PATENT.

No. 392163

Carl Joseph Crane
and
William Charles Ocker.

Date of Patent 7 November 1930

Date of ~~Grant~~ Sealing
(See Section 27) 3 AUGUST 1933

NOTE.—The continuance of this Patent is conditional on the payment (by way of Patents Form No. 14) of the prescribed fees, which, under the Rules at present in force, are :—

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Before the expiration of the 4th year from the date of the patent (*and not from the date of grant*) and in respect of the 5th year		5	0	0
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One moiety only of these fees is payable if, and so long as, this Patent is indorsed "Licences of Right."

As the payment of these renewal fees is regulated by Act of Parliament, a fee cannot be received a *single day* after it is due; but, if the payment has been omitted, application may be made to the Comptroller, on Patents Form No. 15, for an enlargement of time to make such payment, and for this enlargement the fees payable are £2 for one month, £4 for two months, or £6 for three months, but no enlargement can be allowed beyond three months.

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(R9237) Wt 10334A/2082 2,000 9/31 H & Sp Gp 112

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No. 392163

GEORGE V

BY THE GRACE OF GOD

Of Great Britain, Ireland and the British Dominions beyond the Seas King, Defender of the Faith, Emperor of India: To all to whom these presents shall come greeting:

WHEREAS Carl Joseph Crane, and William Charles Ocker, both of Brooks Field, Texas, United States of America, both citizens of the United States of America

(hereinafter called the said applicants) have declared that they have made application abroad for protection of their invention of Improvements in aerial flight integrators

and that the said invention was not in use within the United Kingdom of Great Britain and Northern Ireland, and the Isle of Man, by any other person before the date hereunder written of these presents to the best of their knowledge and belief:

AND WHEREAS the said applicants have humbly prayed that a patent might be granted unto them in priority to other applicants for the sole use and advantage of their said invention:

AND WHEREAS the said applicants have by and in their complete specification particularly described the nature of their invention:

AND WHEREAS We, being willing to encourage all inventions which may be for the public good, are graciously pleased to condescend to their request:

KNOW YE, THEREFORE, that We, of our especial grace, certain knowledge, and mere motion do by these presents, for Us, our heirs and successors, give and grant unto the said applicants as joint tenants our especial license, full power, sole privilege, and authority, that the said applicants, and the survivors and survivor of them, and the executors or administrators of such survivor, their or his assigns (all of which persons or person are hereinafter referred to as the said patentees)

by themselves, their agents, or licensees, and no others, may at all times hereafter during the term of years herein mentioned, make, use, exercise, and vend the said invention within our United Kingdom of Great Britain and Northern Ireland, and the Isle of Man, in such manner as to them may seem meet, and that the said patentees shall have and enjoy the whole profit and advantage from time to time accruing by reason of the said invention during the term of sixteen years from the date hereunder written of these presents: AND to the end that the said patentees may have and enjoy the sole use and exercise and the full benefit of the said invention, We do by these presents for Us, our heirs and successors, strictly command all our subjects whatsoever within our United Kingdom of Great Britain and Northern Ireland, and the Isle of Man, that they do not at any time during the continuance of the said term of sixteen years either directly or indirectly make use of or put in practice the said invention, or any part of the same, nor in anywise imitate the same, nor make or cause to be made any addition thereto or subtraction therefrom, whereby to pretend themselves the inventors thereof, without the consent, license or agreement of the said patentees in writing under their hands and seals, on pain of incurring such penalties as may be justly inflicted on such offenders for their contempt of this our Royal command, and of being answerable to the patentees according to law for their damages thereby occasioned:

PROVIDED ALWAYS that these letters patent shall be revocable on any of the grounds from time to time by law prescribed as grounds for revoking letters patent granted by Us, and the same may be revoked and made void accordingly: PROVIDED ALSO, that if the said patentees shall not pay all fees by law required to be paid in respect of the grant of these letters patent, or in respect of any matter relating thereto at the time or times, and in manner for the time being by law provided; and also if the said patentees shall not supply or cause to be supplied, for our service all such articles of the said invention as may be required by the officers or commissioners administering any department of our service in such manner, at such times, and at and upon such reasonable prices and terms as shall be settled in manner for the time being by law provided, then, and in any of the said cases, these our letters patent, and all privileges and advantages whatever hereby granted shall determine and become void notwithstanding anything herein-before contained: PROVIDED ALSO that nothing herein contained shall prevent the granting of licences in such manner and for such considerations as they may by law be granted: AND lastly, We do by these presents for Us, our heirs and successors, grant unto the said patentees that these our letters patent shall be construed in the most beneficial sense for the advantage of the said patentees.

IN WITNESS whereof We have caused these our letters to be made patent and to be sealed as of the **seventh** day of **November** one thousand nine hundred and **thirty.**

H

M. F. LINDLEY.

~~W. S. JARRATT,~~

Comptroller-General of Patents, Designs, and Trade Marks.

PATENT.

PATENT SPECIFICATION

Convention Date (United States): Nov. 7, 1930. 392,163

Application Date (in United Kingdom): Sept. 10, 1931. No. 25,442/31.

Complete Accepted: May 10, 1933.

COMPLETE SPECIFICATION.

Improvements in Aerial Flight Integrators.

We, CARL JOSEPH CRANE, and WILLIAM CHARLES OCKER, both of Brooks Field, Texas, United States of America, both citizens of the United States of America, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to aerial flight integrators. It is an object of the invention to provide an improved instrument to facilitate aerial flight so as to give a pilot a true stimulus to bank, turn, climb and glide during the blind flight for the elimination of vertigo and erroneous illusions.

Further objects of this invention are to provide an improved gyroscopically and pendulum controlled wing index; an improved statoscopically controlled climb and glide indicator; an improved gyroscopically controlled pressure rheostat device in co-related association with an improved gyroscopically controlled aircraft turn indicating screen positioned in the pilot's field of view.

It has been proposed to provide a repeater for gyroscopic compasses having means for mechanically enlarging the movements of the card of the main compass, characterised by the scale being provided on an endless band passing over drums and driven in accordance with the movements of the card of the main compass.

The present invention consists in an aircraft flight instrument comprising in combination a movable screen having indicating marks thereon and an index associated therewith for determining movement of the screen, means mounting said screen for rectilinear movement within the vision of an observer, a reversible motor for driving said screen, and a gyroscopic turn indicator for operating said motor and reciprocating the screen within the vision of the observer according to directional flight of the aircraft upon which the instrument is installed.

The present invention also consists in an aircraft instrument for facilitating blind flight comprising a movable screen having an observation surface depicted in substantially an indication of the normal earth and sky view of a pilot during flight, and controlling means for moving the screen from left to right and vice versa in integrated proportion and direction with the turn of the aircraft to which the instrument is attached.

Referring to the accompanying drawings:—

Figure 1 is a front elevation of the improved aerial flight instrument.

Figure 2 is a plan view, partly in section, showing the arrangement of details of the improved flight instrument.

Figure 3 is a fragmentary front elevation of the improved flight instrument showing the turn screen and inclinometer as well as the climb and glide indicator in the position which they would assume during a banked climbing turn of the aircraft to the right.

Figure 4 is a vertical sectional view taken through the improved flight instrument substantially on the line 4—4 of Figure 2.

Figure 5 is an enlarged fragmentary sectional view showing details of the improved gyroscopically controlled rheostat device.

Figure 6 is an enlarged sectional view taken substantially on the line 6—6 of Figure 4.

Figure 7 is a fragmentary sectional view taken substantially on the line 7—7 of Figure 5.

Figure 8 is an enlarged sectional view showing a detail of the improved pressure rheostat.

Figures 9 and 10 are diagrammatic views showing different forms of wiring diagrams for the power unit or motor which drives the belt-screen of the flight instrument.

In the drawings, the letter A may generally designate the improved unitary flight instrument. It includes a casing B. It supports a turn indicator C which includes a movable screen 20 operated by means of a motor D, the current through which is controlled by means of a gyroscope E.

[*Price* 1/-]

In the same field of view as the turn indicating belt 20, there is provided an inclinometer F, and a climb and glide indicator G. If desired an altimeter H and an air speed designating instrument K may be associated with the instrument A.

The casing B includes a base 15, an upright rigidly fixed front wall 16 having a transparent panel 17, a detachable top 18, and a rear wall 19.

The screen element 20 is in the form of an endless belt, but may take the form of a reciprocating sliding screen, a cylinder, disc, or the like. The belt 20 travels horizontally from left to right and vice versa, and at its ends it is trained about driven and idler rollers 21 and 22 mounted in suitable bearings 23 in the top and bottom walls of the casing B. The belt 20 is mounted so that substantially one-half of the external surface area of the belt element is visible through the panel 17 and in the field of view of the pilot. The external surface of the belt depicts a view similar to the panoramic flight view of a pilot. It consists of a horizon 24 fixed on the belt, a terrestrial view 25 therebelow, and a sky area 26 thereabove, colored blue with spaced clouds designated at *a*, *b*, *c*, *d*, etc. These clouds are roughly in the form of numerals 1 to 8 inclusive, located at 45° intervals apart along the length of the belt, which facilitates the interpretative effort upon the part of the pilot in determining the angular degree of turn of the aircraft.

The motor D is mounted on the base 15 to the rear of the belt, has a horizontal drive shaft 32 provided with a worm meshing with a worm wheel 34 rotatably mounted on a vertically disposed shaft 35; the latter bearing in suitable brackets 36 supported from the base 15. The roller 21 and the shaft 35 are suitably provided with intermeshing gears 37, by means of which the shaft 21 is driven from the motor D. Obviously, rotation of the roller 21 will cause the belt 20 to move horizontally across the field of view of the pilot.

The motor D is reversible and of the shunt wound type. It is readily apparent that the right to left or vice versa movement of the belt, due to the artificial horizon view depicted thereon will give the pilot a visual stimulus experienced by normal flight stimulus experienced by pilots during clear weather flight. The motor D is of the direct current type having two or more field coil windings, and has a constant speed characteristic under changing loads; the variation in speed of the motor being governed entirely by the gyroscopic device E.

The gyroscope E consists of a casing 40, mounted upon the base 15 by means of brackets 41, and may be enclosed within an independent housing 42. It has a pivotally mounted frame 43 supported upon spindles or bearing pivots 44 and 45, one or more of which may be adjustable as desired. The axis of the frame 43 is horizontal and in alignment with the flight path of the aircraft. The frame 43 is provided with a gyroscopic rotor wheel 47^a, having its spin axis in a horizontal plane normal to the flight path, as designated at 48^a in the drawings. The external periphery of the wheel 47^a has depressions to receive the impulse of air from a fluid jet 50^a.

An electrically driven pump 51^a drives the rotor wheel 47^a, means 52^a withdraws the impulse fluid through conduit 53 from the bottom of the casing 40 and transmits it through a conduit 55 into the nozzle 50^a. It is quite apparent that the gyroscopic frame 43 will precess when an attempt is made to change the direction of flight of the aircraft from a straight path to a lateral turn. The pivoted frame 43 is damped and returned to normal position by means of an adjustable spring device 58. A suitable vent 59 is provided in the casing.

The precessing frame 43 has a shaft 45^a provided with a frame 47. The frame 47 has oppositely extending horizontal arms 48 and 49, and a vertically upstanding leaf spring arm 50 provided with a top contact 51. The frame 47 is of conductive material so that current may pass through the arms 48 and 49 and the spring arm 50 into the head contact 51. An insulation disc 52 is affixed upon an upright wall of the gyroscopic housing 40 immediately facing the frame 47. Contacts 74 and 75 are carried by the disc 52. They have exterior terminal attaching nuts 76^a. Pressure rheostats 70 and 71 are provided upon the disc 52, having exterior terminal wire attaching nut and bolt devices 72 carried by the housing 50. The pressure rheostats 70 and 71 each include a relatively small cylindrical insulation casing 76. In the lower part thereof is disposed a shallow piston 78, to which is swivelly mounted an adjusting screw 79 having a threaded connection at 80 in the central part of the bottom wall 77. Externally of the cylinder 76 the screw 79 has a thumb head 81 and terminal nuts 82 for attachment of a wire extending from one of the terminals 72. Within the cylinder casing 76 there is disposed resistance material in the nature of carbon granules 83, which variably

resists the passage of an electric current according to pressure exerted thereon. In the upper part of the casing 76 is disposed a movable piston 83ª with a hub extending through the top wall of the casing. This hub has a screw threaded opening 84 to receive a calibrating screw 85. A nut 86 may lock against the piston 83 for adjusting the extension of the screw 85. A contact head 87 is provided on the screw for contact with one of the arms 48 or 49.

The contact 51 on the end of the spring arm 50 may engage either of the contacts 74 or 75. It is normally out of contact with them, due to the action of the damping spring 58 which returns the precessing frame to a neutral position. The pressure rheostats 70 and 71 are so located upon the insulation disc 52 that the heads 87 are cooperative with the outer contact ends of the arms 48 and 49 respectively. The damping spring 58 normally positions the frame 47 so that the arms 48 and 49 are out of engagement with the contacts 87 of the pressure rheostat.

In the improved gyroscope E, the gyroscope frame is not allowed to move appreciably as a result of a turn. The precessional force is dissipated in a slight movement of the pressure rheostat piston 83ª as a result of contact of the arms 48 or 49 with the contact 87 of the piston 83ª. The resistance of the rheostats are adjusted by the screws 79 to place the required initial compression in the carbon pile, and calibration of the normal space between the contact ends of the arms 48 or 49 and the cap contact 87 is taken care of through adjustment of the screw 85.

Referring to the wiring diagrams, Figure 9 shows an arcuate current control wherein the motor is provided with field windings 90 and 91 connected with the armature 92 of the motor from opposite ends of the windings. The other ends of the windings 90 and 91 have suitable connection with relays 93 and 94 respectively. The windings of the relays are suitably connected to a storage battery or other electric current source 85ª. An armature 95 for the relays is pivoted at 96 and grounded at 97 in the same ground as the motor circuit. The relay windings at their opposite ends from their common connection in the circuit are respectively connected with the contacts 74 and 75. The motor circuit 98 which may have a manually controlled rheostat 99 is provided with a suitable closure switch 100.

In Figure 10 is shown a field current control for the motor wherein the field windings 90ª and 91ª are connected at opposite relative ends with the armature 92ª of the motor, and at their other ends said field coils may be connected with the resistance pressure rheostats 70 and 71 as shown. The armature 92ª is suitably connected to the contacts 74 and 75. The circuit may generally be designated at 98ª and it includes a manually controlled rheostat 99ª and a closure switch 100ª. The circuit has a battery 85ª therein, one terminal of which is connected to the conductor frame 47 of the gyroscope and the other terminal being connected in the circuit as shown.

The inclinometer F represents the pilot view of a low wing monoplane in flight, and includes the horizontal wing index 101 centrally connected to a hub gear 102. The latter is pivoted at 103 between brackets 104. The index 101 when horizontal lies below the normal horizon 24 of the turn screen, and will give a stimulus similar to a normal stimulus in the field of view of a pilot. The index 101 is gyroscopically and pendulum controlled, so that it will under all conditions give the pilot an accurate indication of the aircraft's position in flight. Its gyroscope L includes a casing 105 with a precessing frame 106 mounted upon suitable pivots 107 which dispose the pivot precessing axis of the frame 106 in the line of flight of the aircraft. A rotor wheel 108 is supported on an axis 109 normal to the path of flight of the aircraft, and is peripherally provided with teeth sloped so that the fluid jet will rotate the wheel with the top portion traveling rearwardly in the line of flight. A pump 110 extracts the fluid from the bottom of the casing 105 through a conduit 111 and discharges the rotor wheel impelling fluid through a conduit 112 and thence through a nozzle 113 into the rotor casing. Keyed with the precessing frame 106 is a gear 117 which partially extends through a suitable slot in the top of the casing 105 and intermeshes with the lowermost of a pair of gears 118 The latter are rotatably supported on pivots 119 carried by the standards 104, and the uppermost meshes with the teeth of the gear-hub 102 of the index 101. When making a turn, with the wings of the aircraft properly banked, the gyroscope L will function so that precessing of the frame 106 through the gears above described will cause the wing type of index 101 to cant in the same direction and degree of bank as the aircraft wing. The indicator 101 is also gravity actuated. It has a pendulum 120 rigidly connected with the frame 106 of the gyroscope and has a lower weighted end 121. The pendulum stem is screw threaded and has a nut 122

for increasing or decreasing the gravity swing action of the pendulum. The pendulum 120 is damped by conventional means 123. During a side slip with the wings of the aircraft canted to the horizontal, gravity will act upon the pendulum so that the weight will swing the frame 106, actuating the indicator 101 through the train of gears and giving the pilot of the aircraft a true indication of the angularity of the wings of the aircraft.

The climb and glide instrument G comprises an indicator 130, movably supported in suitable brackets 131 upon one of the uprights 104, so as to move up and down, transverse to the movement of the screen 20. It is in the form of the fore portion of an airplane normally visible to a pilot during flight. It is mounted so as to be elevated or lowered with respect to the horizon line 24 upon the screen, and gives a stimulus quite similar to the normal stimulus received by a pilot during climb or glide of the aircraft. The indicator 130 is operated by a pressure sensitive device M, preferably a statoscope which includes a pressure sensitive diaphragm element 135 disposed within a substantially thermally insulated casing 136. The element 135 has one wall 137 mounted upon an inner wall of the casing 136, so that the opposite diaphragm wall 138 of the element 135 is movable. During rise and fall of the aircraft atmospheric pressure is permitted to enter the compartment 140 in the statoscope casing 136 through the opening 141, and a slow leak of this pressure is permitted to communicate with the interior of the pressure sensitive element through a minute vent duct 142. The movable wall 138 of the pressure sensitive element 135 has a central connection with one end of a rigid rod 144 which is slidably supported upon a track 145. The rod 144 has upwardly facing gear teeth 147 which mesh with the teeth of a gear wheel 150. The wheel 150 is non-rotatable upon a frame 152, one end of which has a pivoted link 154 connected at its opposite end with the lower end of the stem of the indicator 130. A weight 156 on the frame 152 normally holds the gear wheel 150 upon the teeth of the rack 144, so that the position of mesh of the wheel 150 upon the teeth of the rack 144 may be adjusted merely by lifting the frame 152. This enables the indicator 130 to be calibrated with respect to the horizon on the screen 20, as can readily be understood, and to compensate for pressure conditions actuating the element 135.

Upon rise of an aircraft during a climb the atmospheric pressure becomes rarefied, which condition will be rapidly communicated to the chamber 140 and more slowly communicated to the interior of the pressure sensitive element 135, due to the minuteness of the duct 142. Therefore the diaphragm wall 138 will move away from the other wall 137 due to greater pressure within the pressure element which cannot balance as quick as the pressure within the chamber 140, and as a result the rack 144 will push the frame 152 therewith, due to the fact that the wheel 150 is keyed to the frame. This causes the indicator 130 to rise above the horizon 24, giving a stimulus similar to the normal stimulus of an aircraft during an actual climb. On the other hand, during a glide the pressure sensitive element will collapse to cause the indicator 130 to lower with respect to the horizon 24, for giving a stimulus upon the instrument similar to the normal flight stimulus during a glide.

It is apparent that the contacts of the gyroscopically controlled circuit maker and breaker arrangement in cooperation with the pressure rheostats will control the amount of current which is permitted to actuate the motor. The gyroscope frame 43 tends to precess in one direction or another according to a right or left hand turn of the aircraft, and it is quite apparent that through the circuit maker and breaker above described the directional rotation of the motor is controlled. The intensity of turn of the aircraft proportionately intensifies the action of the precessing frame of the gyroscope E, and the precessional force of the gyroscope proportionately actuates the pressure rheostats 70 and 71, so that the speed of the motor is directly proportionate to the intensity of turn of the aircraft. It follows that the speed of the endless screen is directly controlled by the speed of the motor. By calibrating and balancing the electric circuit and sensitivity of the gyroscope, the screen movement will correspond accurately to turn intensity of the aircraft upon which the instrument is used.

It can readily be understood that the angular degree of turn of the aircraft may readily be determined by reference to the numerically shaped cloud indicia *a*, *b*, *c*, and *d* upon the screen; the spacing being in angular designations of 45°.

It is now apparent that, with the index 101 gyro-pendulum control, and the index 130 mounted in front of the endless screen of the flight integrator in visual relation with respect to the horizon depicted thereon, a true stimulus of bank

and turn, both as to correctness of angularity and intensity thereof is conveyed to the pilot, which will prevent the occurrence of vertigo and erroneous illusions and interpretations. All of this tends to eliminate fatigue which accompanies ordinary blind flight.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. An aircraft flight instrument comprising in combination a movable screen having indicating marks thereon and an index associated therewith for determining movement of the screen, means mounting said screen for rectilinear movement within the vision of an observer, a reversible motor for driving said screen, and a gyroscope turn indicator for operating said motor and reciprocating the screen within the vision of the observer according to directional flight of the aircraft upon which the instrument is installed.

2. An aircraft instrument for facilitating blind flight comprising a movable screen having an observation surface depicted in substantially an indication of the normal earth and sky view of a pilot during flight, and controlling means for moving the screen from left to right and vice versa in integrated proportion and direction with the turn of the aircraft to which the instrument is attached.

3. An instrument as claimed in claim 1 or 2, comprising means including a tiltable indicator for indicating the banking of the aircraft to which the instrument is attached, said indicator being placed in the pilot's co-related field of view with the screen.

4. An instrument as claimed in claim 3, comprising means for indicating the angularity of the aircraft during climb and glide including an indicator element movable in a path normal to the path of movement of the screen and in the co-related field of view of the pilot with the screen and tiltable indicator.

5. An aircraft flight instrument comprising in combination a supporting frame, a turn indicating surface upon the frame movable from left to right and vice versa and having suitable indicia delineated thereon for facile indication to an observer of the direction of movement of the surface with respect to the frame, a gyroscopic turn indicator for moving said surface to indicate to an observer the true turn of the aircraft, an inclinometer having a bank indicator upon the frame in the same line of sight to an observer as said turn indicating surface, and climb and glide apparatus having an indicator with an up and down movement in the same line of sight to an observer as said turn indicating surface and bank indicator.

6. An instrument as claimed in claim 3, 4 or 5, wherein the tiltable indicator or inclinometer simulates the wing structure of an aeroplane.

7. An instrument as claimed in claim 4 or 5, wherein the means for indicating the angularity of the aircraft during climb and glide simulates part of the fore structure of the aircraft.

8. An aerial flight instrument as claimed in claim 1 or 2 comprising in combination a supporting frame structure, an inclinometer simulating the wing structure of an aeroplane pivoted between its ends for right and left tipping, means for actuating the inclinometer to the right or left according to the corresponding inclination of the aircraft to which the instrument is attached, and a climb and glide indicator having an indicating member simulating part of an aircraft in co-relation to the wing structure of the inclinometer and movable in an up and down direction.

9. An instrument as claimed in any of claims 3—8, wherein the tiltable indicator or inclinometer is gyroscopically and pendulum controlled.

10. An instrument as claimed in any of claims 4—8, wherein the climb and glide indicator element is statoscopically controlled.

11. An instrument as claimed in any of claims 1—7, wherein the controlling means for moving the screen comprise a reversible electric motor associated with a gyroscopically controlled pressure rheostat device.

12. An aircraft flight instrument as claimed in any of the preceding claims, comprising electrically controlled means for operating the indicator including a circuit, a gyroscope including a precessing frame, and means for varying the intensity of the electrical circuit including a pressure rheostat and means upon the precessing frame of the gyroscope acting against the pressure rheostat so that precesssional force thereupon will be expended in operation of said rheostat.

13. An instrument as claimed in claim 12, wherein the gyroscopic device comprises in combination a gyroscope including a precessing frame, a pressure rheostat including a resistance pile of electrically conductive granules and a resistance controlling plunger operating thereupon, and means mounting the pres-

sure rheostat so that the precessional force incident to precessing of said frame will be dissipated in a slight movement of said plunger for current control purposes.

14. An aircraft instrument for facilitating blind flight constructed and operated substantially as described with reference to the accompanying drawings.

Dated this 10th day of September, 1931.

MARKS & CLERK.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1933.

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

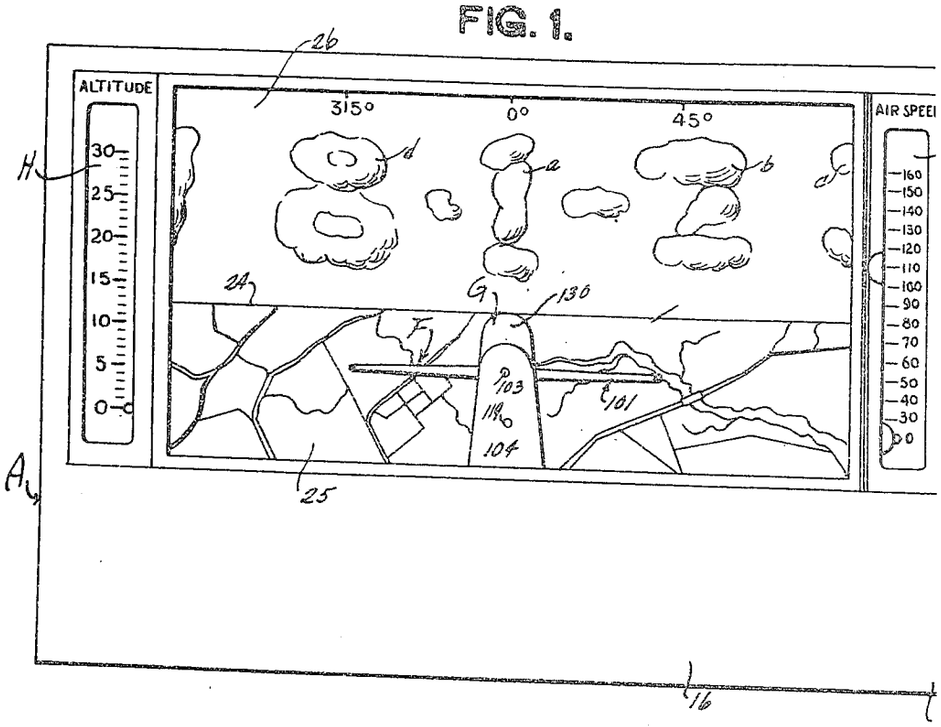


FIG. 2.

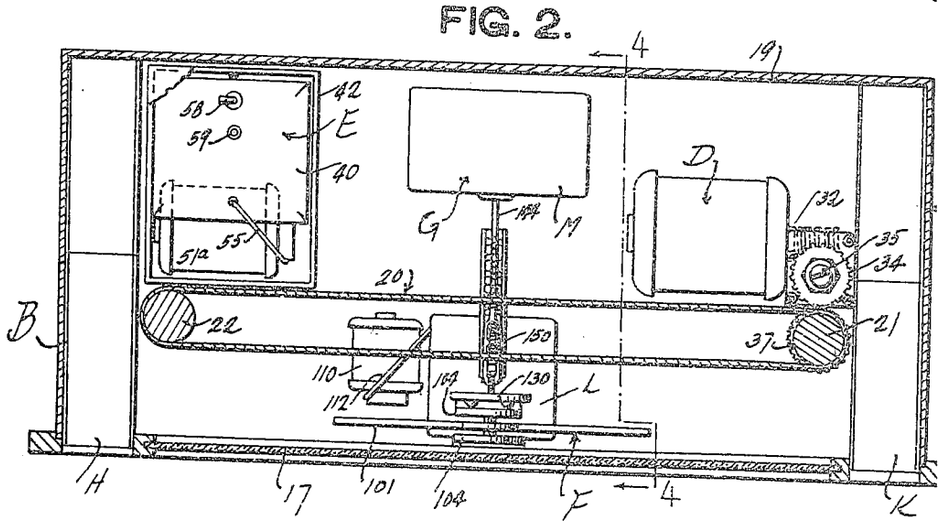


FIG. 3.

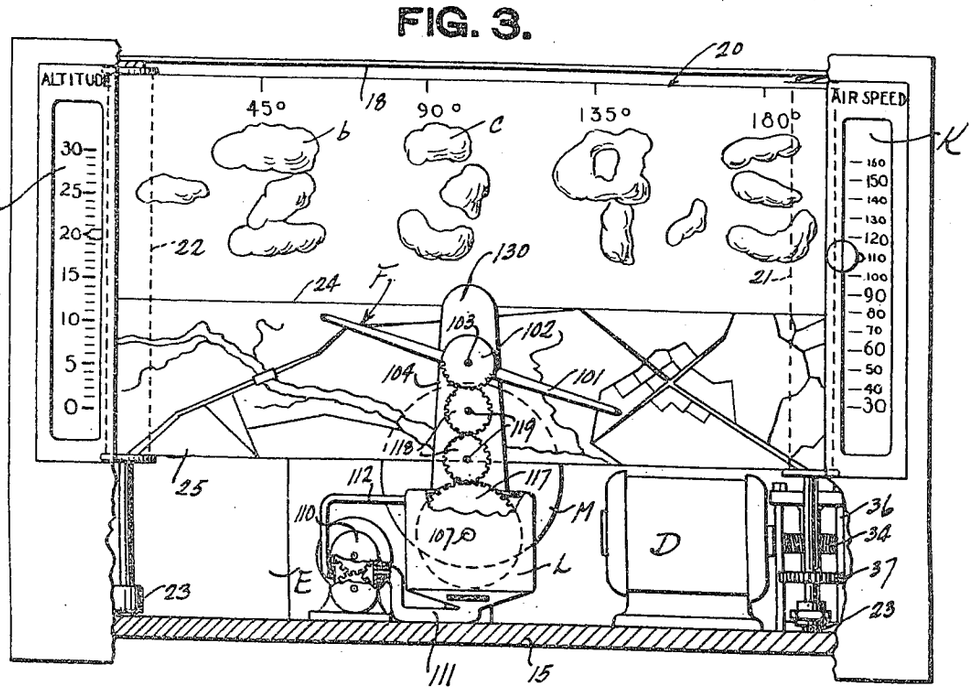


FIG. 9.

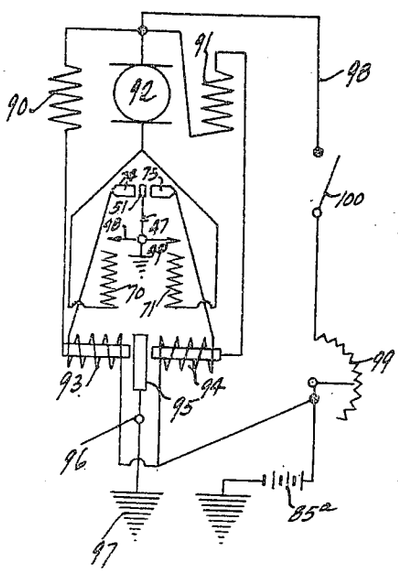
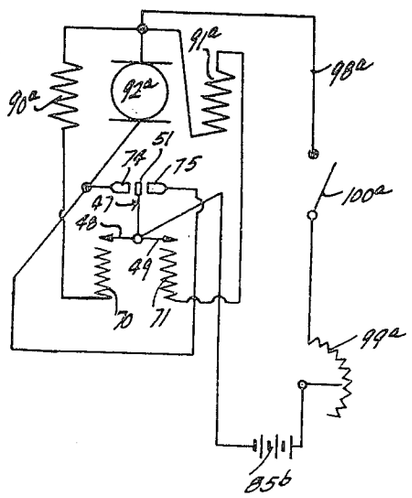


FIG. 10.



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[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 4.

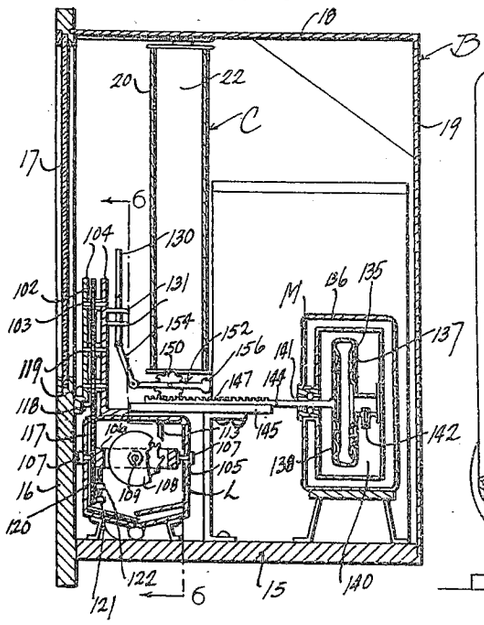


FIG. 5.

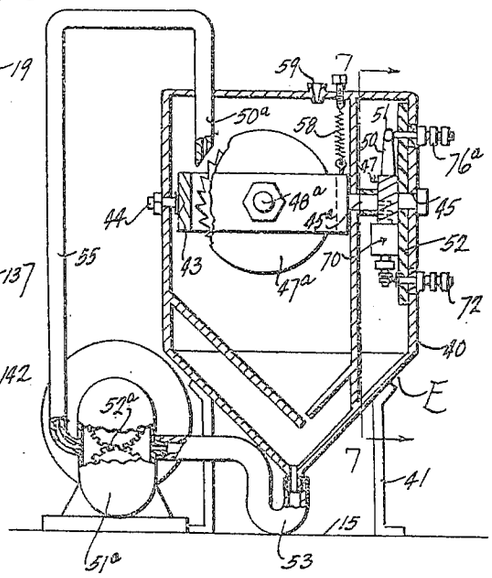


FIG. 6.

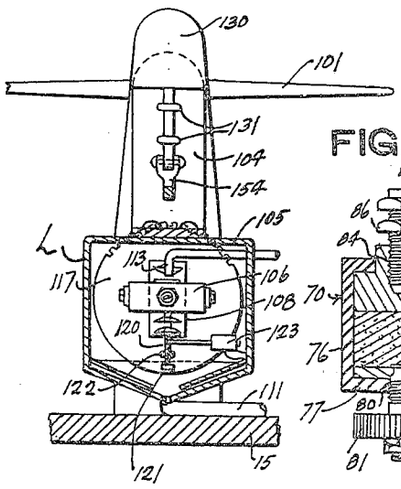


FIG. 8.

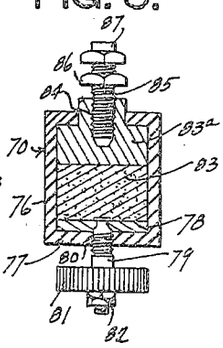
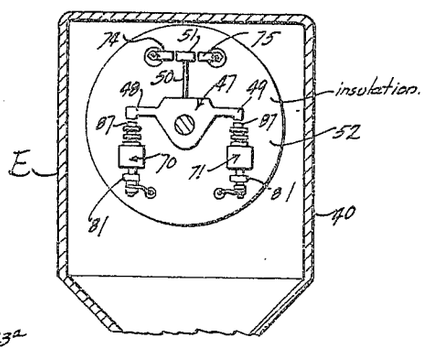


FIG. 7.



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LETTERS PATENT.

COUNTRY GREAT BRITAIN

NUMBER 392163 DATE November 7,1930
Date of Sealing August 3,1933.

PATENTEE Carl Joseph CRANE and William Charles OCKER

INVENTION Improvements in aerial flight integrators.

TAXES DUE November 7,1934 and annually.

WORKING August 3,1936 and annually.

DURATION 16 years from November 7,1930.

MARKING:— All articles made and sold under this Patent should bear the number of the Patent in a prominent position thereon as-Patent No.392163.