

Oct. 7, 1941.

F. D. BRADDON
AIR BORNE GYROCOMPASS

2,257,730

Filed April 26, 1940

4 Sheets-Sheet 1

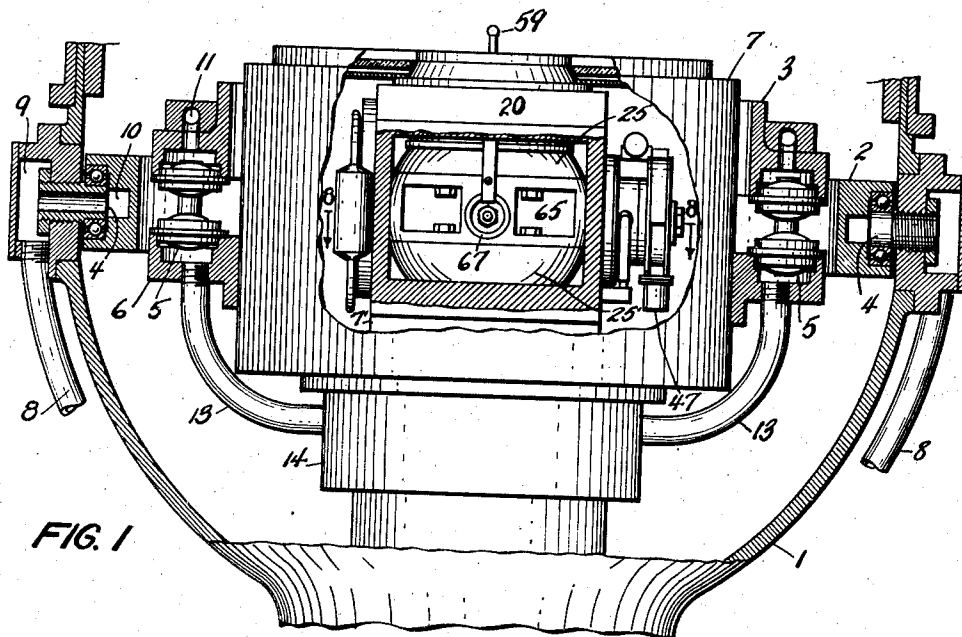
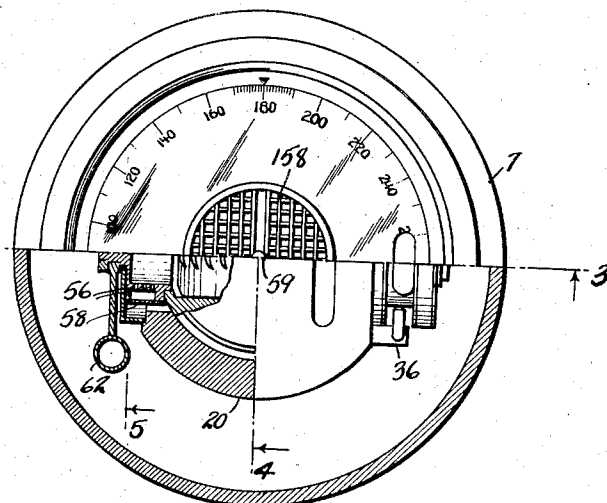


FIG. 2



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4 Sheets-Sheet 2

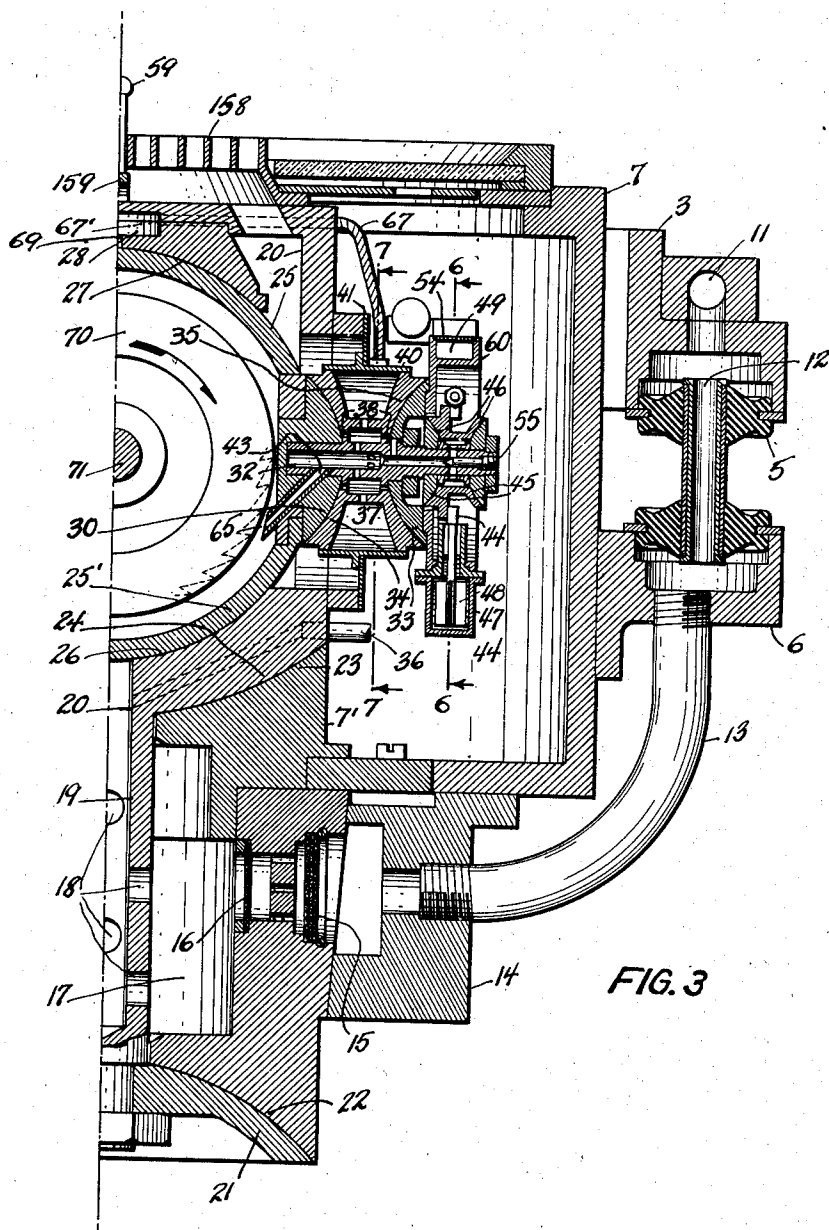


FIG. 3

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4 Sheets-Sheet 3

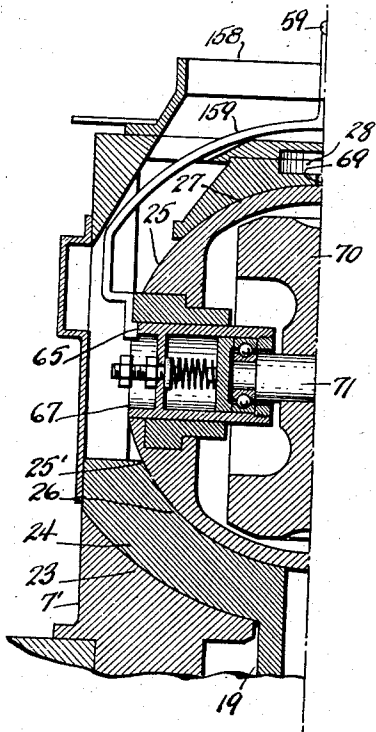


FIG. 4

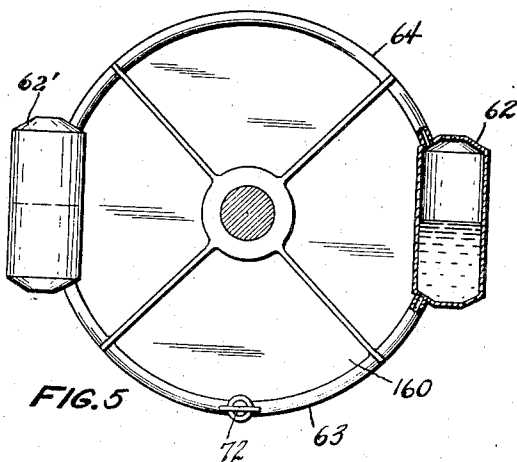


FIG. 5

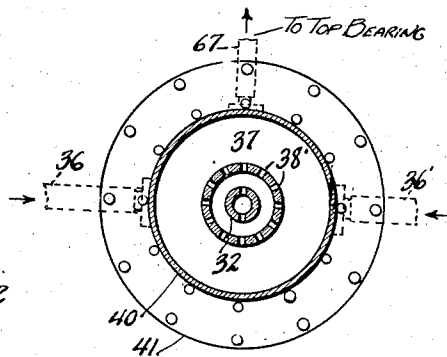


FIG. 7

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4 Sheets-Sheet 4

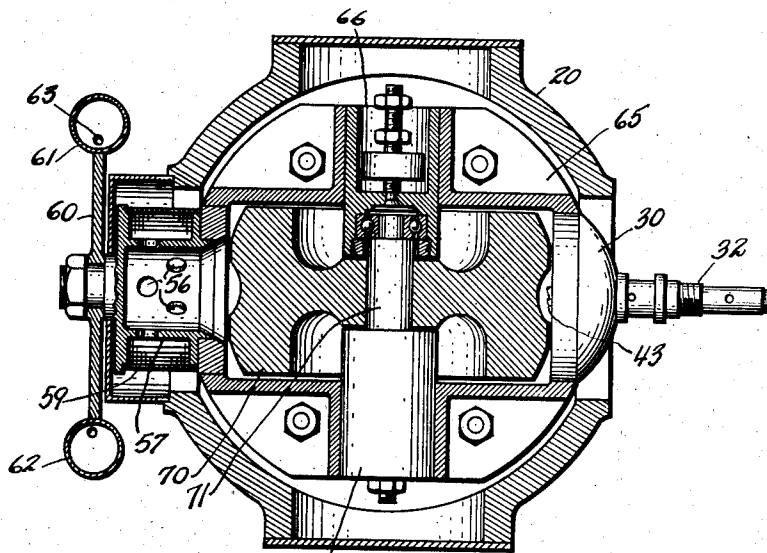


FIG. 8

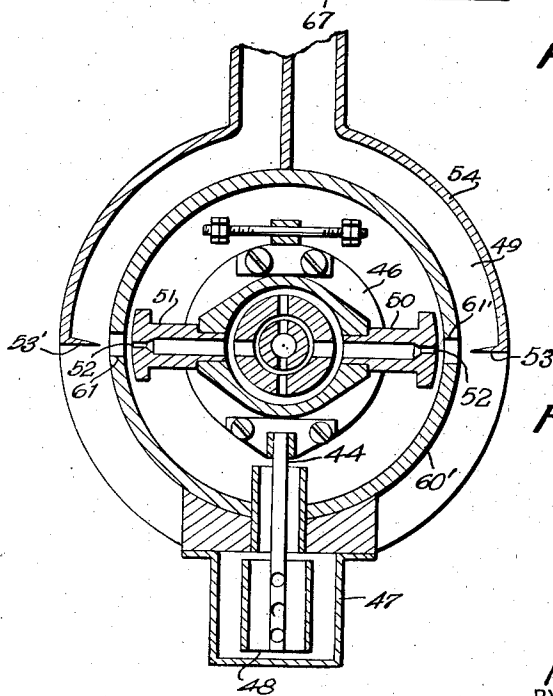


FIG. 6

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2,257,730

AIR BORNE GYROCOMPASS

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Application April 26, 1940, Serial No. 331,760

10 Claims. (Cl. 33—226)

This invention relates to air borne gyro compasses.

One object of the invention is to design a small, simple and comparatively inexpensive direct reading gyro compass which is compact in form, silent in operation, and of non-magnetic construction so that it may be installed in the ship's wheel house in full view of the helmsman and in proximity to the magnetic compass without disturbing the latter.

Another object of my invention is to simplify and improve the construction of the air-borne type of gyro compass by employing a novel horizontal guide pivot between the rotor casing and the vertical ring, the pivot being connected to the vertical ring by a flexible diaphragm, thus making the bearing self-aligning. Preferably, such a bearing is employed at one side only of the casing, preferably the west side, so that the east side may be employed to discharge the air used in spinning the rotor along the tilt axis thereof, thus minimizing possible disturbing torques from this source. This air is preferably discharged within the vertical ring which encloses the rotor casing, the air from said ring being discharged upwardly, thereby minimizing any reactive torques that might otherwise be created thereby.

A further improvement accomplished by my invention is in the liquid gravitational control element. I propose to use as the liquid, a non-viscous or mobile organic compound of greater specific gravity than oil but less than mercury, and I propose to completely seal the same in glass containers to prevent evaporation and contaminating, with adjustable means to constrict the rate of flow therebetween.

Another improvement achieved by my invention is leading the air supply in through the shock mounting fixtures, thus avoiding extra flexible tubing, the position of which may vary and affect the balance of the compass.

Other objects of my invention will appear from the following description, from which it will be apparent that many features thereof have application to other types of gyroscopic instruments.

Referring to the drawings,

Fig. 1 is a side elevation, partly in section, of my improved air borne gyro compass.

Fig. 2 is a plan view of the same, also partly in section.

Fig. 3 is a vertical section through the compass, looking north or south.

Fig. 4 is a vertical section of the same, looking east or west.

Fig. 5 is a detail, partly in section, through the liquid gravitational element.

Fig. 6 is a sectional detail taken approximately on line 6—6 of Fig. 3.

Fig. 7 is a similar sectional detail taken approximately on line 7—7 of Fig. 3.

Fig. 8 is a horizontal section through the rotor and its casing.

My gyroscopic compass is shown as mounted in the usual enclosing bowl-shaped stand 1 by means of a gimbal ring 2 which universally supports the intermediate ring 3, the gimbal being supported in the bowl 1 on major trunnions 4—4 with the minor trunnions (not shown) at right angles thereto. The compass is shock mounted or flexibly supported from the ring 3 by means of a plurality of universal rubber couplings 5, 5 which suspend the ring 6 which supports the compass housing 7 in a shock absorbing suspension from the ring 3.

The gyroscope, besides being air supported, is also preferably air spun. The air for both purposes is supplied from a pump (not shown) through the supply pipe 8 which leads into a chamber 9, from which the air passes through hollow trunnion 4 into a segmental channel 10 in the gimbal ring. Thence, the air passes to annular channel 11 in ring 3 through one of the hollow minor trunnions (not shown), and thence it passes downwardly through a central bore or tube 12 in one or more of the shock mountings 5 into the pipes 13 leading within the lower extension 14 on the compass housing 7. Thence the air passes through filters 15 and 16 to a chamber 17. A portion of the air then passes through apertures 18 in the central vertical stem 19 extending downwardly from the vertical ring 20 of the compass. Another portion of the air in chamber 17 passes outwardly between the spherical shaped button 21 on the lower end of the stem 19 and the complementary cup 22 on the lower end of the housing, thus furnishing an air bearing between these parts. Another portion of the air forms an air film between the upper cup 23 and the concentric spherical surface of button 24 formed in the vertical ring. The vertical ring is thus mounted on air bearings for turning about a vertical axis only.

The rotor casing is preferably made up of three parts, one being an equatorial channeled ring 65 which carries the rotor bearings 66 and 67 and the sides of which closely approach the sides of the rotor to reduce windage losses.

Above and below the said ring are bolted a pair of large hollow, concentric spherical buttons 25 and 25' which fit in complementary spherical concavities 26 and 27 in the vertical ring 20 giving the casing three degrees of freedom.

In order to suppress angular movement of the casing about all axes except the horizontal E-W axis, I have shown the casing 65 as provided with a spherical button 30 at one side only, from which projects a hollow stem 32. On said stem is secured an oppositely facing button 33, said buttons forming portions of each of two oppositely facing concave air bearings 34 and 35 supported by the vertical ring 20, thereby preventing movement of the rotor casing except about the common diameter of said buttons. The complementary portions of said bearings are provided by a pair of oppositely facing cup members 34 and 35, air being forced between said button and cup members from pipes 36, 36' connected to the interior of stem 19, which in turn leads air within the chamber 37 between the cups. This air passes through ports 38 to pass outwardly between the complementary button and cup surfaces. The chamber 37 is enclosed by a ring 40 which supports both cup members and is connected to the vertical ring by means of a flexible diaphragm 41. The cups are thus given universal self-aligning support in the vertical ring. Air for spinning the rotor 70 also passes from the chamber 37 into the interior of the stem 32, and thence outwardly through one or more driving nozzles 43. Air is also supplied to the upper spherical bearing 27 from the chamber 37. For this purpose, a flexible pipe 67 is shown as leading from the chamber 37, connecting with the bore 67' leading through the top of the vertical ring and into the chamber 28, whence the air passes downwardly through aperture 69 to flow between the spherical surfaces on cap 25 and cup 27.

Preferably, I also mount the damping means on said hollow stem 32. For damping the compass, I use an air supported pendulum 44 which may be mounted on the stem by complementary button and cup bearings 45 and 46 similar in construction, but smaller than the hereinbefore described bearings 34, 35. The pendulum 44 is shown as depending from the cup structure 46, while the oppositely facing cooperating buttons 45 are secured to the stem or trunnion 32. The lower portion of the pendulum preferably dips into a container 47 containing oil or other fluid. Said container is mounted to tilt with the gyro casing 25, being shown as secured to the lower part of the circular framework 60', which in turn is secured to the back of the button 33 mounted on stem 32. To secure effective damping, blades or paddles 48 may be secured to the pendulum. Also mounted on the cup member 46 from which the pendulum depends are oppositely directed tubes 50 and 51, from the ends of which air jets 52 are normally discharged horizontally in opposite directions. Said jets are normally bisected by baffles or spoilers 53 and 53', which are shown as formed by bending inwardly knife edges on segmental covering 54 for channels 49 formed by the circular channelled enclosure 60' which is secured to button 35 on the gyroscope. Said enclosure has a pair of apertures 61 normally in line with but of greater height than jets 52, permitting limited tilt of the jet. Enclosure 60' thus, acts to shield the pendulum from stray air currents. That portion of the air which is not engaged by the knife edges

exerts a reactive torque on the gyroscope about its vertical axis, while that portion of the air which is engaged or spoiled by the knife edge is deflected up the chute or channel 49 and out at the top in a direction so as to exert no torque on the compass. Hence any relative tilt of the pendulum and gyroscope causes unbalanced torque about the vertical axis to reduce the tilt and damp the compass. The damping rate may be effectively varied by an adjustable throttle valve 55.

No bearing whatever is provided at the side of the casing opposite the stem 32, and advantage is taken of this fact by discharging all of the used air from the rotor spinning means through apertures 56 (Fig. 8) in a hollow cylindrical extension 57 secured to the gyro casing 65. The air is then discharged through a ring-shaped screen 58 so that torque on the gyroscope is avoided. Thence the air passes upwardly into the interior of the vertical ring 20 and out the grill 158 at the top so that the air passes slowly into the atmosphere without disturbing the gyroscope.

A knob 59 may be provided on top of a frame 159 secured to rotor casing 65 which may be pushed in a general axial direction so as to exert a torque about the horizontal axis of the compass to quickly reset the compass in azimuth.

Gravitational control may be furnished by liquid container framework 160 (Fig. 5) secured to one end of the rotor casing. As shown, the liquid containers 62 and 62' are made of glass connected at top and bottom by small bore glass tubing 63 and 64, so that the system is entirely closed to the atmosphere. I prefer to employ as the liquid for the ballistic a heavy mobile liquid, such as a heavy organic compound, such as methylene iodide, which has a specific gravity between that of water or oil and mercury.

Preferably, also, I provide an adjustable throttle valve 72 in tube 63 so that the rate of flow of the liquid may be varied at will to secure proper out-of-phase relation between the rate of flow and the normal roll and pitch of the ship.

In order that my improved compass may be used in the wheel house without disturbing the magnetic compass, I preferably construct all parts of the compass, except possibly the ball bearings, of non-magnetic material, the metals employed being preferably aluminum alloy for the supporting structure and brass for the rotor 70. The rotor shaft 71 may also be of brass, but is preferably made of the same material as the rotor bearing ring 65, i. e., of aluminum alloy, to avoid troublesome temperature compensation.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In air spun gyroscopic apparatus, a supporting ring for the gyroscope, a universal mounting for said ring including a gimbal ring, hollow pivots for leading air into said gimbal ring and from said gimbal ring to said inner ring, and rubber shock mountings for supporting said compass from said inner ring, at least one

of said mountings being hollow to pass air from said inner ring into said compass.

2. In an air borne gyro compass, a generally spherical rotor casing, a vertical ring, spherical air bearings universally supporting said casing within said ring, means for anchoring said casing to said ring about all axes except an E—W axis comprising a stem extending E—W from one side only of said casing, and air bearings between said stem and said vertical ring permitting rotation of said casing only about an E—W axis.

3. In an air spun gyroscopic apparatus, the combination with a gyro casing, a normally horizontal pivot means therefor at one side of said casing, means whereby the spinning air is introduced through said pivot, means whereby the used air is discharged in a plurality of directions radially of said horizontal pivot axis from the opposite side of said casing, and means for directing the discharged air upwardly at the center of the casing to avoid torques thereon about any axis.

4. In a liquid controlled gyro compass, a pair of glass containers mounted on said compass, and spaced in a N—S direction, small-bore glass tubes connecting said containers both at the bottom and at the top, and an organic mobile liquid sealed in said containers and tubes of a specific gravity greater than water and less than mercury.

5. In an air spun gyroscopic compass, a generally spherical rotor casing, a vertical ring substantially surrounding said casing, air bearings between said ring and casing whereby said casing is supported for oscillation about an E—W horizontal axis within said ring, means for supporting said ring for turning about a vertical axis, and means for discharging air from said casing within said ring along said E—W axis, said vertical ring having an opening at the top permitting said air to be discharged along the vertical axis of said ring.

6. In a gyro compass, a rotor and rotor bearing casing, a vertical ring, bearings universally supporting said casing within said ring for turning about all axes, and means for anchoring said casing to said ring about all axes except an E—W axis, comprising a stem extending E—W from one side only of said casing, a guide bearing between said stem and said casing permitting rotation of said casing about said E—W axis, and means for flexibly supporting the fixed portion

of said bearing in said ring, whereby the bearing is self-aligning.

7. In an air borne gyro compass, a generally spherical rotor casing, a vertical ring, spherical air bearings universally supporting said casing within said ring, means for anchoring said casing to said ring about all axes except an E—W axis comprising a stem extending E—W from one side only of said casing, air bearings between said stem and said vertical ring permitting rotation of said casing only about an E—W axis, and means for flexibly supporting the portion of said bearings secured to said vertical ring from the vertical ring, whereby said bearings are self-aligning.

8. In a gyro compass, a rotor and rotor bearing casing, a vertical ring, bearings universally supporting said casing within said ring for anchoring said casing to said ring about all axes except an E—W axis, comprising a stem extending E—W from one side only of said casing, a guide bearing between said stem and said casing permitting rotation of said casing about said E—W axis, a pendulum also pivoted on said stem, and means controlled by the relative tilt of said pendulum and casing for damping the compass.

9. In an air borne gyro compass, a generally spherical rotor casing, a vertical ring, spherical air bearings universally supporting said casing within said ring, means for anchoring said casing to said ring about all axes except an E—W axis comprising a stem extending E—W from one side only of said casing, air bearings between said stem and said vertical ring permitting rotation of said casing only about an E—W axis, a pendulum, air bearings supporting said pendulum on said stem, and air flow means controlled by the relative tilt of said pendulum and casing for damping the compass.

10. In an air borne gyro compass, a generally spherical rotor casing, a vertical ring, spherical air bearings universally supporting said casing within said ring, means for anchoring said casing to said ring about all axes except an E—W axis comprising a stem extending E—W from one side only of said casing, and air bearings between said stem and said vertical ring permitting rotation of said casing only about an E—W axis, said casing having apertures therein on the side thereof opposite said stem, permitting exhausting the air from said casing adjacent the axis opposite said stem.

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