Oct. 3, 1950 C. W. SOULÉ 2,524,238

FLIGHT TRAINER

Filed Nov. 15, 1946 2 Sheets-Sheet 1

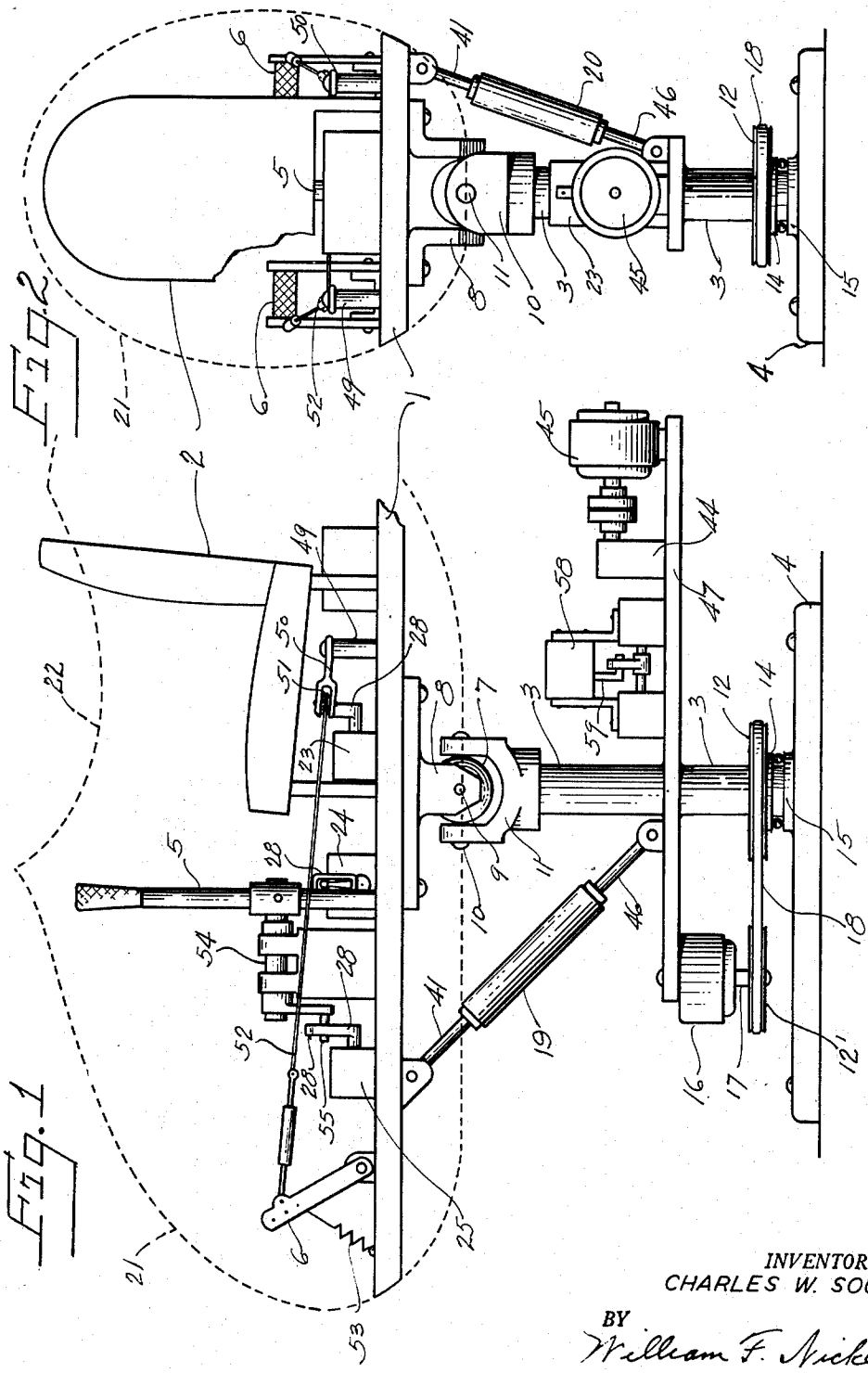


Fig. 2

Fig. 1

INVENTOR.
CHARLES W. SOULÉ

BY
William F. Nickel

ATTORNEY

Oct. 3, 1950 C. W. SOULÉ 2,524,238

FLIGHT TRAINER

Filed Nov. 15, 1946 2 Sheets-Sheet 2

Fig. 3

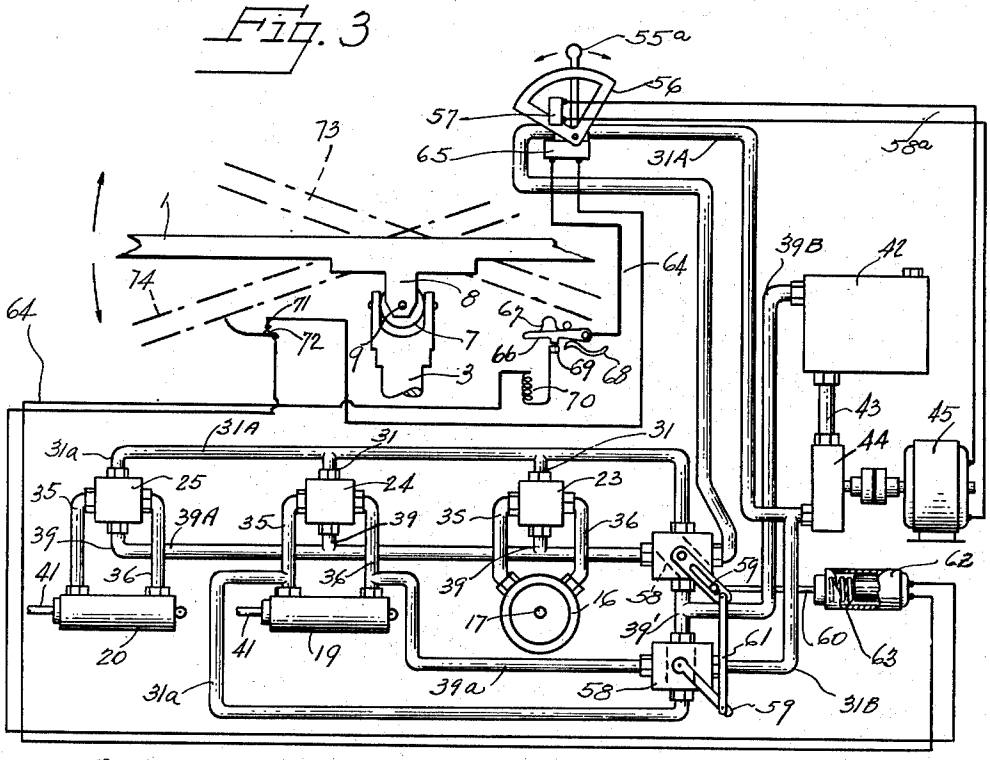


Fig. 5

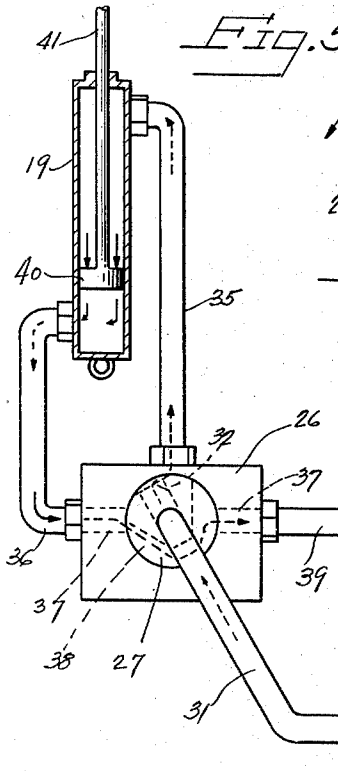
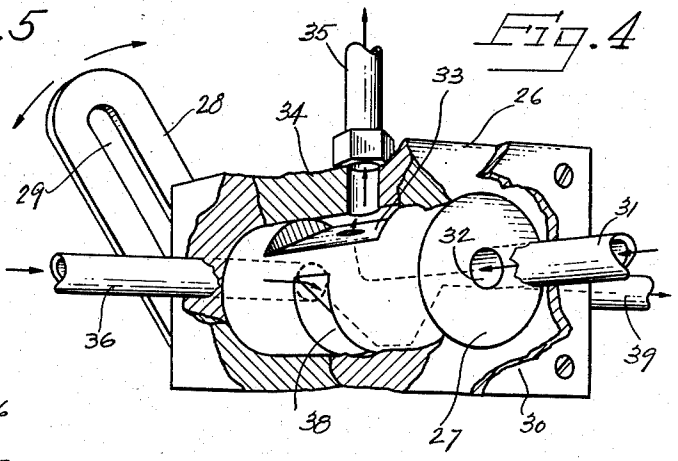


Fig. 4



INVENTOR.
CHARLES W. SOULÉ

BY William F. Nickel

ATTORNEY

Patented Oct. 3, 1950

2,524,238

UNITED STATES PATENT OFFICE

2,524,238

FLIGHT TRAINER

Charles W. Soulé, Reno, Nev., assignor to Jessie Chess Soulé, Washington, D. C.

Application November 15, 1946, Serial No. 709,975

1 Claim. (Cl. 35—12)

1

This invention is an improvement in flight trainers and particularly an apparatus for the schooling and practice of students of aviation who wish to qualify as aeroplane pilots.

An important object of the invention is to provide a simple and easily operated combination of control members arranged adjacent a chair or seat; and so designed that, by proper manipulation, all of the movements of an airplane can be imitated and produced, in the same manner and by the same operations and adjustments as with a real airplane in actual flight.

Another object is to provide additional means, capable of responding automatically, if the apparatus should ever be tilted to lift the forward end of the trainer to such an extent as to reach the usual stall angle, for immediately superseding all the other control members and bringing the apparatus back into a position corresponding to what is necessary for normal flight; and when this condition is reached, said means becomes ineffective and permits the other control members to be again actuated in the usual way.

The invention is shown on the accompanying drawings, which disclose a single embodiment thereof and the novel features are pointed out in the claim appended hereto. But this disclosure is of course explanatory only and numerous changes in details may be made without departing from the essential construction and lay-out of connections which contain the principle of the invention.

On the drawings:

Figure 1 is a side view of the apparatus showing the general arrangement of the various parts of the trainer;

Figure 2 is an end view thereof;

Figure 3 shows in outline the various connections by which the different movements of an aeroplane in flight are imitated;

Figure 4 is a detail view in perspective partly broken away, showing the construction of one of the valves for the medium which actuates the control members of the trainer; and

Figure 5 is an outline of the connections showing how the necessary movements are produced.

In the description of what the drawings set forth, numeral 1 is used to indicate a movable platform on which is mounted a chair or seat 2. The platform is supported upon a pillar or column 3 which rests upon and is rigid with a base 4 secured to the ground or floor or other supporting surface. In upright position on the platform 1 is the control stick 5 in front of the chair or seat 2; this stick being so mounted that it can be moved forward and pulled back or swung from side to side about its lower end as a pivot; and in front of the stick 5 are foot pedals 6, one at each side of the platform 1. A pupil occupying the seat 2 can actuate the stick

2

5 with either hand and the pedals 6 with his feet in the usual way; the stick 5 being so connected to various elements in the apparatus that, when it is moved forward or backward it tilts the platform up and down from front to rear; and when urged sideways to right or left, it rocks or banks the platform in the same direction; and the foot pedals 6 being so disposed and joined to the other actuating parts that when one or the other is depressed the platform 1 remains level but is swung to one side or the other with the same movement that an aeroplane takes when it is turning to one hand or the other in flight.

To permit the platform 1 to move in this way it has a universal joint uniting it to the top of the column 3. This joint comprises a couple of bearing members 8 affixed to the under side of the platform 1; these bearing members being attached to a ball 7 by means of a horizontal pivot pin 9 which passes through the center of the ball 7. On top of the column 3 is a yoke-shaped member, the arms of which provide a bearing which carries a horizontal pivot pin 10 that passes through the ball 7 at right angles to the pin 9. The pin 9 extends crosswise of the platform and the pin 10 lengthwise thereof. Hence the platform 1 can tilt up and down at the ends or oscillate sidewise about the length thereof.

To enable the platform to swing from right to left without tilting or rocking sideways, the lower part of the column 3 bears a grooved pulley 12, and the end below this pulley fits into a thrust or foot bearing 13 on the top of the base 4. Between the foot bearing 13 and the hub 14 of the pulley 12 is a ball bearing indicated at 15, on which the weight of the entire apparatus rests. The column or pillar 3 can thus turn freely in the foot bearing on the base 4.

To produce the various movements above mentioned, a hydraulic motor 16 having a main shaft 17 is connected by a belt 18 to the pulley 12. The shaft 17 carries a corresponding pulley 12' over which the belt 18 also passes; and when the motor 16 rotates the column 3 rotates and the platform 1 turns with it. The motor 16 can be one of any well-known type, with a movable member or rotor therein that oscillates back and forth through a predetermined angle; or it may contain a rotor that revolves through a complete circle or more, and the belt gearing between the shaft 17 and the column 3 may be so designed that the platform 1 will at the same time swing only through a selected arc. The motor 16 is affixed to a support or shelf 47 that is rigid with the column 3 a short distance above the base 4. To tilt the platform 1 by raising and lowering its ends a hydraulic motor, the casing of which is indicated by the numeral 19, is

connected to both this support 47 and the platform 1. Said motor extends from the support 47 upward and forward as shown in Figure 1. A similar motor, the casing of which is shown at 20, is connected to the shelf 47 and to the platform 1 beside the column 3. This motor 20 tilts the platform 1 sidewise about the pivot 19 as an axis.

The entire platform 1 and the apparatus carried thereby and the upper part of the column 3 is enclosed in a housing 21 which resembles the pilot's cockpit or nacelle of an aeroplane; this nacelle having in the top an opening indicated at 22 which permits the pilot to get into seat 2 and to climb out again. The motors 16, 19 and 20 are controlled respectively by valves 23, 24 and 25 on the top of the platform 1, and so placed that they can easily be adjusted by connections from there to the stick 5 and pedals 6. Said valves are all four-way valves and motors 16, 19 and 20 are fluid actuated, the fluid being delivered through hose connections not shown but disposed mostly between the platform 1 and the shelf 47. The general layout of the connections and the source of supply of operating medium is shown in Figure 3, and the structure of one of the controlling valves is illustrated in Figure 4; the means by which the fluid and the valves are actuated to pass the fluid to energize the various motors being indicated on Figure 5. I shall first describe the construction of one of the four-way valves and the manner by which it is attached to the pedals and control stick.

Each of these valves comprises a body 26 having an internal cavity which receives a rotatable cylindrical body or plug 27 having a shaft rigidly connected at one end projecting to the outside of the casing; and there carrying a rigid arm 28 with a longitudinal slot 29 therein. The valve casing 27 may be made of one piece and bored out to receive the body 27 at one end, which is closed by a plate 30. In Figure 4 the body of the valve is shown as broken away to reveal the plug or cylinder 27. The hatchings at different inclinations in this view merely indicate different imaginary surfaces as if several pieces were taken off from this member. At one end of this valve is a conduit 31 which is affixed to the cover 30 and is in line with an axial bore 32 in the plug 27. This bore or duct 32 bends sideways and terminates in a port opening through the bottom of a recess 33 at one side of this plug; and in line with an outlet port 34 leading to a pipe or conduit 35 secured to said valve in line with said outlet. Another conduit 36 is connected to the side of the valve casing 26 in line with a recess in the outside of this valve to permit fluid to pass through the valve from one side to the other. At one side of this recess 38 is a port 37 which is in line with the conduit 36, and at the other end of this recess is a similar port 37 in the valve casing 26 which is in line with a conduit 39, shown as delivering to a reservoir 42. In Figure 5 the pipe 35 is shown as connected to one end of the casing or cylinder of the hydraulic motor 19 and the pipe conduit 36 as connected to said cylinder at the other end. This cylinder contains a piston 40, the rod 41 of which projects out at the upper end and is pinned to the lower face of the platform 1. The reservoir 42 is connected by a pipe 43 with a pump 44 which is driven by an electric motor 45. The pump 44 delivers to the conduit 31. This motor 45 and pump 44 are both shown as mounted on the shelf 47 and the motor 20 will have a similar piston therein, the rod 41 of which is pinned to the lower side of the platform 1 at one side thereof, the same as the rod 41 of the motor 19. The cylinders of the two motors 19 and 20 are shown as having rigid rods 46 at the lower ends pivotally connected to the shelf 47, and in operation the platform 1 is given the desired movement by the upward and downward movements of the pistons and the rods 41.

Obviously when the motor 45 is in operation the hydraulic actuating fluid will be pumped from the reservoir 42 and delivered to the conduit 31 and supplied to the valve, which will be in the position shown in Figures 4 and 5. The fluid will be impelled through the plug 27 and out through the conduit 35 to the top of the cylinder 19 to force the piston 40 downward. At the same time fluid will be discharged from the cylinder 19 to the conduit 36 and by way of the transverse recess 38 in the valve plug 27 through the pipe 39 back into the reservoir 42. Hence, the front end of the platform will be depressed. If the arm 28 is now actuated so as to rotate the valve plug 27 counterclockwise with reference to Figures 4 and 5, the transverse recess 38 in the plug 27 will connect the port 34 to the port 37 leading to the conduit 39 and reservoir 42, and the recess 23 will put the conduit 31 into communication with the pipe 36. The piston in the casing 19 will now be forced upward and fluid from the cylinder of this motor will be discharged from the top into the reservoir 42. The rod 41 will now be forced out and the front of the platform 1 will be raised. The same mode of operation will take place under the control of the valves 24 and 25 to rock the platform sideways or to swing it to one hand or the other without rocking or tilting. For the motor 16, a cylinder and piston similar to the unit 19 could be substituted, and a rack on the outer end of the piston rod could engage a gear on the column 3 to rotate the latter; the belt 18 and pulleys being discarded.

The connections by which the reservoir 42, the valves 23, 24 and 25 and the motors 16, 19 and 20 are joined together, are outlined on Figure 3, which also shows certain electric connections by which the motor 45 and some other parts of the apparatus are supplied and controlled under some conditions by electric current. This view is diagrammatic, however, and the arms 28 for the valves are omitted; the four pipes coupled to each valve are not in the same relative positions as shown on Figures 4 and 5; but, as will be understood, the valves in actual use will operate exactly as already described.

In this view the reservior is shown connected as before by a pipe 43 to the pump 44 driven by the motor 45. From the pump 44 leads a supply conduit 31—A to an assemblage of controlling devices to be described presently above the platform 1 and within reach of the occupant of the seat 2. From that point the conduit 31—A is continued to the three valves 23, 24 and 25 with which it is separately connected by branch pipes 31 to supply fluid to the ducts 32 in the cylinders or plugs 27 and each of these valves. Further, all these valves are connected by branch outlet pipes 39 to a common return pipe 39—A which leads back through a conduit 39—B to the reservoir 42. The casings of the three valves 23, 24 and 25 are each joined by pipes 36 to one point of the casings of the hydraulic motors 16, 19 and 20 and by similar pipes 35 to the other end of these casings so that the pistons in these casings can be moved in the same manner as the piston 40 on Figure 5. The valves have the same in-

ternal ducts and are adapted to give the same mode of operation as shown on Figure 4.

Connected to the one pipe 35 and the casing of the motor 19 adjacent its junction with this motor is another conduit 31a which likewise receives actuating fluid from the pump 44 and returns it by way of pipe 39—B to the reservoir 42; and coupled to the pipe 36 of the motor 19 is another conduit 39a which is also connected to receive actuating fluid from the pump 44, and deliver to pipe 39—B to be returned to reservoir 42. This motor is designed to be especially operated independent of the others under conditions to be presently set forth.

Referring now to Figures 1 and 2, I locate a pair of posts or studs 49 adjacent the seat 2, and to the top of each post is affixed a horizontal yoke 50 in which is pivotally mounted a pulley 51. These pulleys are each side of the seat and a cord chain 52 passes over them and has one end secured to one of the foot pedals and the other end to the remaining pedal. At the middle of the cord between the studs 49 the cord chain 52 is secured to the arm 28 which controls the valve 23 that governs the admission of actuating medium to the motor 16. Hence, by pressing on one pedal or the other the occupant of the seat can move the arm 28 in one direction or in the opposite direction and thus admit fluid to the valve 23 through the conduit 31 and either pipe 35 or 36 to turn the motor 16 so as to swing the platform to right or left. Springs 53 connect the pedals 6 to the floor so as to keep the cord 52 taut. Also the control stick 5 is connected so as to actuate the valves 24 and 25 to operate the motors 19 and 20; for this purpose a shaft 54 is mounted on suitable bearings on top of the platform 1 adjacent the stick 5. The shaft has a crank with a pin 55 to engage with the arm 28 of the valve 25, and the stick is so connected to the shaft 54 that when the stick is moved to right or left the valve 25 will be similarly actuated to admit fluid to one side or the other of the piston in the casing of the motor 20, and thus rock the platform sideways. The stick 5 also has connections with the arm 28 of the remaining valve 24, and when it is pushed forward or pulled back, will actuate the valve thereof to admit the fluid to one end or the other of the motor 19, and the piston thereof will swing the platform up and down about the pivot 9.

The supply conduit 31—A has in the line thereof a different four-way valve 58 through which the motive fluid passes by way of pipe 31—A to the three valves 23, 24 and 25, and returns by way of the conduits 39—A and 39—B to the reservoir 42. A similar valve controls the additional pipes 31a and 39a between the motor 19 and the pump 44. These two valves are joined by pipe 39' that is also coupled to the pipe 39—B leading to reservoir 42; and the pipe 31—B is connected to the lower valve 58 for the pipes 31a and 39a, and extends between said valve and the pipe 31—A where it is coupled to the pump 44. In the position shown, one valve 58 allows communication through ducts indicated by broken lines between the pump 44 by way of conduit 31—A and the three valves 23, 24 and 25; and from these valves to the conduit 39—A, the pipe 39' and conduit 39—B, which leads back to the reservoir 42; while the other valve 58 obstructs communication between the pipes 31—B and 31a and the pipes 39a and 39—B, similar dotted lines thereon indicating ducts in non-communication relation to said pipes. The moving parts of the

valves 58 have outside arms 59 which are operated by a plunger rod 60 and are joined by a link 61 pinned to the outer end of both arms 59. The rod 60 is shown as having pin-and-slot connection with one arm 59. It is connected to an armature or plunger which is operated by a solenoid 62 and a spring 63 normally keeps the parts in the positions which Figure 3 illustrates. This means of actuating the valves 58 as illustrated is purely diagrammatic. Any other suitable way can be employed; as for example, using two solenoids in parallel, each having a plunger connected to one arm 59 in the same manner.

Just above platform 1 near the seat 2 is an arm 55a which can be moved into any adjusted position along a curved rack 56 and controls a pair of switches 57 and 65. The switch 57 opens and closes the circuit of the conductors 58a leading to the electric motor 45, and the switch 65 opens and closes a circuit which leads to the solenoid 62. This arm 55a also controls a valve in the conduit 31—A. A single movement of this valve starts the motor 45 and opens the line of the conduit 31—A from the reservoir 42 to the valves 23, 24 and 25; and at the same time it puts the circuit of the solenoid 62 in condition to be closed when the platform 1 assumes a certain position.

The pipes and conduits can all be set up under the platform 1, with flexible connections to the valves, motors, pump, etc., and stout hose can of course be utilized. With the layout as shown in Figure 3 the student occupying the seat 2 can work the pedals 6 or push the stick 5 forward and pull it back or move it from side to side to cause the fluid from the reservoir 42 to flow through the conduit 31—A past the valve 58 therein to the three valves 23, 24 and 25 into the motors 16, 19 and 20 and out from these motors through the branch pipes 39 to the main pipe 39—A, and through said valve 58 into the short conduit 39' back to the conduit 39—B and the reservoir 42. The extent of the longitudinal tilting of the platform 1, the rocking sideways or swinging movement thereof around the pillar 3 in imitation of steering the plane or changing its direction can be governed by the degree of movement given to the pedals 6 or the stick 5. Such movement always governs the amount of fluid delivered to the motors and expelled therefrom to be returned to the reservoir 42; and by varying the amount, the extent of each movement is regulated.

If, however, the platform is tilted to raise the front end too much, approaching what is known as the angle of stall in the operation of an aeroplane, the aforesaid valve 58 will be so actuated as to cut out the valves 23, 24 and 25 and their connections to the motors 16 and 20, and the other valve 58 will open the auxiliary connections for the motor 19.

The actuation of the valves 58 to bring about the adjustments named is produced by the energization of the solenoid 62; which is connected through conductors 64 to the switch 65. In the line of one of these conductors is a pivoted switch arm 66 having a knob or projection 67 just under the platform 1. This switch is wholly or partly of magnetic material and is held up by a spring 68 out of engagement with a contact 69. In series with the conductors 64 is a magnetic coil 70 adjacent the switch arm 66. When the platform 1 is elevated at the front to the angle of stall, as shown by dot and dash lines 73, the knob is depressed by the platform and

the switch arm 66 forced down to engage with the contact 69, and the circuit to the solenoid 62 is complete.

The solenoid then acts to swing the arms 59 of valves 58 through an arc of about 45 degrees, cutting off the valves 23, 24 and 25 from the reservoir 42 and pump 44; while the lower valve opens the auxiliary pipe connections 31*a* and 39*a* from the motor 19 to the pipes 31—B, and 39' and 39—B, running to the pump 44 and the reservoir 42, respectively. When this takes place the pump supplies fluid through the line 31—B and the conduit 31*a*, these conduits now being in communication through a duct in the valve indicated by the broken line at the right to the end of the casing 19 where the piston rod 41 projects, and forces the piston in such direction as to pull the front end of the platform downward. At this time fluid is discharged from the other end of this motor through the pipe 39*a* to the valve 58, and through the duct therein indicated by the other broken line, to the connection 39' and the conduit 39—B to the reservoir 42. This continues even after the platform releases the knob 67, because the coil 70 remains magnetic to hold the switch arm 66 against the contact 69. The platform thus sinks at the front end till it reaches the position indicated by the dot-and-dash lines 74. It finally engages a movable switch arm 72, which engages a fixed contact 71; these two elements also being in series in the conductors 64. The circuit to the solenoid 62 now opens; the solenoid is de-energized; so is magnetic coil 70; and then the spring 63 at once withdraws the plunger rod 60. The two valves 58 are now returned to their former positions, in which the one establishes communication from the pump 44 to the valves 23, 24 and 25; and from these valves to the reservoir 42; while the other again obstructs the pipes 31*a* and 39*a*. The control devices by which the front and rear ends of the platform can be tilted up and down, rocked sidewise and rotated about the vertical axis of the column 3 as in steering an airplane; are once more rendered effective to operate in their predetermined manner. The auxiliary control connections of the platform 1 thus supersede the regular control members in case the student ever manipulates the control members of the trainer so as to produce what would be a stall of the plane in actual practice, and he cannot work the device further until the stall has been automatically corrected.

The foregoing description thus sets forth clearly the construction and mode of operation of my improved flight trainer; and it is evident that the combination of various members is nicely and conveniently arranged and well calculated to give the pupil all the instruction and practice he requires and the means for automatically correcting a stall condition will always demonstrate most impressively that going into a stall is a serious error, and by the need for handling the apparatus a stall does not occur.

Having described my invention, what I believe to be new is:

Training apparatus comprising a base, a column rotatably supported on the base, a horizontal shelf fixed to the column, a universal joint at the top of the column, a platform on the column connected thereto by said joint, a motor

device connected to the shelf and to the platform adjacent one end of the latter to raise and lower the ends of the platform, a second motor device connected to the shelf and to one side of the platform to tilt the latter sidewise, a third motor device on the shelf, a mechanical connection between the last named motor device and said column to swing the platform about the column as an axis, a motor and pump for a power fluid on the shelf, a rotary valve on the platform having an operating arm movable longitudinally of the platform, a second rotary valve having an operating arm movable transversely of the platform, a third rotary valve having an arm movable from side to side of the platform, a supply conduit between said valves and pump, branch conduits separately connecting said valves in the order named, to the first, second and third motor devices, respectively, and a return conduit connecting said valves to the pump so that when either valve is actuated to admit said fluid to the motor device connected thereto said last named motor device is then energized; the aforesaid first named motor device also having auxiliary supply and return connections coupled to said supply and return conduits, respectively, a casing with a valve connected to said supply and return conduits, a casing and valve coupled to said auxiliary connections, said last named valves having operating arms, a link joining said last named arms, a solenoid connected to operate said last named arms, an electric circuit for said solenoid, a switch in the circuit in position to be closed by the platform when the front end thereof is tilted too high to energize the solenoid and actuate the last named valves to shut the supply and return conduits and open the auxiliary connections to the first named motor device and reverse the latter, a magnet coil in said circuit to hold said switch closed when disengaged by the platform, and a switch adjacent the platform to be opened by the platform to break said circuit when the platform is moved back from said tilted position.

CHARLES W. SOULÉ.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
844,270	Emery	Feb. 12, 1907
1,025,517	Davis	May 7, 1912
1,825,462	Link	Sept. 29, 1931
1,865,828	Buckley	July 5, 1932
1,944,180	Huffman	Jan. 23, 1934
2,063,231	Custer	Dec. 8, 1936
2,099,857	Link	Nov. 23, 1937
2,306,429	Edwards	Dec. 29, 1942
2,316,181	Ocker	Apr. 13, 1943
2,358,016	Link	Sept. 12, 1944
2,362,486	Holbert	Nov. 14, 1944
2,366,603	Dehmel	Jan. 2, 1945
2,372,741	Horsfield	Apr. 3, 1945
2,385,095	McCarthy	Sept. 18, 1945

FOREIGN PATENTS

Number	Country	Date
127,820	Great Britain	1919
396,538	Great Britain	1933
553,139	Great Britain	1943