously moved in a manner to overcome the effect of the corresponding increase in engine torque which would ordinarily result from the increased power applied in a power climb, a signal circuit to be completed by relative movement of the slidable members bringing the conducting portions thereof together.

4. In a flight control coordination trainer, in combination with the usual airplane controls, a floating lever one point of which is connected to move in response to throttle movement in the high power range, a second point of which is connected to move in response to movement of the rudder controls and a third point of which is connected to one of a pair of relatively slidable members the other of which is connected to move in response to the aileron controls, an insulated spring contact fastened to one of said members and slidable over the surface of the other member, said surface having an insulated strip between two conducting contact portions, the three points on the floating lever being so selected and arranged that the spring contact will remain on the insulated strip while the throttle is advanced from idling to full power as long as the rudder and/or aileron controls are simultaneously moved in a manner to overcome the effect of the corresponding increase in engine torque which would ordinarily result from the increased power applied in a power climb, a buzzer circuit to be completed by relative movement of the slidable members bringing the conducting portions thereof together.

5. In airplane pilot training apparatus, in combination with a dual-ignition switch having off, L, R and B positions mounted in a simulated

cockpit, a tachometer with means for operating it in response to throttle movements to indicate the corresponding tachometer readings, means for normally causing the maximum R. P. M. reading at full throttle to drop a normal amount in response to switching the dual-ignition switch from position B (both magnetos) to either L or R (left or right magnetos) and to always drop to zero in response to switching to off, additional means under control of the instructor for selectively causing an abnormal drop in the R. P. M. reading in response to switching to either L or R (or both L and R) while obtaining a normal drop for the R or L switch position respectively and a maximum R. P. M. for the B position, or causing a drop all the way down to zero reading on the tachometer in response to switching to either L or R while getting a normally small drop when switching to the other magneto alone or to the B position.

6. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, means to cause the tachometer to indicate engine operation in response to actuation of the throttle and switch, and signal means responsive to an improper coordination of the rudder and/or aileron controls with an advance of the throttle to its full power range which would normally be necessary to overcome the effect of increased engine torque and to maintain a straight flight course in executing a power climb, particularly at low flying speed.

7. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, signal means responsive to an improper coordination of the rudder and/or aileron controls with an advance of the throttle to its full power range which would normally be necessary to overcome the effect of increased engine torque and to maintain a straight flight course in executing a power climb, particularly at low flying speed.

8. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, means to cause the tachometer to indicate engine operation in response to actuation of the throttle and switch, means under control of the instructor for modifying the tachometer readings selectively to indicate faulty ignition in either or both of the ignition systems or a complete failure of either system, and signal means responsive to an improper coordination of the rudder and/or aileron controls with an advance of the throttle to its full power range which would normally be necessary to overcome the effect of increased engine torque and to maintain a straight flight course in executing a power climb, particularly at low flying speed.

9. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, signal means responsive to an improper coordination of the rudder and/or aileron controls with an advance of the throttle to its full power range which would normally be necessary to overcome the effect of increased engine torque and to maintain a straight flight course in executing a power climb, particularly at low flying speed, said signal means including a buzzer circuit completed by relatively slidable contacts one of which is connected to

move in response to movement of the aileron control and the other in response to movement of a point on a floating lever one end of which is connected to move in response to movement of the rudder control and the other end in response to the throttle in its high-power range.

10. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, means to cause the tachometer to indicate engine operation in response to actuation of the throttle and switch, and signal means responsive to an improper coordination of the rudder and/or aileron controls with an advance of the throttle to its full power range which would normally be necessary to overcome the effect of increased engine torque and to maintain a straight flight course in executing a power climb, particularly at low flying speed, said signal means including a buzzer circuit completed by relatively slidable contacts one of which is connected to move in response to movement of the aileron control and the other in response to movement of a point on a floating lever one end of which is connected to move in response to movement of the rudder control and the other end in response to the throttle in its high-power range.

11. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, means simulating engine connections to cause the tachometer to indicate selected representative engine operation conditions simulating perfect operation, imperfect operation or failure of operation of either one or both of the ignition systems respectively in response to actuation of the throttle and switch.

12. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, means to cause the tachometer to indicate engine operation in response to actuation of the throttle and switch, said means including a drum on the tachometer shaft, a cord passed around said drum and out of the tachometer casing over a suitable system of pulleys to the throttle, a spring biasing the tachometer shaft and drum in a direction to draw the cord inwardly and move the pointer toward the maximum R. P. M. reading in response to movement of the throttle toward full open position, a lever spring-pressed against a stop in one direction and actuated in the opposite direction by an electromagnet, one arm of said lever being connected by a cord to a point on the first mentioned cord so as not to interfere with the normal movement of said first-mentioned cord, but upon actuation of the electromagnet in response to movement of the switch to off (the cut-off position), to pull on the first-mentioned cord and unroll it off the drum sufficiently to turn the tachometer pointer down to its zero reading should it not be there already as a result of the throttle being in its closed position.

13. In a simulated cockpit of an airplane, in combination with the normal controls includ-

ing a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, means to cause the tachometer to indicate engine operation in response to actuation of the throttle and switch, means under control of the instructor for modifying the tachometer readings selectively to indicate faulty ignition in either or both of the ignition systems or a complete failure of either system.

14. In a simulated cockpit of an airplane, in combination with the normal controls including a stick, a rudder control, a throttle, a tachometer and a dual-ignition switch, means to cause the tachometer to indicate engine operation in response to actuation of the throttle and switch, means under control of the instructor for modifying the tachometer readings selectively to indicate faulty ignition in either or both of the ignition systems or a complete failure of either system, said first mentioned means including a drum on the tachometer shaft, a cord passed around said drum and out of the tachometer casing over a suitable system of pulleys to the throttle, a spring biasing the tachometer shaft and drum in a direction to draw the cord inwardly and move the pointer toward the maximum R. P. M. reading in response to movement of the throttle toward full open position, a lever spring-pressed against a stop in one direction and actuated in the opposite direction by an electromagnet, one arm of said lever being connected by a cord to a point on the first mentioned cord so as not to interfere with the normal movement of said first-mentioned cord, but upon actuation of the electromagnet in response to movement of the switch to 0 (the cut-off position), to pull on the first-mentioned cord and unroll it off the drum sufficiently to turn the tachometer pointer down to its zero reading should it not be there already as a result of the throttle being in its closed position, said means under control of the instructor including a switch for the circuit of each ignition system connected to the L and R points on the ignition switch and each circuit switch having upper and lower positions and a mid position and being tied mechanically to operate single switches connected in parallel to complete a branch of a circuit from the B point of the ignition switch to a line connected with the mid points of both circuit switches when the latter are moved to their upper position, a connection from said line to one of a pair of coils of a second electromagnet, the lower points of said circuit switches being connected to the other coil of said second electromagnet and to a single throw switch which is in turn connected to the coil of a third electromagnet, the second and third electromagnet being arranged to cause a reduction in tachometer reading of approximately 25 and 75 R. P. M. respectively from maximum, when actuated by passing a current through their respective coils, the other ends of all the coils being connected to a power source and the arm of the ignition switch being grounded to a common ground with that of the power source.

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