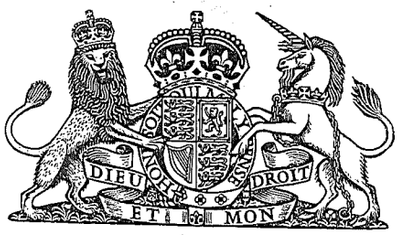
Patent
No. 715269



Elizabeth the Second by the Grace of God of the United Kingdom of Great Britain and Northern Ireland and of Her other Realms and Territories Queen, Head of the Commonwealth, Defender of the Faith: To all to whom these presents shall come greeting:

WHEREAS Carl Joseph Crane, a Citizen of the United States of America, residing at Sacramento, County of Sacramento, State of California, United States of America.

(hereinafter referred to as the said applicant) hath prayed that a patent may be granted unto him for the sole use and advantage of an invention for Indicating device for facilitating aircraft control.

AND WHEREAS the said applicant (hereinafter together with his executors, administrators, and assigns, or any of them referred to as the patentee) hath declared that there is no lawful ground of objection to the grant of a patent unto him:

AND WHEREAS the complete specification has particularly described the invention:

AND WHEREAS We, being willing to encourage all inventions which may be for the public good, are graciously pleased to condescend to his 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 patentee our especial licence, full power, sole privilege, and authority, that the said patentee by himself, his agents, or licensees, and no others, may subject to the conditions and provisions prescribed by any statute or order for the time being in force 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, and that the said patentee 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 patentee 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 either directly or indirectly make use of or put in practice the said invention, nor in anywise imitate the same, without the consent, licence or agreement of the said patentee in writing under his hand and seal, 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 patentee according to law for his 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 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 patentee that these our letters patent shall be construed in the most beneficial sense for the advantage of the said patentee.

IN WITNESS whereof We have caused these our letters to be made patent and to be sealed as of the sixteenth day of January one thousand nine hundred and fifty-one

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

Date of Foreign Application
10 July 1950

PATENT SPECIFICATION

715,269

Date of Application and filing Complete Specification: Jan. 16, 1951. No. 1172/51.

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Complete Specification Published: Sept. 8, 1954.

[illegible] of acceptance:—**Classes 4,** K, V; **97(1),** J11B3; **and 106(4),** I1A, I1B(1:2).

COMPLETE SPECIFICATION

Indicating Devices for Facilitating Aircraft Control

I, CARL JOSEPH CRANE, a Citizen of the United States of America residing at Sacramento, County of Sacramento, State of California, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to indicating devices for facilitating aircraft control, in clear weather or under blind flight conditions.

The primary object of the invention is to provide a device of the above kind having indices which can be viewed by a pilot in relative positions, such that during flight of an aircraft the attitude and direction of flight and changing attitude and direction of flight and its position and change of position relatively to radio glide and course paths are presented at a common locus.

It is well known that aircraft are manoeuvered under conditions of blind flight by the aid of airborne instruments having an artificial horizon index, an azimuth index and a speed indicating device.

So far as is known no device has been made available by which the pilot of an aircraft can roll or pitch or turn the aircraft with visual reference to indices responsive to a radio beam and which provides a similar visual reference to that provided by indices of an artificial horizon gyro and a directional gyro. Neither is it known that there exists in the art a unitary indicating means which presents both an artificial horizon indicator and a radio beam indicator substantially parallel to each other whereby a pilot, viewing the unitary indicator can take advantage of trained reflexes to safely and accurately control his aircraft.

Various attempts have been made in the past to accomplish the result of controlling an aircraft with respect to the earth and to radio beam patterns. These attempts have resulted in separated reference indicia having no visual resemblance to objective reality nor indeed if combined into a unitary indicator did the resultant present a visual reference to which the pilot could react in a normal manner with the speed required for safe and accurate flight control in the normal clear weather manner in which he was trained to fly.

The present invention therefore provides a unitary indicator by which the experienced and inexperienced pilot may control his aircraft with respect to terrestial and radio planes of reference. It not only provides in a unitary indicator information of bank, pitch, turn, heading deviation from a radio glide path, deviation from vertical radio course path and rates of approach thereto, and rates of departure therefrom, but, presents this information in a natural manner.

According to the invention indicating apparatus for facilitating aircraft control comprises an horizon gyro, an artificial horizon index, an aircraft index operatively connected thereto, and horizontal and vertical indices independently operable by electrical means adapted to be energised by radio receiving means to move them respectively horizontally and vertically and wherein all said indices can be viewed at a common locus by light reflection in relative positions such that during flight of an aircraft the attitude and direction of flight and changing attitude and direction of flight thereof are presented in simulation at said locus.

Preferably the direction index is a compass card provided with degree indicia and a cloud pattern having North, South, East and West quadrants tinted in contrasting colours.

There may also be provided a speed, rate of climb and attitude instruments arranged so that indicating means thereof can also be viewed by light reflection adjacent said common locus.

In the use of the instruments the cloud

pattern and artificial horizon appear to be slightly beyond the aircraft index as is the case in direct viewing in clear weather thus relieving the pilot of eye strain common to cathode ray type of reference indicators which need frequent adjustment for brilliance control and flicker control.

In the accompanying drawings, forming a part of this specification, and wherein similar reference characters designate corresponding parts throughout the several views:—

Fig. 1 is a front elevation of the indicating face of the unitary flight control indicator;

Fig. 2 is a fragmentary sectional elevation showing some of the instruments of the improved aircraft control device, the view being taken substantially on the line 2—2 of Fig. 3, but with a screen 31 removed;

Fig. 3 is a sectional plan showing certain instruments of the improved aircraft indicating system;

Figs. 4 and 5 are cross-sectional views taken through the indicator substantially on the respective lines 4—4 and 5—5 shown in Fig. 3.

Fig. 6 is a diagrammatic fragmentary perspective view, showing an improved type of radio receiving and indicating instrument;

Fig. 7 is an elevational view of the gyro-horizon looking at the index end thereof showing the casing base in cross-section and a screen 97 in dot and dash lines;

Fig. 8 is a view taken in front of the screen 31 which masks the non-indicating parts of the instruments shown in Fig. 2, and showing the indicating parts as being visible through the openings in that screen;

Fig. 9 is a perspective view partly broken away showing an instrument lamp, several of which are employed in the device in connection with the optical system and instrument indicating parts;

Fig. 10 is a front view of the panel of the indicator;

Fig. 11 is an enlarged cross-sectional view taken through the altimeter control resetting means, the view being taken substantially on the line 11—11 of Fig. 10;

Fig. 12 is a diagrammatic view showing electrical illuminating means for the indicating instruments;

Fig. 13 is a direct front view of the indicating parts of the directional gyro;

Fig. 14 is a fragmentary view, partly in section, showing a horizon turn knob arrangement for raising and lowering a horizon bar of the gyro horizon instrument;

Fig. 15 is a cross-sectional view taken substantially on the line 15—15 of Fig. 14;

Fig. 16 is a cross-sectional plan view taken across the part 78 of Fig. 15;

Fig. 17 is a perspective view of an optical mirror associated with the instrument;

Fig. 18 is a fragmentary view showing the pivot mounting of one of the optical mirrors.

In the drawings, wherein for the purpose of illustration is shown only a preferred embodiment of the invention, the letter A may generally designate the flight instrument. It includes a casing structure B having associated therewith an altimeter C; air speed indicator D; rate of climb instrument E; directional gyro F; gyro-horizon G and a radio receiver instrument and indicator H. Optical means K is provided to optically blend or merge images of the various indicating parts of these instruments at the common reference plane or locus of the indicating face of the instrument "H" viewed through an eye piece L. Improved illuminating means M is provided, and a shield N is associated within the instrument to perfect the images of the various indicating parts of the instruments, as will be subsequently mentioned.

The casing structure B preferably includes a base 20 having a front panel 21 upon which the eye piece L is positioned. The casing structure furthermore includes a top wall 22, side walls 23 and 24 and rear wall 25. The walls 22-25 may be of metal, plastic or other material. Preferably they are integral and detachably connected to the base and the front panel, as shown.

The eye piece or viewing tube L has a tapered passageway therethrough and it is directed so as to permit viewing therethrough a blended assemblage of the indicating parts of various instruments, both direct and as reflected by means of an optical system.

In the compartment of the casing is located an altimeter C; air speed indicator D; rate of climb indicator E and the indicator H. The air speed and rate of climb indicators are respectively supported on the base 20 by means of brackets 27 and 28. The indicator H is directly secured to the base 20, and a bracket 30 secured therewith, as shown in Fig. 4, mounts the altimeter C in position.

Forming part of the shield N is a screen 31, shown in Fig. 3, located forwardly of the instruments C, D, E, and H, which screen is provided with openings 32, 33, 34 and 35 therein for the respective instruments C, D, E and H, as shown in Fig. 8. These instruments are located in such relation to the openings that their indicating parts are clearly visible to an observer looking through the eye piece L.

The altimeter C is somewhat different from the conventional altimeter construction in that the casing cylindrical wall 36, as shown in Fig. 2, is provided with sight opening 37, Fig. 4, through which is visible the rotatable barometric dial 38. The latter carries readings which are located peripherally upon a dial or card which takes the place of the pressure actuated pointer of the conventional altimeter and is therefore rotatable.

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The instrument C is provided with the usual adjusting means to calibrate the instrument for varying atmospheric conditions. The adjusting means includes a bevelled gear 39, shown in Figs. 2, 3 and 4 of the drawings, which meshes with the manual adjusting control gear 40. The latter has a horizontally disposed shaft 41 extending through the panel 21 where it is provided with a manually controlled knob 42, as shown in Fig. 11. The panel 21 is provided with a wheel 43 in mesh with a pinion 43*a* keyed upon the shaft 41, as shown in Fig. 11, and a shield 45 is provided, having a window opening to see the readings on the wheel 43, as shown in Fig. 10. The screen 31 may be provided with upper and lower white index markings 50 thereon in complementary relation to the altimeter readings 38 of the dial, as shown in Fig. 8.

The air speed indicator D is mainly conventional in construction including a casing 51 of cylindrical formation having a window opening 52 in the periphery of the casing, as shown in Fig. 2. In place of the pointer of the conventional air speed instrument moving over a stationary dial or card, the card 53 of the present instrument is connected to the conventional pointer shaft 54, and the flanged periphery of the card 53 is provided with the air speed markings 56 thereon, as shown in Fig. 2. The screen 31 is provided with fixed white indicating marks 55 to facilitate reading of the dial air speed marks 56.

The rate of climb instrument E is similar to that of the air speed indicator D and has a casing structure 60 provided with a segmental peripheral opening 61 in the cylindrical end thereof through which are readable the markings 62 upon a peripheral flange of a movable dial or card. The dial is keyed to the pointer shaft of the conventional instrument. The readings 62 are visible through the screen opening 34, Fig. 8, and said shield has white reference markings 65 for determining the proper reading.

The artificial horizon instrument G is basically of the Sperry (Registered Trade Mark) type, but modified as hereinafter mentioned. It includes a casing structure 70 mounted upon the front panel of the instrument A. The visible opening of the gyro horizon instrument does not face the pilot, but faces the direction of flight. In place of the conventional movable horizon bar the instrument G is provided with an airplane index 73, shown in Fig. 7 of the drawings and elsewhere. The index 73 has a nose simulation portion 73*a* located within a V shaped central portion 73*b*. The ends of the latter have aligning wings 73*c* and angled tips 73*d*, the outer surfaces of which are at an angle of 45° to the wings 73*c*. In a 30° left bank the left wing root of the "V" portion 73*b* will be parallel to the horizon as shown in the drawings; in a 45° left bank the left wing tip 73*d* would be perpendicular to the horizon, and in a 60° left bank the right wing root of the "V" portion 73*b* would be perpendicular to the horizon. The index 73 functions the same as the horizon bar of the conventional gyro-horizon instrument. A conventional caging adjustment is provided of the knob and gearing type shown at 75 of Fig. 3. The gyro-horizon instrument G has a white coloured terrestrial horizontal bar 77, and means for manually raising and lowering it. In the conventional gyro-horizon the airplane index is manually moved upward or downward by means of a trim mechanism, whereas in the present invention the white horizontal bar 77 is so raised and lowered. In the conventional instrument the horizontal bar is operated by the gyroscopic mechanism, but in the present instrument the airplane index shown at 73 is so operated. The horizon bar 77 which is normally fixed relatively to the other parts of the instrument is the terrestrial horizon and the index 73 is the bank and climb index, as will be subsequently mentioned.

Referring to Figs. 3, 14 and 15, the white horizontal bar 77 is mounted upon the upper end of a vertically disposed shaft 78 sliding in a bearing 79. The shaft is spring loaded at 80 to normally force the flanged end 81 of the shaft against a cam 82. The latter is rotatably mounted upon a shaft 83. The latter has a gear 84 in mesh with a gearing and trim knob control assemblage indicated at 85 leading to the face of panel 21. The terrestrial horizon references marks 77*a* are etched on the cover glass 77*b* of the instrument, as are also a vertical line 77*c*, a horizontal line 77*d*, a centre circle 77*e*, and concentric arcs 77*f*.

Referring to the directional gyro F, the same includes a casing 90 with its axis normal to the axis of the instrument G. It is supported upon the frame of the casing B, adjacent to the side wall 23.

The directional gyro F is substantially equivalent to the conventional "Sperry" (Registered Trade Mark) directional gyro except that its card 91, as indicated in Fig. 13 of the drawings, is provided with a cloud pattern 92 and degree indicia 93. The latter are reversed (Fig. 5), since they will be reflected from an optical mirror, as will be subsequently described. This instrument may be replaced by other directional indicating devices, such as the repeater card of well known and conventional "Gyrosyn" (Registered Trade Mark) or Flux Gate compass repeater, if so desired.

The cloud pattern can be tinted in contrasting colors. For instance clouds in the North quadrant can be tinted white; in the East, blue; in the South, amber and in the West, red. This will associate cardinal

directions with the cloud line.

As part of the shield N, a second screen 94 is provided, as shown in Figs. 3 and 13 of the drawings. It has an opening 95 therein through which are visible the cloud pattern 92 and the indicating part 93, with reference to a white indicator mark 96, which may be located upon the screen 94. The dot and dash lines in Fig. 5 show the opening in this screen.

A third screen 97 is shown in Fig. 3, within the casing B in front of the instrument G. It has an opening indicated by the dot and dash line 98 in Fig. 5, through which are visible the terrestrial horizon 77 and the airplane index 73.

The gyro horizon G and directional gyro F are provided with the usual operating suction to the cases through the conduits 100 and 104 as shown in Fig. 3. Air withdrawn from the cases is replaced with air that enters through any suitable openings (not shown) to the cases.

The air speed meter D is provided with two tubes 101 and 102, the former leading to the pressure element at the pitot-static tube, and the other leading to the static element of the pitot-static tube. The static line is connected to the cases of the air speed meter, altimeter and vertical speed indicator and functions as in conventional practice.

Referring to the optical image concentrating means K, the same includes partial mirrors 71 and 87. That is, they are both transparent, partially surfaced mirrors and are disposed vertically with their faces substantially 90° to each other. The mirror 71 is fixed, but mirror 87 has adjusting means which will be subsequently described.

It is understood in the art that a partial mirror is one that has a chromium or aluminum deposit on the front of the glass rather than the back. The intensity or amount of the deposit will determine the amount of light transmitted through the mirror in relation to the amount reflected. Since the reflecting agent is on the front of the glass only, one image is reflected.

The mirror 71 faces diagonally at an angle of 45° with respect to the indicating faces of instruments F and G. The mirror 87 faces the opening of tube L at angle of 45°. The mirror 87 reflects the card of the directional gyro to the observer. The airplane index and horizon of the instrument G, are viewed through two reflections, one from the first surface of the mirror 71 and again from the first surface of the mirror 87, to the eye of the observer. These images of the two instruments F and G are thus reflected substantially as shown in Fig. 5, where the dot and dash lines designate the reflection from the instrument G; the card of the instrument F being clearly visible through the mirror 71. The broken border dot and dash lines in this view designate the shield 94.

The readings from the instruments C, D, E and H are visible through the mirror 87, without reflection therefrom.

The mirror 71 is preferably mounted in a suitable channel moulding 110*a* shown in Fig. 3 of the drawings, upon the base 20 of the casing structure.

The mirror 87 is mounted as shown in Figs. 3, 17 and 18, in order that it can be adjusted. As shown, the mirror 87 is mounted in a suitable moulding 110, channeled at the bottom margin thereof. The moulding 110 is preferably provided with suitable extensions 111, which have hinge barrels adapted to align with complementary hinge barrels of leaves 112 screwed or otherwise detachably mounted upon the base 20 of the casing structure. These hinge barrels receive pintles 113.

The means for manually controlling the position of the mirror 87 includes a stiff but flexible spring steel wire 115 rotatably bearing at 116 in a bracket 117 attached to the mirror 87. The wire 115 at the panel 21 is provided with screw threads 118 threaded in a suitable opening in the panel 21. The wire has a knob 118*a* by rotation of which the mirror may be caused to tilt to the desired degree in order to properly transmit the image to the eye of the observer.

Referring to the illuminating means M (Figs. 3 and 12), the same includes lamps 150 and 151 for casting rays of light upon the indicating parts of the instruments C, D, E and H; a lamp 152 for casting rays of light upon the indicia of the instrument F, and a lamp 153 to cast rays of light upon instrument G.

The type of lamp is shown in Fig. 9. It includes a "Plexiglas" (Registered Trade Mark) cylinder 155 externally of dull black color, and provided with a slot 156 through which light rays are transmitted. An electric lamp bulb 157 is supported by the usual socket mechanism 158.

As shown in Fig. 12 of the drawings the lamps are connected in a circuit 157*a*. The lamps 150 and 151 are provided with a rheostat switch 158*a* for the control thereof, and the lamps 152 and 153 respectively have individual rheostat switches 159 and 160. The knobs for control of the switches 158*a*, 159 and 160 are shown upon the panel 21, Fig. 10, at 158*b*, 159*a* and 160*a* respectively.

All of the screens 31, 94 and 97 of the shielding means N are provided with dull black surfacing, particularly the sides facing the optical arrangement, in order to expose to view only the scales and other indicating parts of the instruments or to mask and avoid reflection of light from other parts.

It should be noted that the density of the two partial mirrors is such that there is substantially uniform readability between

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the various images. This is also controlled by the amount of illumination which is cast upon the indices of the various instruments. The intensity of illumination will be regulated by the rheostat switches to suit night or day conditions. The distances from the eye of the observer to the various indicating parts of the instruments, however reflected, or illuminated, must be substantially the same in order that the superimposing of the various instrument indications will provide an absence of parallax. This principle may be departed from slightly in order to give an impression of depth when reviewing the reflected images, such as may be desired in having the image of the face of the directional card, upon which the cloud pattern is portrayed, a slightly greater distance away; giving the effect of a cloud pattern line beyond the airplane index of the artificial horizon instrument. Such slightly greater distance will not result in parallax of any order that would be detrimental to the precise use of the instrument.

Referring to the radio receiver and indicator H, as shown in the various views of the drawings, and to fragmentary and diagrammatic form in Fig. 6 of the drawings, the instrument includes a casing structure 120 which supports a cover glass 121 at the front thereof, held in the case by means of clips 122. A shield 123, which is spherically curved and segmental in cross section, is supported by brackets 124. The convex face is coloured dull black and over it operate the vertical index bas or pointer 125 and horizontal index bar or pointer 126.

The casing structure 120 supports galvanometers 127 and 128 in any approved manner. The vertical bar 125 swings from side to side and is connected by an arm 125*a* to the movable coil of galvanometer 127. The bar or pointer 126 sweeps up and down and is connected by an arm 126*a* to the movable coil of galvanometer 128. The arrows shown in Fig. 6 at the face of the instrument designate the sweep of the bars 125 and 126.

The galvanometers 127 and 128 are essentially microammeter types, the coils thereof rotating to swing the pointers either left or right or up and down, depending on the flow direction of current. Of course the pointer 125 only swings left and right and the pointer 126 up and down. The galvanometers are actuated by means of energy received from associated radio-receiving equipment which may be the well known ILS localizer and glide beam receivers, an Omni Directional receiver; a Direct Finder receiver, or a "Sperry" Zero-Reader.

The vertical bar or pointer 125 is provided with laterally extending horizontal arms 130, the ends of which are downturned, and the vertical bar presents the general appearance of a runway. Complementary thereto, the horizontal bar 126 is provided with a horizontal arm portion 131 supported below the bar 126 by a bracket 132. The arm 131 is intended to present appearance of the approach end of the runway.

The vertical bar 125 and the arm portions 130 are tinted green upon their visible faces. Likewise, the complementary segment or arm portion 131 may be tinted green. The face of the arm 126 may be tinted some contrasting color, if desired.

The horizontally disposed up and down swinging arm or pointer 126 registers movement "up" when the aircraft is below the glide beam and "down" when the aircraft is above the glide beam. The vertical arm or pointer 125 shows movement of the aircraft to the right or left, of the ILS localizer beam, or of the Omni Directional Beam, or the transmitted signal outputs from the "Sperry" Zero Reader by selected switching.

When the cross pointers 125 and 126 are in the neutral or zero position for landing, the portions 130 and 131 will present a closed figure.

The socket plug 133 receives the wire leads from the galvanometers 127 and 128 as shown. The pointers 125 and 126 are transversely curved, as indicated in Fig. 6, in order that they will always remain in close proximity to each other as the pivoted pointers of the galvanometers swing, and thereby eliminating parallax, regardless of their position.

Switching means diagrammatically illustrated in Fig. 6 is provided for selecting the output of the rotating talking Beacon receiver known as VHF, or the output from the Omni Directional receiver, or the output of a device known as "Sperry Zero Reader."

Fig. 6 shows the Omni Directional receiver output at 140; the ILS output at 141 and the "Sperry Zero Reader" output at 142. In Fig. 6, 143 represents a pivoted switch handle which, as shown diagrammatically, is connected to a switch actuating cam 144 by means of a shaft 145. The Omni Directional output is provided with a switch 146; the ILS localizer receiver output with a switch 147; and the "Sperry Zero Reader" output with a switch 148. The single cam 144 is intended to selectively actuate the switches 146, 147 and 148, as shown. The lines leading to the electronic vertical and horizontal actuating galvanometers 127 and 128 are shown in the drawings. It is to be noted that placing the switch arm or handle 143 in position for actuating the switch 147 by the cam 144 will energise both pointers of the cross pointer instrument H, the runway localizer vertical pointer and the glide path horizontal pointer, as indicated. Actuating the "Omni-Range" switch 146 by means of the cam 144, through turning the handle 143,

will actuate the vertical pointer of the instrument H by whatever current, in microamperes, is flowing from the receiver to the cross pointer galvanometer. At this time the current to the glide path (horizontal pointer) is left open, since the Omni Directional receiver includes no glide path receiver.

The "Sperry Zero Reader" output 142 consists of the yaw, compass, bank and radio track unit 142*a*, and the pitch, altitude and glide path unit 142*b*, as is known to those skilled in the art. The unit 142*a* actuates the galvanometer of the vertical bar, and the unit 142*b* actuates the galvanometer of the horizontal bar.

It is to be noted that the movable switch members of the switches 146, 147 and 148 are spring loaded to normally opened position. They may be of any commercially available type, and are only diagrammatically shown in Fig. 6. As shown in the drawings, the springs are of the compressor types.

It is to be noted that a resistor 149 is provided for each of the glide path and localizer outputs and "Sperry Zero Reader" and a single resistor unit 149*a* for the Omni Directional receiver output. In the open position of the switches, the switch contacts are electrically made to place the resistors across the circuits leading to the switches respectively from the outputs 140, 141 and 142. The high resistance resistors have the purpose of placing an electrical load on the output of the respective devices, in order that they may be left in a electrically ready condition for on-switching at all desired times, even though the switch handle 143 is in an "off" position.

With the switch handle 143 in an "off" position the resistor of the switch 146 is shunted acros the two wire circuits leading to the said switch from the output 140; the resistors of the switch 147 are shunted respectively across the two wire circuits leading from the localizer unit of the output 141 and the two wire circuits leading from the glide path receiver portion of the output 141, and the resistors of the switch 148 are shunted, one of them across the two wire circuits leading to the switch from the unit 142*a* and the two wire circuits leading to the switch from the unit 142*b*.

Referring again to the gyro-horizon instrument G, the airplane index 73 remains parallel to the real horizon, and the horizon line 77 banks with the aircraft. Thus is imparted correct knowledge of the bank angle. At the same time this imparts a banking reference to the artificial terrestrial horizon, as well as the artificial horizon of the instrument H. In Fig. 1 is shown the observer's view of the various indicia. It indicates to the pilot the aircraft is flying with the left wing down, and the degree is determined by the relation of the lines of the index 73 to th horizon and vertical lines otherwise visabl That is, if the left wing tip line assumes position perpendicular to the horizon, a ban angle of 45° would instantly be indicated t the pilot, etc. The aircraft upon which th instrument of Fig. 1 is located is in a le bank and turn, resulting in the cloud patter of the background and its markings c azimuth moving from left to right. Th speed with which this movement takes plac depends upon the type and speed of th aircraft used. The pilot familiar with th type of aircraft soon learns and "feels" th proper bank angle for rate of turn when h can see in clear weather, and in the case o the present invention a similar result can b achieved. Should the aircraft begin to climb while in the left turn, the airplane index 7 would appear to rise above the horizon line 77 and its image would then appear to be passing across the cloud pattern.

Should a diving turn to the left be started, the airplane index 73 will begin to fall, passing the horizon line 77 and then assume some position below the horizon line representative of the glide angle. It is therefore quite obvious that various combinations of bank, turn, climb and glide will present to the pilot a realistic visual indication of the various flight attitudes and turn rates which will be presented in the normal natural manner rather than in the separated present methods of indicated flight attitudes and changes.

Referring to the pilot's view of the instruments as shown in Fig. 1, it will be noted that the lubber line 96 is over the directional scale indicating 270°. The airplane index shows the aircraft to be to the right of the approach path beam as shown by the position of the vertical bar 125. The airplane index 73 indicates a gliding left turn in progress, and it lies above the glide path beam as shown by the horizontal bar 126. The latter lies below the horizon bar 77, indicating that the aircraft is above and to the right of the flight line which will bring the aircraft to a landing on the runway, for example, whose axis lies 270°.

As the left turn progresses, the desired object would be, first, to have the nose of the airplane index intersect the vertical bar 125 at the vertical lubber line. This then would insure that the aircraft was on the approach path beam and as this obtains, the pilot noting the direction indicator, will then turn the aircraft to the right to recover a heading of 270°, insuring that the aircraft is headed down the runway axis. This condition can be met and held only in the absence of a cross wind component.

Should a cross wind be present, say from the South, some heading less than 270° will be sought. This would permit the vertical bar 125 to pass through the nose of the air-

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plane index 73. This procedure of adjustment, using the present invention is quite as easy as would be obtained in an approach to the runway in clear weather.

By visual flight reference, simultaneously viewing of all necessary factors, namely direction, rate of change of direction, displacement from runway course radio beam, and rate of closure thereto are seen and evaluated.

After reaching a steady runway course, to be held for the aproach, the glide beam is approached, either by reducing the speed, maintaining attitude of level flight and accepting a rate of descent until the horizontal bar 126 rises and intersects the horizon bar 77 in every case, at which moment the aircraft is on the proper glide path.

Another method of reaching the desired glide path is to change the pitch attitude of the airplane index 73, placing the nose on or in the direction of the glide path horizontal bar 126, applying or reducing engine power to maintain desired air speed, and as the horizontal bar 126 returns to coincidence with the horizon bar 77, the pitch angle changes producing a "follow-up" method of pitch control of the aircraft to produce the direction with respect to the glide path to the runway for landing of the aircraft.

In the approach landing just described, no other instrument need be referred to at any time other than the pilot's view through the viewing tube, since all necessary elements are contained in the presentation of indices shown in Fig. 1.

Obviously if a landing is not being made, and if the cross pointer vertical bar 125 or horizontal bar 126 are not needed for navigational purposes, such as would be true in the case of the rotating talking Beacon receiver or the Omni Directional Beacon receiver, the light switch controlling current which illuminates the cross pointer indicator may be opened, thereby eliminating the pattern from view. Any of the other scale or index presentations may be eliminated or selected at will. For instance, in clear weather the only desired presentation may be the cross pointer pattern in order to use the vertical bar 125 in conjunction with the Omni Directional Beacon receiver or other receiver employing a left-right sensing galvanometer.

Various changes in the rearrangement of the various units of the instrument may be made within the casing structure without departing from the scope of the invention defined in the claims.

What I claim is:—

1. Indicating apparatus for facilitating aircraft control comprising an horizon gyro, an artificial horizon index, an aircraft index operatively connected to said gyro, a directional gyro having a direction index operatively connected thereto, and horizontal and vertical indices independently operable by electrical means adapted to be energised by radio receiving means to move them respectively horizontally and vertically and wherein all said indices can be viewed at a common locus by light reflection in relative positions such that during flight of an aircraft the attitude and direction of flight and changing attitude and direction of flight thereof are presented in simulation at said locus.

2. Indicating apparatus as claimed in Claim 1, wherein the images of the artificial horizon index, the aircraft index and the direction index which is a compass card are produced by optical means at the common locus, the image of the compass card being above but adjacent that of the artificial horizon index.

3. Indicating means as claimed in Claim 2 wherein said vertical and horizontal indices are independently actuated by galvanometers or equivalent means energised by the receiving means to move them respectively horizontally and vertically.

4. Indicating apparatus as claimed in Claim 2 or 3, wherein the configuration of said aircraft index is that of a miniature aeroplane and having a nose portion within a V-shaped central portion from the ends of which extend aligned wings each of which has a downwardly extending tip the outer surface of which is at an angle of 45° to the wing.

5. Apparatus as claimed in Claim 2, 3 or 4 having a vertical compass card which rotates about a vertical axis and having thereon a cloud pattern in quadrants indicating north, south, east and west zones and degree indicia above the cloud pattern.

6. Apparatus as claimed in Claim 5, wherein said zones are tinted in contrasting colors.

7. Apparatus as claimed in any one of the preceding claims wherein said horizon gyro is arranged so that when the apparatus is supported in position on an aircraft the artificial horizon and the index bar face forwardly of the aircraft and the images thereof are reflected by mirrors to an eyepiece which faces the pilot.

8. Apparatus as claimed in Claim 7, wherein said mirrors are partial mirrors arranged so that the images of the horizon index and the aircraft shaped index are reflected by both mirrors and the image of the compass card or dial is transmitted through one mirror and reflected by the other to the eyepiece.

9. Apparatus as claimed in Claim 8, wherein the images of the vertical and horizontal indicators are transmitted through said other mirror to the eyepiece.

10. A device as claimed in Claim 6 or 7,

wherein said actuating means comprise two galvanometers each having a rotatably mounted coil one of the coils rotating about a horizontal axis and having the horizontal bar secured thereto and the other about a vertical axis and having the vertical bar secured thereto in crossing relation to the horizontal bar.

11. A device as claimed in Claim 10, having a fixed dull coloured shield adjacent the rear of said bars the latter having their forward surfaces convexly shaped and contrastingly coloured with respect to the shield.

12. A device as claimed in Claim 10 or 11, wherein said vertical bar carries means designating a silhouetted perspective view of an aircraft runway in approach and the horizontal pointer carrier means representing the leading edge view of an aircraft runway said pointers being arranged with respect to each other that when the pointers are in positions for correct runway approach by the aircraft the means carried by the pointers present a closed figure.

13. Apparatus as claimed in any one of Claims 2 to 12 having an altimeter with barometric indicia on the periphery of a rotary indicator and which is so arranged that an image of the exposed portion of the indicator is presented above but adjacent said locus.

14. Apparatus as claimed in Claim 13, having an air speed indicator with air speed indicia on the periphery of a rotary indicating member and which is so arranged that an image of the exposed portion of the member is presented on one side of but adjacent said locus.

15. A device as claimed in Claim 14, ing a rate of climb indicator with indici the periphery of a rotary member and w is so arranged that an image of the exp portion of the member is presented on other side of but adjacent said locus.

16. A device as claimed in Clair wherein the artificial horizon index is a and means is provided for vertically ad ing the bar.

17. A device as claimed in Clain wherein switch means is provided whe the output of a landing system receiver zero reader receiver can be selected for ergisation of both galvanometers, or output of an Omni range receiver ca selected to energise the galvanometer w actuates the vertical pointer.

18. A device as claimed in Claim 14 o having screens apertured so that the in of instruments are exposed and which m other portions of the instruments.

19. A device as claimed in Claim wherein each instrument is provided means arranged for projecting artificial laterally from an electric lamp bulb on t exposed indicia.

20. A device as claimed in Claim wherein the lamps are connected in ci with rheostat switches whereby the inte of the light can be varied.

21. Indicating apparatus for facilita aircraft control substantially as descr with reference to the accompan drawings.

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may be obtained.

Date of Foreign Application
10 July 1950

Fig. 1

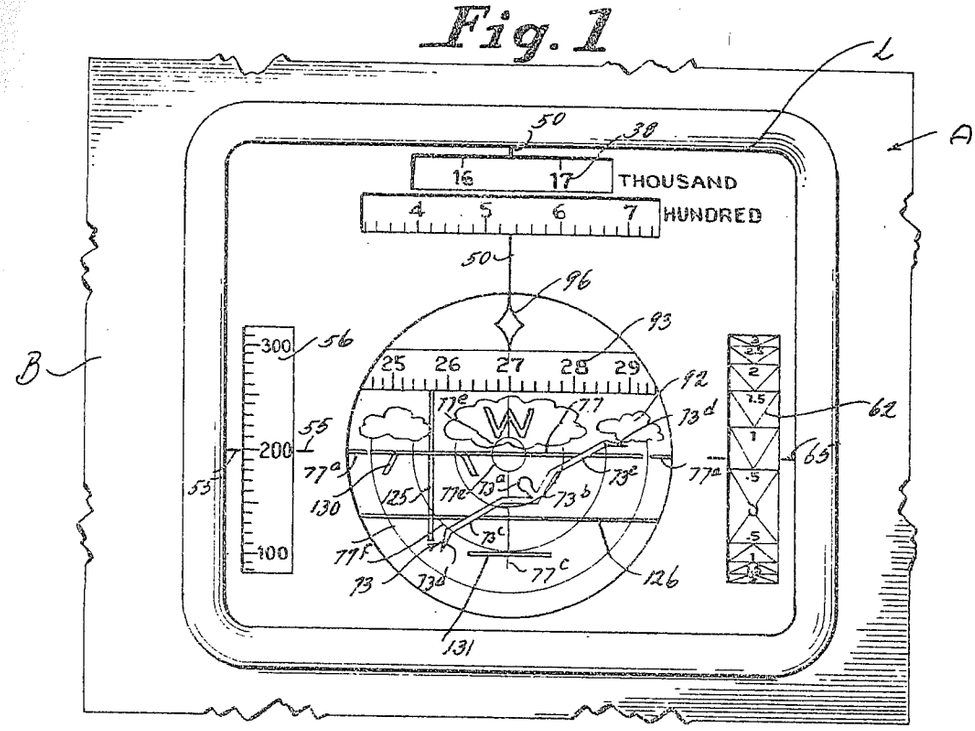
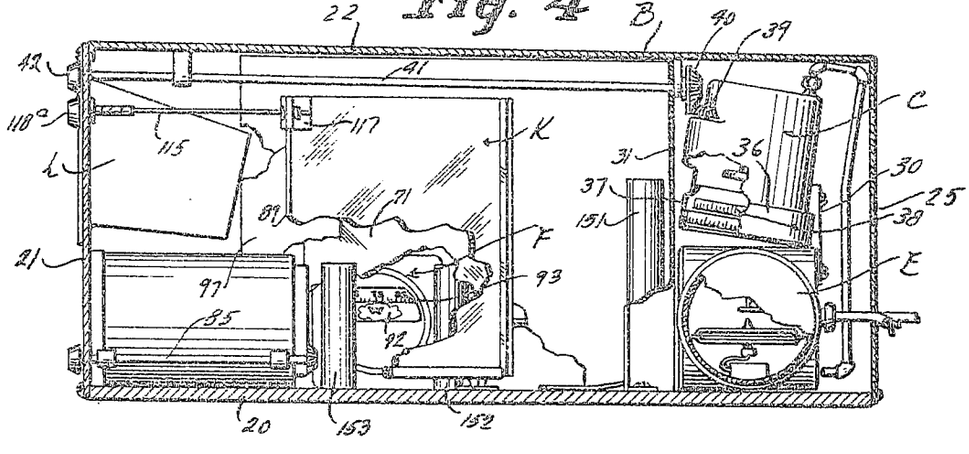


Fig. 4



715,269 COMPLETE SPECIFICATION

3 SHEETS

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SHEET 1

Fig. 2

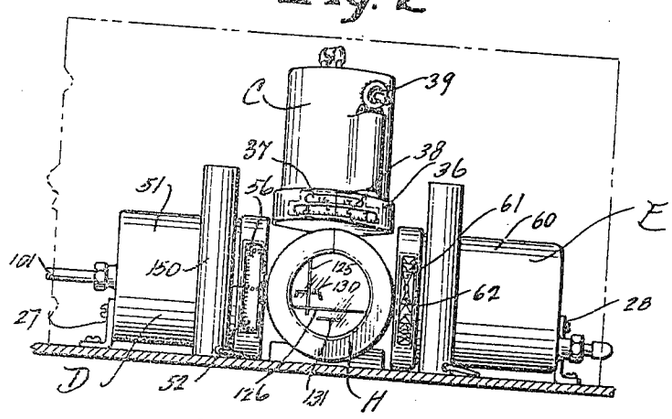
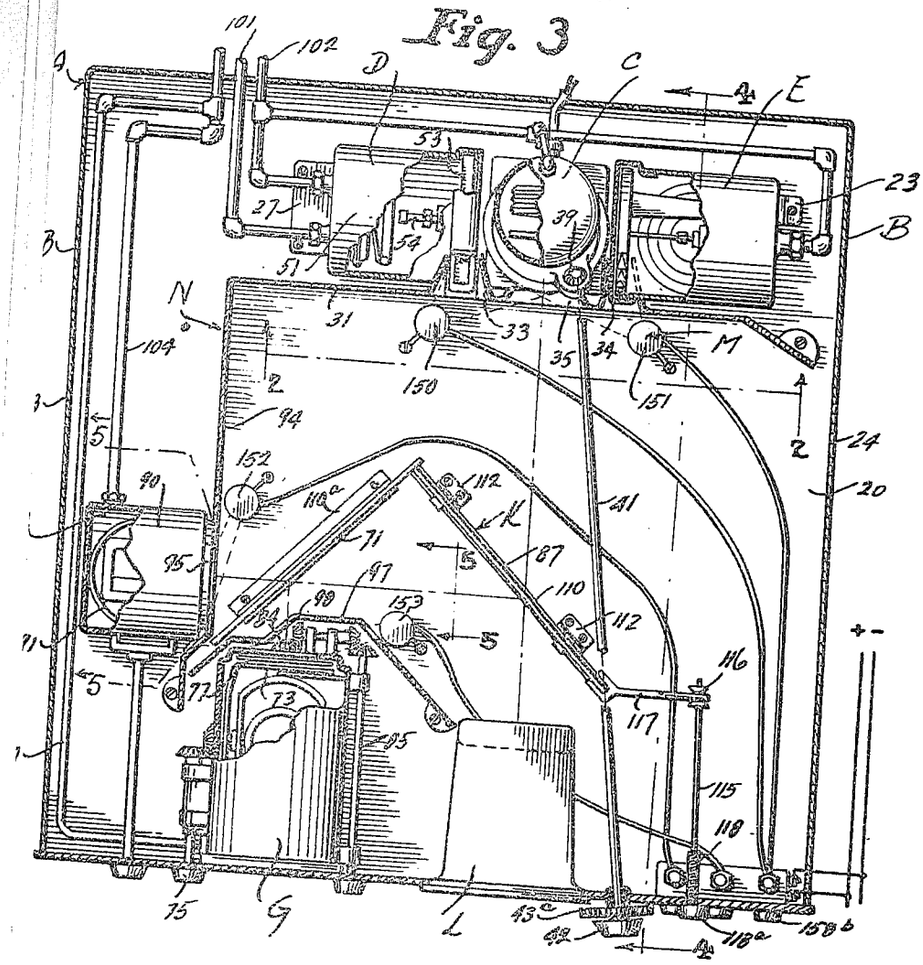


Fig. 3



Date of Foreign Application
10 July 1950

Fig. 5

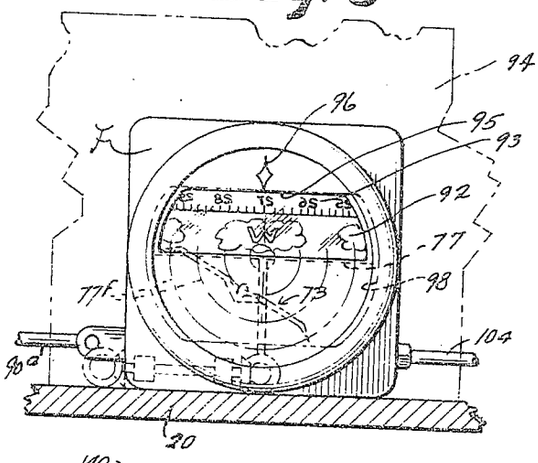


Fig. 7

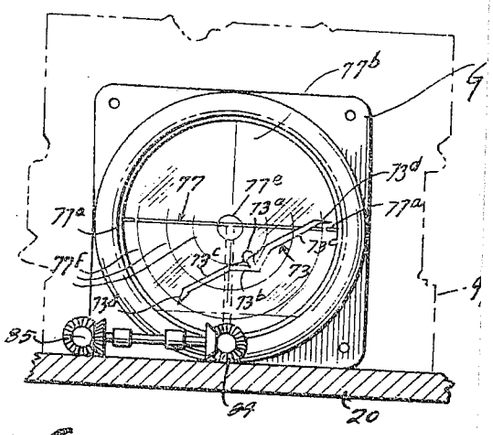
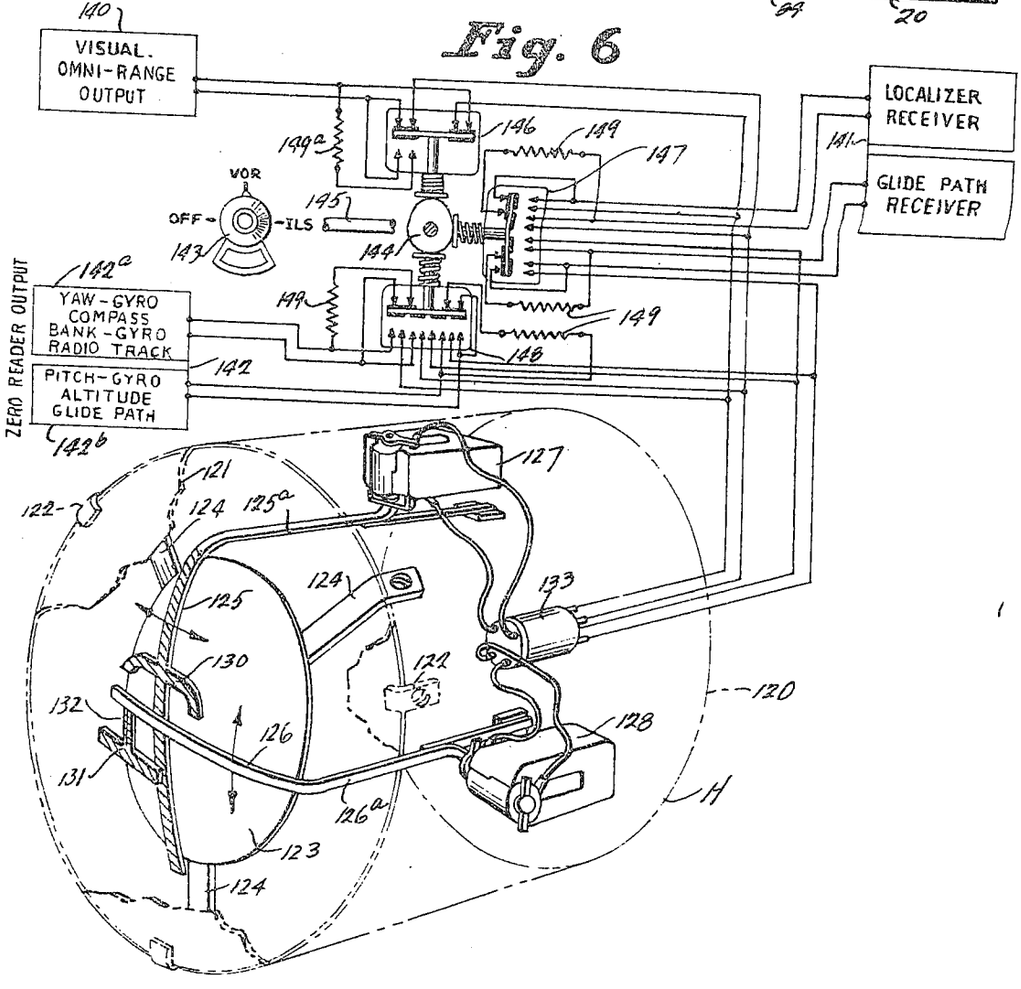


Fig. 6



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SHEET 2

Fig. 8

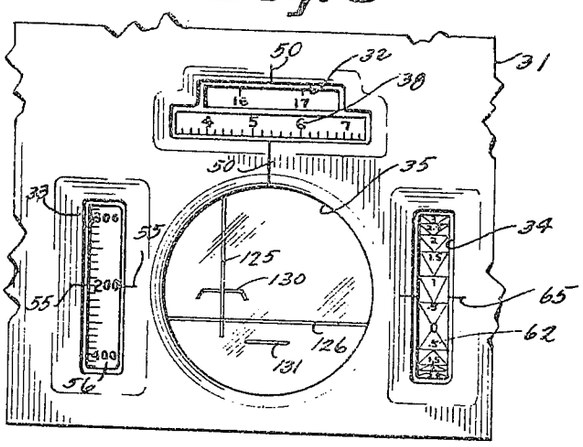

Fig. 9

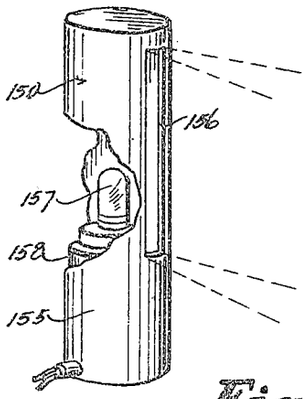

Fig. 10

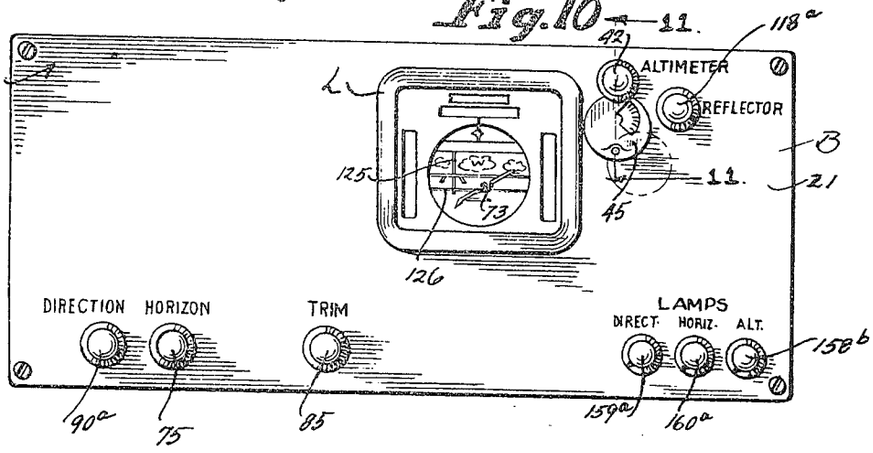

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Fig. 11

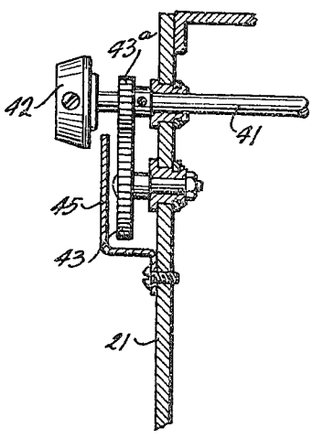


Fig. 12

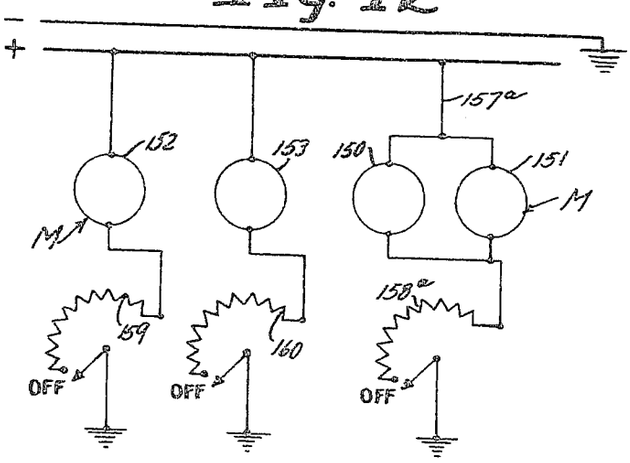


Fig. 13

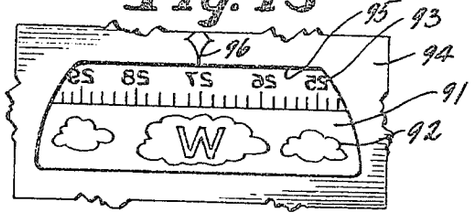


Fig. 15

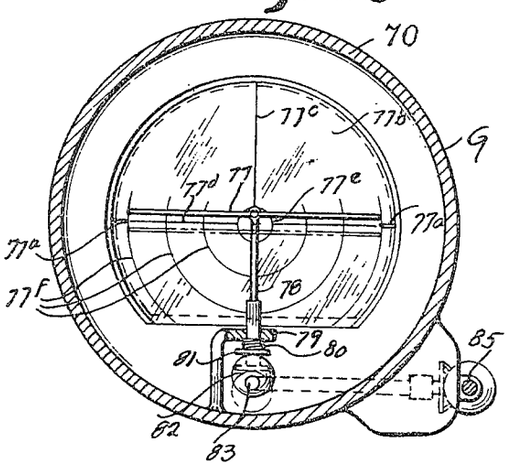


Fig. 16

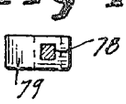
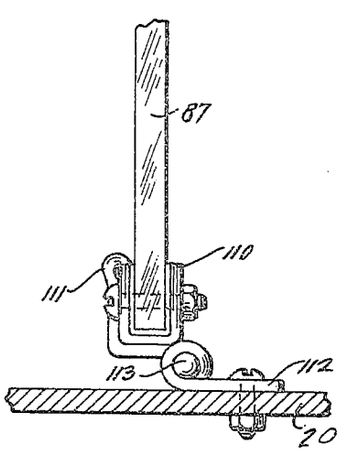
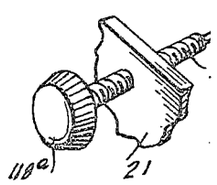


Fig. 18





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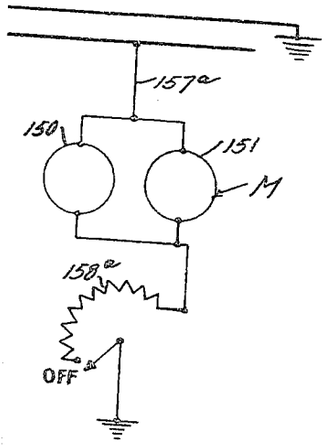
SHEET 3

y. 12



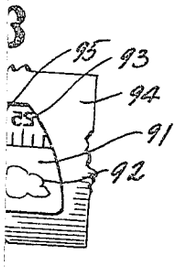


Fig. 14

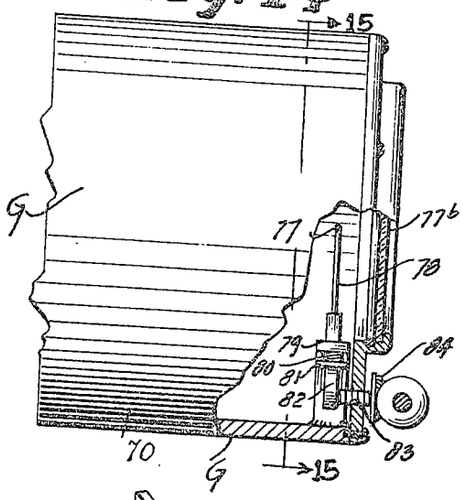
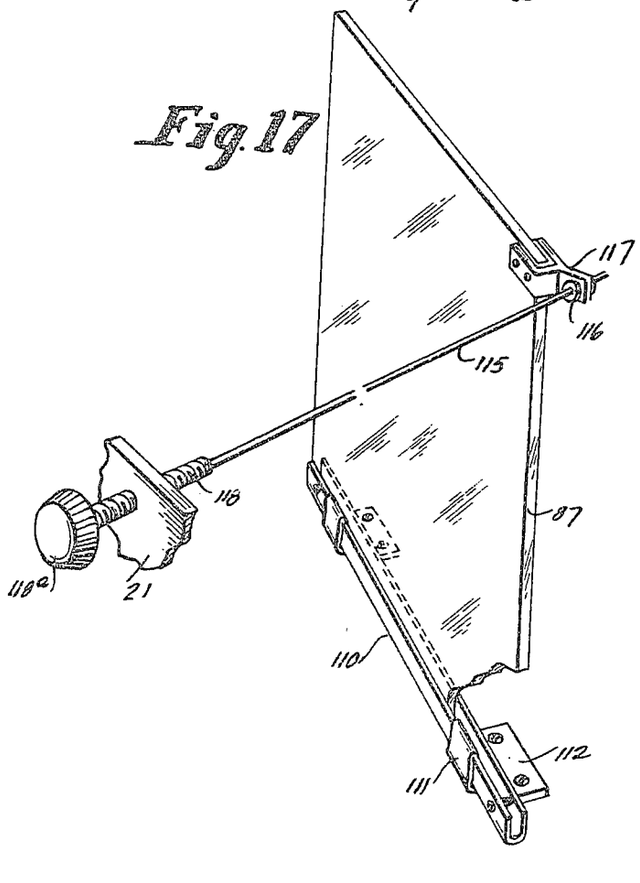
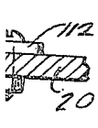


Fig. 17





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Date of Foreign Application
10 July 1950

PATENT No. 715269

Carl Joseph Crane.

Date of Patent 16 January 1951

Date of Sealing 18 JANUARY 1951

(see Sections 32, 37 and 40 of the Patents Act, 1949.)

E.—The continuance of this Patent is conditional on the payment (by way of Patents Form No. 24) of the prescribed fees, which, under the Rules at present in force, are :—

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(49004) W.O.P.

LETTERS PATENT

COUNTRY GREAT BRITAIN

NUMBER 715269 **DATE** January 16, 1951

PATENTEE CARL JOSEPH CRANE

INVENTION Indicating device for facilitating aircraft control.

TAXES DUE January 16, 1955 and annually

WORKING DUE January 18, 1958

DURATION 16 years from January 16, 1951

MARKING All articles made and sold under this patent should bear the number of the patent in aprominent position thereon, as: No. 715269.