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BY A. P. C.

P. M. G. TOULON

ORIENTATION SYSTEMS

Filed June 11, 1941

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397,647

8 Sheets-Sheet 1

Fig. 1

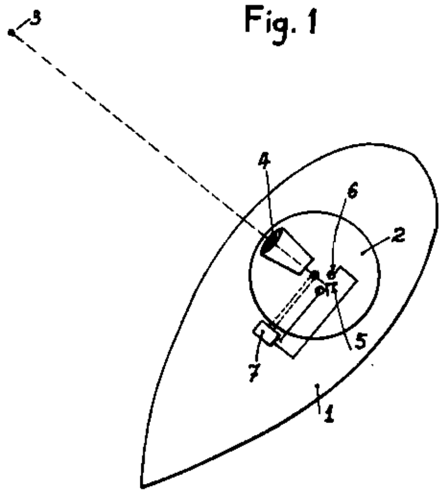

Fig. 2

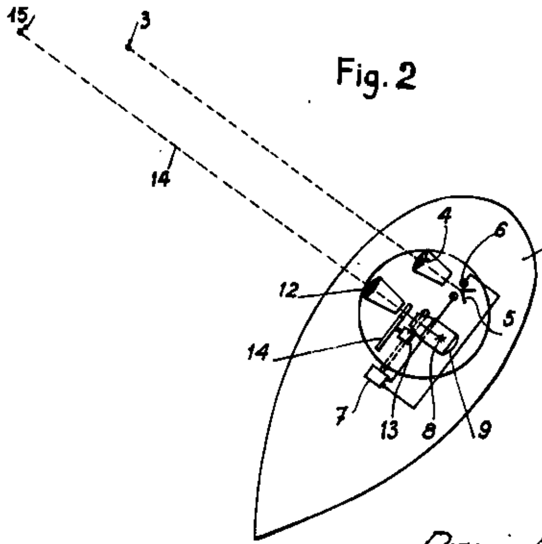

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Fig. 3

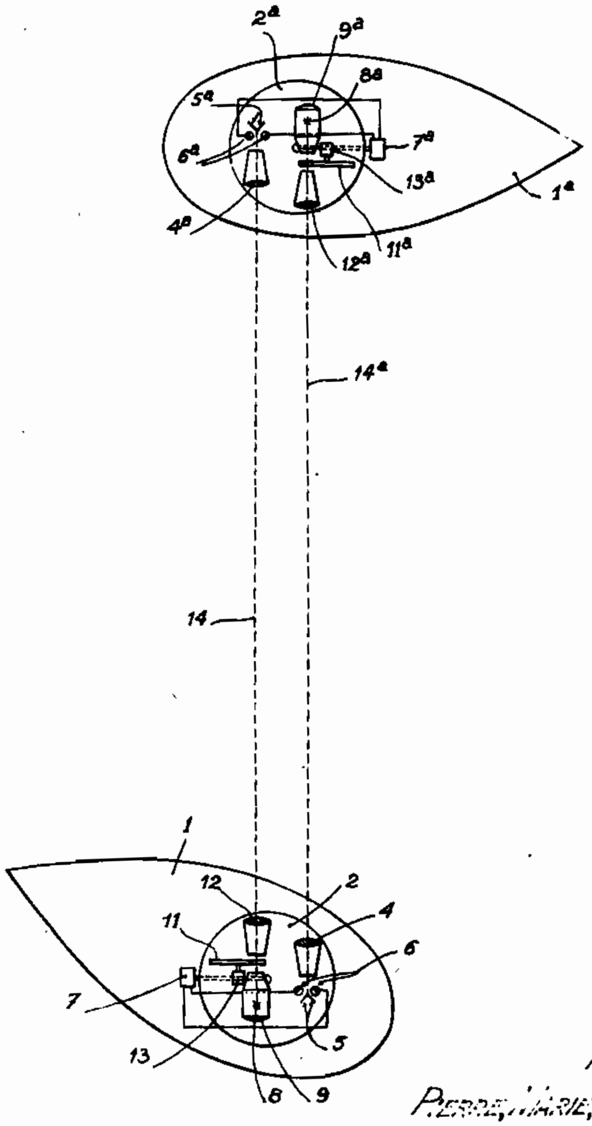

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Fig. 4

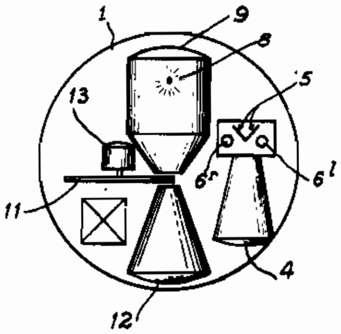

Fig. 5

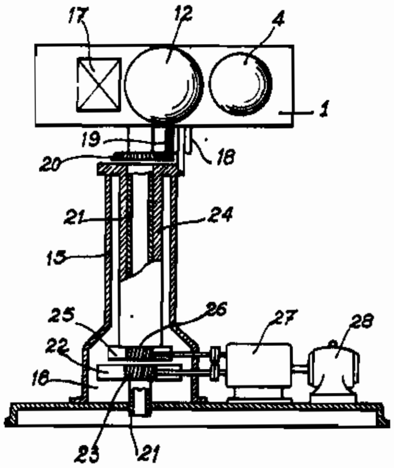

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Fig. 6

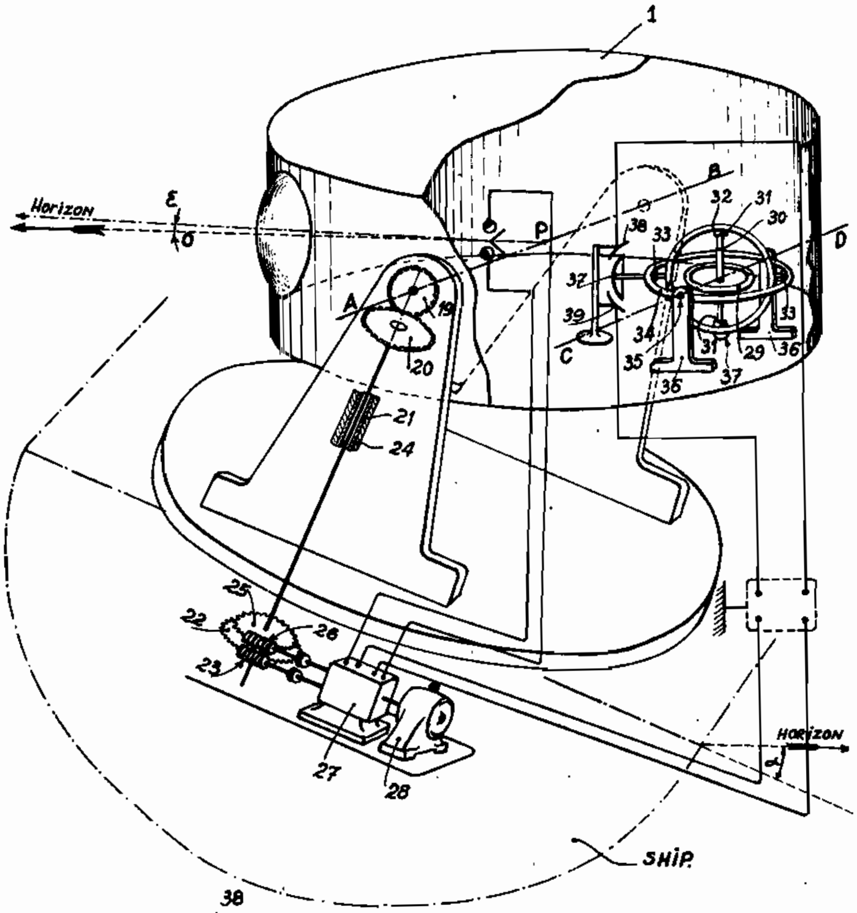

Fig. 7

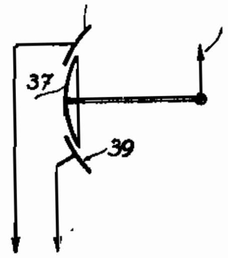

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Fig. 8

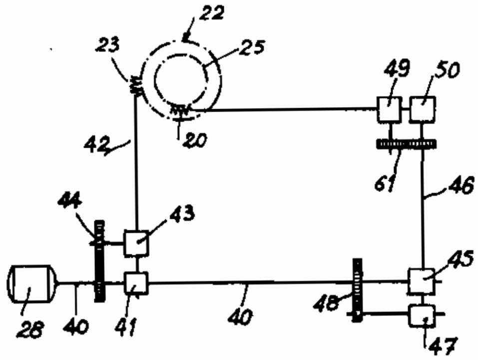
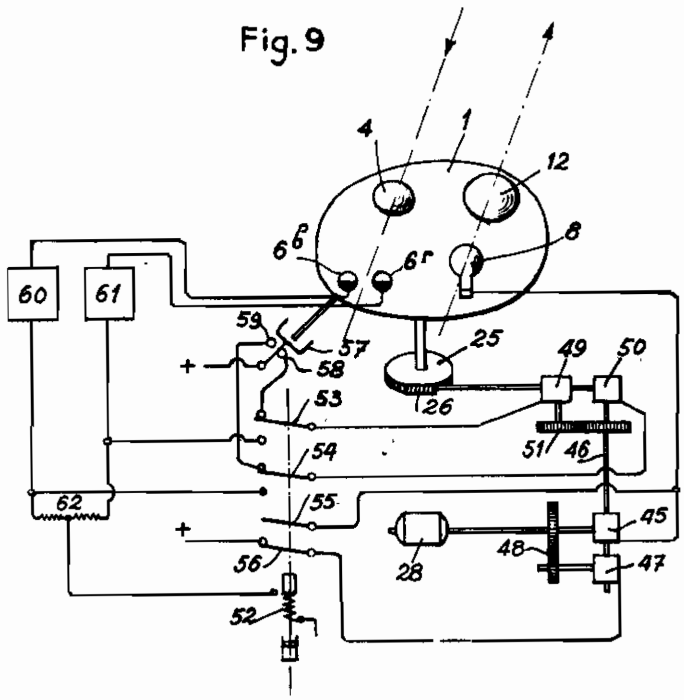


Fig. 9



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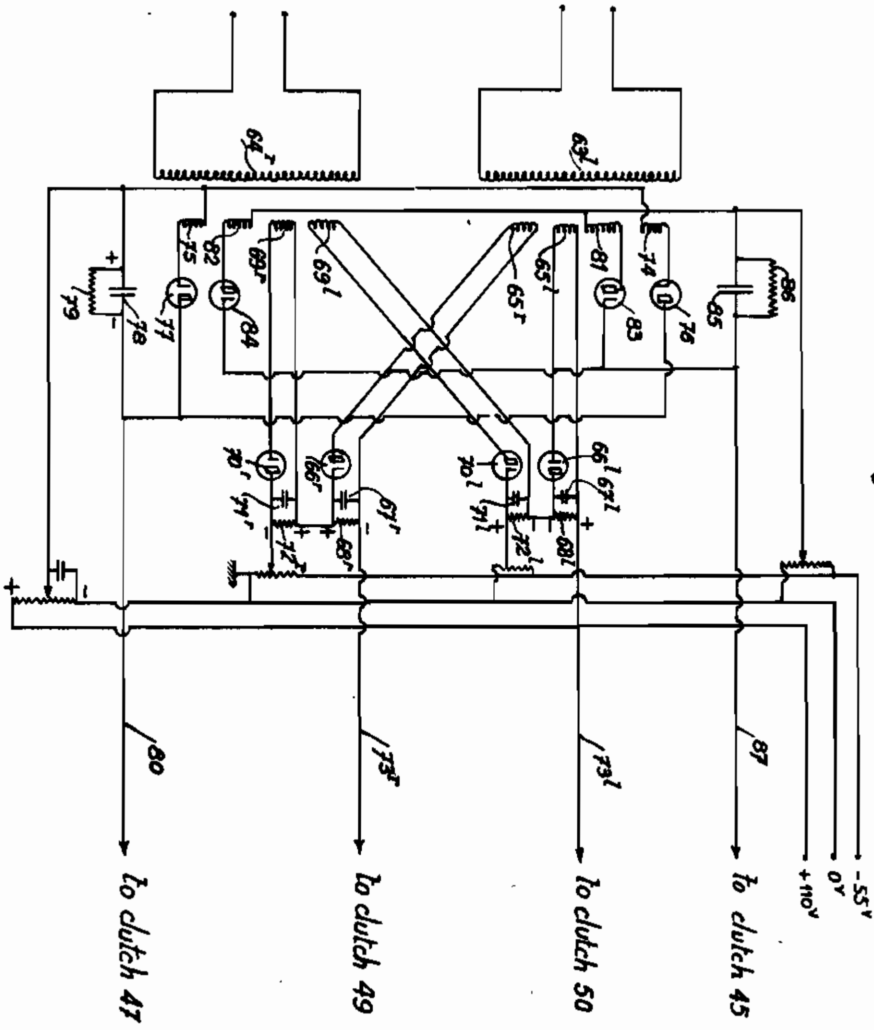

Fig. 10

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Fig. 11

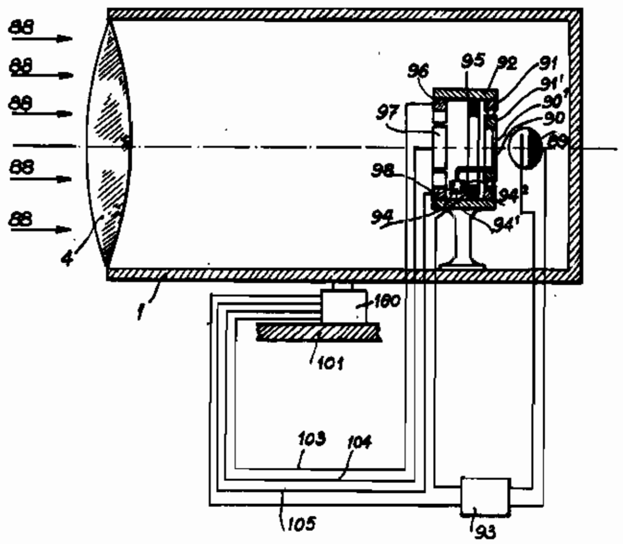

Fig. 12

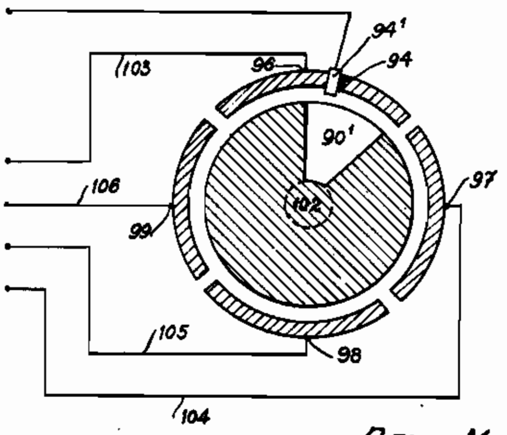

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Fig. 13

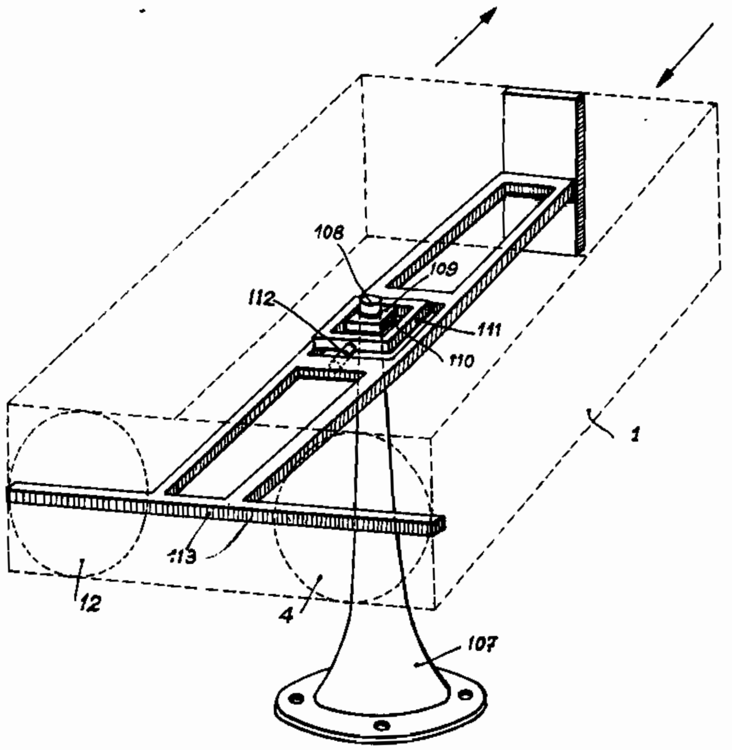
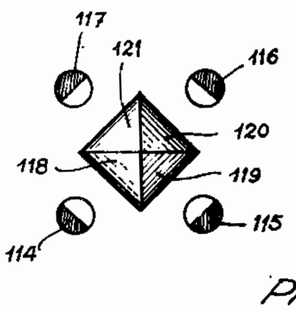


Fig. 14



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ALIEN PROPERTY CUSTODIAN

ORIENTATION SYSTEMS

Pierre Marie Gabriel Toulon, Neuilly sur Seine, France; vested in the Alien Property Custodian

Application filed June 11, 1941

My invention relates to improvements in systems for orienting or pointing an apparatus on a determinate direction or objective, and more particularly in such systems in which the apparatus to be pointed is located upon a moving body, such as a ship, which is continually oscillating by rolling and pitching.

An important object of my invention is to provide a novel method for automatically pointing an apparatus in the direction of a distant source of radiant energy. This source can radiate waves of different nature, for instance visible or invisible luminous waves and electro-magnetic waves of short wave length, but preferably in embodiments of the invention, a source of invisible luminous rays is used, for instance a source of infra red rays.

Another particular objeet of the invention is to provide a system for automatically and reciprocally maintaining two orientable apparatus pointed each on other, which are located upon distant moving bodies subjected to continual movements, such as ships, and thus to realize a safe and permanent telecommunication between two ships, in spite of continual oscillations and respective and relative displacements of said ships.

The invention provides also improved means for searching a correspondent by sweeping of the horizon in order to establish this telecommunication, which will be afterwards automatically secured by the novel method above mentioned, at the mercy of the correspondents.

A further object of the invention is the use of this telecommunication for the transmission of intelligence.

Still another object of the invention is to indicate automatically on board of a ship the direction of another ship, and also the approximate distance of the same.

Other objects and advantageous features will become apparent from the description hereafter and appended claims.

The method according to the invention comprises the steps of directionally receiving and focusing in the apparatus to be pointed a beam of the radiation emitted by the distant source of radiant energy, producing an electric effect by said focused beam in dependance of the angular relation between the directional axis of the apparatus to be oriented and the direction of the radiating source and controlling the movement of the orientable apparatus by said electric effect.

In accordance with a preferred embodiment of the invention, a source of invisible luminous rays is used, particularly a source of infra red rays, the directional receiving of these rays and the focusing of the same being performed by a optical system included in the apparatus to be oriented. This system leads and concentrates the infra red rays on a detecting photo-electric device in dependence of the angular relation between the optical axis of said optical system and the direction of incident infra red rays, and the output of the detecting device controls the displacement of the apparatus to be oriented; by this system the detecting device is not influenced when the optical axis of the optical system coincides with the direction of the incident infra red rays, while on the contrary, when said optical axis stands at an angle to the direction of the incident infra red rays, the photo-electric detecting device is influenced and causes the control of the movement of the orientable apparatus for bringing back said optical axis in coincidence with the direction of incident infra red rays, and consequently the orientable apparatus in desired direction.

By associating a source of infra red rays with the directional optical system in the vicinity of this, inside the orientable apparatus, it is obtained a system capable of emitting in his turn a beam of infra red rays which follows truly the displacements of the orientable apparatus and can thus works out a distant control of an orientable apparatus according to the above mentioned method.

In this association, the effect produced at a distance by the beam of infra red rays is considerably increased because the directional property of said beam and optical receiving system, which permits either an important increase of the range for a given power of the beam, or a decrease of this power for a predetermined range.

By coupling two systems such as the latter, the beam of one system being used for automatically controlling the orientation of the other system and reciprocally, it becomes possible to reach the object above mentioned, namely, to maintain pointed each on other, regularly and permanently two orientable apparatus lying upon distant moving bodies. This mutual control at a distance also permits safe and uninterrupted optical telecommunication between both moving bodies, such as ships, as above mentioned.

Further on account of the fact that each of the beams is constantly pointed on each of the optical receivers a third party has no possibility to disclose the position of said orientable apparatus.

In this telecommunication system, it is important to prevent disphony, that is the influence of the very powerful beam on the adjacent optical receiver. This end is reached by a feature of the invention according to which the respective luminous beams, projected by the orientable apparatus, are breaked at different frequencies, particularly by means of rotative obturating discs drived by electric motor, which permits the association of electric filters with each of the optical receivers.

The invention also provides means allowing to stabilize these breaking frequencies at fixed and predetermined values by producing electric currents respectively dependent of said frequencies and intended to act on the speed of the respective driving motors, which may be also provided with speed stabilizing means through electric filtering.

For obtaining with certainty a fast connection between correspondents the invention forsees that during the listening all receivers are adjusted and sensitized a predetermined breaking frequency f, while the luminous beams have a different breaking frequency f^1. For calling, the set, wanting to emit, reverses these two frequencies, whereby it can enter in touch with a correspondent and afterwards the bilateral communication can be maintained.

For searching a correspondent in order to establish the telecommunication, it is provided improved means for sweeping the horizon. According to a preferred embodiment of the invention, a gyroscope having a vertical axis is used, which maintains each luminous beam in horizontal plane and permits to sweep the horizon by means of said beam. Preferably this sweeping takes place at a great speed and means are foreseen to decrease considerably this speed when the correspondent has been touched up.

According to an improved modification, the gyroscope is mounted in the orientable apparatus and has one of its suspension axis parallel to one of oscillation axis of the orientable apparatus, so that the gyroscope has cnly to disclose and to compensate weak angular displacements. Such angular displacements are translated advantageously by high frequency electric currents with the help of means having no sliding contact.

According to a preferred embodiment of the invention the movement of the orientable apparatus is secured by a electric motor in continuous rotation associated with electromagnetic clutches, which are preferably formed by a differential system. Each clutch secured the connection of two coaxial shafts, which are thus rapidly interchangeable. The displacement towards the top and the bottom, also towards the right and the left, with a great and slow speed is obtained by identical clutches actuating a suitable mechanism.

The optical projector and receiver of each orientable apparatus comprise preferably lenses adapted to form simultaneously water-tight joints. Besides, the evacuation of the heat produced within projector is secured by a cap made in a metal having a high heat conducticity, such as aluminium, which cap is provided with internal ribs picking-up calories delivered by the projector lamp and evacuating these on external ribs.

Another feature of the invention resides in the use of means which permit to limit the output level of amplifiers associated with photo-electric cells, and to make said amplifiers act differentially on the orientation mechanism of the orientable apparatus.

For a clear understanding of the manner the objects of the invention are achieved, reference may be had to the accompanying drawings illustrating a preferred embodiment of the invention, it being understood, however, that the specific illustration is for the purpose of disclosure only and places no limitation upon the invention.

In the drawings

Fig. 1 represents in schematic form an automatic orientation system embodying the method according to the invention.

Fig. 2 shows in schematic form a similar system with relaying.

Fig. 3 represents in schematic form the method according to the invention as applied to the mutual and reciprocal orientation of two orientable apparatus located on distant moving bodies.

Fig. 4 is a plan view of an embodiment of an orientable apparatus according to the invention.

Fig. 5 is an elevation, partly in vertical section, of Fig. 4, showing a control mechanism for the apparatus to be oriented.

Fig. 6 represents in schematic form the basis arrangement of a gyroscope with vertical axis inside the orientable apparatus for securing said apparatus to be maintained on the horizontal plane.

Fig. 7 illustrated in schematic form an electrostatic control of the orientable apparatus by the gyroscope.

Fig. 8 represents in schematic form the arrangement of clutches acting upon the mechanism of Fig. 4.

Fig. 9 illustrates in schematic form the circuit arrangement for the control of the orientable apparatus.

Fig. 10 shows a differential circuit arrangement for the control of the clutches.

Fig. 11 illustrates, in vertical section an embodiment of an orientable apparatus with a single photoelectric cell.

Fig. 12 represents the obturating disc associated with an distributor included in the embodiment of Fig. 11.

Fig. 13 is a basis view of a three perpendicular axis suspension enabling the orientable apparatus to be suspended in indifferent equilibrium.

Fig. 14 represents the arrangement of four photoelectric cells for the embodiment of Fig. 13.

Referring to Fig. 1, the embodiment for carrying in effect the method according to the invention comprises the arrangement on a moving body, especially a ship **1**, of an orientable platform **2** to be maintained continually and automatically in the direction of a remote source radiating infra red rays **3**. The orientable platform **2** is provided with an directional optical device including a lens **4** and a set of mirrors **5** standing at an angle each other; the lens **4** directs the incident infra red rays on the set of mirrors, which concentrates said rays on a set of photoelectric cells **6**. This set of photo-electric cells acts upon a mechanism **7**, illustrated here in schematic form, but which be described later, the function of which is to move the orientable platform. The system is so arranged that, when the ship has no movement, the optical axis of the lens **4** is pointed on the source **3**, and the infra red rays, which are concentrated by the mirrors **5**, do not impinge on the photo-electric cells **6**. On contrary, when the ship has continual oscillating movements or when the location of the source **3** changes, the optical axis of the lens 4 stands at an angle to the direction of the source 3, and the result is that the infra red rays impinge on either photo-electric cell 6. The excited cell causes then through his onput circuit the control of the mechanism 7 and the latter brings back the orientable platform in the direction of the source 3.

The system above described may be improved by the adjunction to the orientable frame-work of a radiation source, such as a source of infra red rays, which may be used for automatically orienting another distant orientable apparatus, similar to the apparatus illustrated in Fig. 1. This improvement is illustrated in schematic form in Fig. 2. In the orientable platform or frame-work 2, besides the apparatus previously described, a search light or projector is arranged, particularly a projector of infra red rays, this axis of which is parallel to the axis of the optical system 4—5 and including a luminous source 8 of great intensity and surface which is located in vicinity of a concave mirror 9. This mirror reflects luminous rays from a source of light 8 under a wide angle, so that a good luminous efficiency is obtained. At 10, upon a rotative disc 11 breaking the luminous beam, is formed a magnified image of the source 8, which is projected to infinity by means of a lens 12. On account of the great surface of the image at 10 and the small focal length of the lens 12 it is possible to obtain a very high degree of illumination for a great surface, and consequently to realize a beam with a large cone of light, which may be easily picked-up. An electric motor 13 drives the disc 11 at a constant speed, so that the breaking frequency of the luminous beam is exactly determined, whereby the system is not influenced by the daylight or other parasitic light and the amplification at the reception is facilitated. In the described system, it is advantageous to utilize invisible radiations, particularly infra red rays, by use for instance of suitable filters.

In the improved system thus establish, the light projectors 8, 9, 12, in fixed relation with the orientable platform or frame-work 2, is subjected to the same displacements as said frame-work, which displacements result from angular digressions between the direction of the source 3 and the optical axis of the receiving device 4—5—6, so that the luminous beam supplied by the projector 8, 9, 12 can relay at a distance these angular deflections for controlling an apparatus, located for example at 15, similar to the apparatus illustrated in Fig. 1.

By pairing two systems similar to this illustrated in Fig. 2. located upon distant moving bodies, such as ships, it becomes possible to ensure a mutual and reciprocal control of two orientable frame-works, and consequently a safe and uninterrupted telecommunication between two ships. The Fig. 3 illustrates in schematic form such a pairing system of two orientable frame-works located upon two distant ships 1 and 1a, which are subjected to the action of the surge and can move about. In this figure, the same reference numbers are used to designate the same pieces as above. The first ship 1 supports an orientable frame-work 2 fitted up in the above described manner, that is comprising a light projector including a concave mirror and a lens 12, which supplies from a source of light 8 a luminous parallel beam 14, breaked by a rotative disc 11. This beam impinges on the optical receiving device included within the orientable frame-work 22, which is mounted on board of the ship 1a; thence the beam is directed by a lens 4a on a set of mirrors 5a standing at an angle to each other and from these condensed on photo-electric cells 6a. This arrangement, as above stated, ensures the automatic pointing of the orientable frame-work 2a on the projector 8—9—12 of the orientable frame-work 2 mounted on board of the ship 1, by means of a mechanism 7a controlled by the photo-electric cells 6a. In the pointable frame-work 2a is arranged a projector including a concave mirror 9a and a lens 12a, which supplies from a luminous source 8a a parallel beam 14a breaked by the rotative disc 11a. The optical axis of this projecting device having a fixed position in relation to the optical axis of the receiving device 4a—5a, which is maintained in a pointed position on the projector 9—12 of the orientable frame-work 2, it results therefrom that the beam 14a is parallel to the beam 14 and just pointed on the frame-work 2 of the ship 1. There it impinges on the optical receiving device included within the frame-work 2, which is similar to this of the frame-work 2a, namely including a lens 4 associated with a concave mirror set 5 for directing and condensing the luminous beam on a set of photo-electric cells 6. This arrangement ensures the automatic pointing of the orientable frame-work 2 on the projector 8a—12a by means of the mechanism 7 controlled by the photo-electric cells 6. Thus each luminous source 8, 8a maintains pointed on it the orientable frame-work located on the other ships so that the orientable frame-works 2 and 2a of both ships remain continually pointed each on other, whatever may be the movements caused by the surge and the relative displacements of both ships.

Owing to these continually pointed each on other frame-works, the above described system permits to establish a bilateral, regular and uninterrupted telecommunication between the two ships. This telecommunication may be either optical, as described in the instance, or performed by way of electromagnetic waves by utilizing a directional wireless beam at each emitting device.

For preventing the local optical reaction, that is the straight action of the projector on the adjacent photoelectric device, it is advantageous to use different breaking frequencies for the luminous beams 14 and 14a. For instance the beam 14 may be breaked at a frequency of 1000 cycles per second, and the beam 14a at a frequency of 1500 cycles per second; correspondingly the photo-electric cells included in the receiving devices are sensitized respectively the one 6a at said frequency of 1000 and the other 6 at the frequency of 1500. Advantageously each photo-electric cell is associated with an eleetric filter which makes the amplifier of one pointable frame-work unable to be influenced by the adjacent projector located in the same frame-work, while making said amplifier excessively sensitive to the breaking frequency of the frame-work located on the other ship. Also the breaking of the beam may be used simultaneously in combination with a separate photo-electric cell for supplying an electric current which, after amplification, is intended to stabilize the speed of the electric motor respectively 13, 13a at a constant value. This stabilisation may be obtained by means of an electric discharge tube, to the control electrode of which is applied the said electric current, while the anode current of said tube influences the excitation circuit of the motor 13, 13a driving the breaking disc 11.

According to a preferred embodiment of the mechanism 7 or 7a controlled by the set of photo-electric cells 6 for moving the orientable frame work, said mechanism is mounted on a dual cardan suspension and a vertical axis gyroscope included within the orientable frame-work and having a gravity step-back device, ensures the horizontal stability of said frame-work; consequently the set of photo-electric cells 6 causes only the control the frame-work displacements in the horizontal plane. This embodiment is illustrated in Figs. 4–5.

Each orientable frame-work 1 or 1a is mounted upon a pedestal base 15 and rotation and oscillation of this frame-work are obtained by a mechanism 16 arranged in the lower part of the pedestal base 15. The movement of the frame-work in the vertical plane is controlled by a stabilizing gyroscope 17, the arrangement of which will be described later, and in the horizontal plane by two photo-electric cells 6r and 6l. For the purpose the frame-work is supported by a spindle 18 and a right angle bevel gearing 19, 20 causes the optical axis of the frame-work 1 to be deviated either towards the top or the bottom. The pinion 20 is connected with a vertical axis 21 which is controlled by a toothed wheel 22 driven by a worm 23. The support 24 for the axis 18 is connected with a toothed wheel 25 driven by another worm 26, which secures the rotation of the framework round the vertical axis.

For supplying the amplifiers associated with the photo-electric cells and the projector included within the frame-work 1, electric connections must be used. According to the invention, the vertical shaft 21 is tubular and thus permits all conductors to be passed towards the apparatuses of the frame-work 1. This tubular shaft is water-tight so that the gear case enclosing the wheels and worms 22, 23, 25, 26 may be filled with oil.

The driving of the wheels 22 and 25 is controlled by electromagnetic clutches enclosed within a case 27; these clutches have a great time constant and a progressive effect. The whole is driven by an electric motor 28 in continuous rotation.

The motor 28 and the clutches 27 are enclosed within a case not illustrated, and a suitable water-tight and flexible joint is inserted between the pedestal base 15 and the frame-work 1, so that the whole is not infurled by spray.

The stabilisation of the orientable frame-work 1 in the horizontal plane is realized by means of the small size gyroscope 17 in the manner described thereafter, referring to Fig. 6, which illustrates in schematic form the basis arrangement and operating way of the gyroscope within the framework 1. This gyroscope comprises a revolution body 29 journalling at 31, 31 within a ring 32 rotatable, in his turn, at 33, 33 within another ring 34. This latter rotates at 35 within a pedestal base 36 fastened to the frame-work 1. The spindle 30 is brought back in vertical direction by a heavy mass 37 and the ring 34 remains permanently in the horizontal position. The position of the pedestal base 36 within the frame-work 1 is so arranged that the suspension horizontal axis A B of the frame-work 1 is parallel to the suspension horizontal axis C D of the gyroscope. Thus the optical axis of the frame-work 1 is parallel to the axis O P of the gyroscope, that is perpendicular to the common direction of the respective cardan suspension axis of the frame-work 1 and gyroscope. Owing to this arrangement, it is no longer need to stabilize the frame-work 1 in two directions but only in one direction for ensuring the horizontality of the luminous beam. When under effect of the ship oscillations, the frame-work 1 and consequently the pedestal base 36 of the gyroscope, begin to list over the horizontally maintained ring 34, the list is translated immediately by above described means for controlling the clutches enclosed in 27, and the orientable frame-work is operated for bringing back the optical axis in the horizontal plane. In these conditions the gyroscope has only to disclose weak angular deflections of the frame-work 1 in relation to the stabilizing horizontal position of the optical axis, that is angular deviation of one to two degrees about, while the oscillation amplitude of the ship can reach thirty degrees.

According to a preferred realization the angular position of the small size gyroscope in relation to the frame-work 1 is disclosed by means of high frequency currents, whereby it is prevented any sliding friction which would have a tendency to occur, for instance under action, of a brush rubbing on a contact piece. The amplitude is disclosed proportionally so that in the desired clutch a current is obtained which varies independence of angular deviation between the true and momentary position of the frame-work.

This high frequency current control is illustrated in schematic form in Fig. 7. The ring 34 of the gyroscope 17 is connected in any suitable manner with an electrode 37 facing two electrodes 38 and 39 fastened to the frame-work 1. The variable capacity between 37 and 38 forms a part of an oscillating circuit not illustrated; the variable capacity between 37 and 39 form a part of another oscillating circuit not illustrated. The resonant frequencies of these circuits, consequently the intensities of respective currents flowing through said circuits, are varied necessarily in accordance with the relative position of the electrodes 37, 38, 39 and consequently in accordance with the relative direction of the optical axis of the frame-work 1 and the suspension horizontal axis of the gyroscope. After amplification these currents act upon the corresponding clutches 27 which control the rotation of the worm 23 in the desired direction. This system, which can offer any desired sensitiveness and working rapidity, compensates automatically the oscillations owing to rolling and pitching and also the acceleration which may be exerted on the ship.

In the telecommunication system above described, the initial finding of a correspondent is difficult since the optical axis of both frame-works, which are moving in space and independent, must be brought in coincidence. For making easier this initial finding, it is foreseen that, during the period of watching, the orientable frame-work is moved continuously in the horizontal plane until it receives a luminous impulse from his correspondent. At this instant the orientable frame-work is brought automatically under control of the received luminous beam, by means of the method above described. The initial calling of the correspondent is obtained by momentarily stopping the horizontal sweeping during a time and by lighting the projector in the most likely direction of the correspondent. If this latter is responding, an automatic mechanism releases the control which ensures the pointing of both frame-work on each other. In order that the correspondent finding may be rather fast, rather fast alternative movement is imparted to the orientable frame-work until such time as the beam of the correspondent has been received. At this instant the frame-work is subjected on contrary to slow displacements which permit the control. In other words, one changes from the horizontal sweeping taking place at great speed during the watching period to adjustments at slow speed during the control period.

This improvement is accomplished by a particular arrangement of the clutches enclosed in 27, which is illustrated in schematic form in Fig. 8. The motor 28 drives a shaft 40 which may be coupled with another shaft 42 by intervention of the clutch 41 in order to point the orientable framework upwards by means of the transmission gear 22—23. When the clutch 43 is operated, the shaft 42 rotates in the opposite direction, owing to the gearing 44, and point the frame-work downwards.

A clutch 45 causes a shaft 46 to rotate slowly, while another clutch imparts to said shaft 46 a fast rotation by intervention of a gearing 48. Finally clutches 48 and 50 cause the tubular shaft 24 of the mechanism 16 (Fig. 5) to rotate at right hand and left hand by means of a gearing 51, and consequently the orientable framework 1 follows these displacements by intervention of the transmission gear 25—26. This pointing at right hand and left hand may be thus accomplished rapidly or slowly according to the intervention of clutches 47 or 45.

The clutches 41 and 43 are controlled by the gyroscope 17, through intervention of the device of Fig. 7, during the watching period; clutch 47 causes the shaft 46 to rotate rapidly, and clutches 48 and 50 control the alternative sweeping of the horizon by the optical axis of the frame-work according to the desired angle. If, in the course of this fast sweeping, either of cells 8^r, 8^1 is influenced by a suitable modulated luminous beam, the great speed clutch 47 is replaced automatically by the slow speed clutch 45; clutches 48 and 50 are controlled by photo-electric cells 6^r and 6^1 and cause the frame-work 1 to be pointed on the received beam. Simultaneously a particular relay lights the source 8 and starts the small motor 13 which modulates the light beam of the source 8.

The Fig. 9 illustrates in schematic form this arrangement. During the watching period, a relay 52 controlled by photo-electric cells 6^r and 6^1, is not excited, and its movable contacts 53, 54, 55, 58 are in the illustrated position. The motor 28 is rotating and the great speed clutch is supplied with current by contact 58, so that the frame-work 1 is rotating rapidly, at right hand for instance. After a time, the frame-work 1 causes a fork 57 to rock, which instead of making contact with fixed contact piece 58, as illustrated in the drawing, passes over contact 59; this has as a result that clutch 49 is no longer excited; while clutch 50 starts in operation, so that the orientable frame-work begins to rotate rapidly at left hand. The frame-work thus performs the horizontal sweeping above mentioned.

As soon as either of cells 6^r or 6^1 receives through the lens 4 the suitably modulated radiation from the other ship, amplifiers 80 and 61 supply by a voltage divider 82 the relay 52 which attracts its armature. This has as a result that the movable contact 55 supplies with current the clutch 45, while the circuit of the clutch 47 is open by the movable contact 56, which causes also the luminous source to light. On the other hand amplifiers 60 and 61 supply with current through movable contacts 53 and 54 the clutches 49 and 50, which maintain automatically the orientable frame-work pointed on the luminous beam of the correspondent. The relay has a time limit release, so that it is not influenced by short interruptions of its exciting current when the incident beam changes from one photo-electric cell to the other. But, if for any reason, the communication has been interrupted, the system returns automatically to the watching state.

In this system local reaction of the projector, that is direct action of the projector on the adjacent photo-electric cells, is prevented by use of different breaking frequencies for the luminous beams, as already mentioned. During the watching period photo-electric cells 6^r and 6^1 are sensitized for instance, to a breaking frequency of 1500 cycles per second, while, on contrary, said cells are particularly adapted to give no response to the frequency of 1000 cycles per second, that which the rotative disc 11 imparts to the beam of light of the source 8.

After having picked up the beam of the correspondent, which is also in watching condition, one ship for calling sends a settled signal "demand-watching"; at this instant the operator changes the breaking frequency of the projected luminous beam and also the frequency of electric filters associated with output circuits of photo-electric cells. During the demand period, the photo-electric cell device is sensitized for instance to the frequency of 1000 cycles per second, while the luminous beam is breaked at the frequency of 1500 cycles per second.

Once the telecommunication established, the frame-work having called keeps its new adjustments, namely emission at 1500 cycles per second and receiving at 1000 cycles per second, while the other frame-work keeps the adjustments corresponding to the watching period, namely emission at 1000 cycles per second and reception at 1500 cycles per second.

In these conditions no interference is feared between there and back luminous beam, because the communication between the two ships is ever started by either of correspondents, and by choosing the breakings different in frequency, the communication may be ensured without fear of interference.

The range of said telecommunication may be excessively variable, the luminous beam strength varying not only with distance, but also with opacity of air or fog, so that the intensity relation at the reception may be varied from 1 to 10^6. This is a great difficulty. On the other hand the supply voltages of the board main are frequently variable and amplifiers gain are very irregular.

These drawbacks are overcome by thereafter described means. Each amplification channel has an automatic gain control which adjusts automatically the output level at the suitable value. The gain is preferably settled upon the general output level; an electric filter permits the signal amplitude having the desired characteristic frequency to be picked up; thus the quotient of the background noise and the effective signal is measured automatically.

Moreover in order that the orientable frame-work response towards right-hand and left-hand takes place truly, the invention contemplates the use of a differential detector device between the amplifier output and electromagnetic clutches **27**, which device is described thereafter in reference to Fig. 10. Windings **63^l** and **64^r** are respectively the amplifier output windings. With the winding **63^l** are coupled two windings **65^l** and **65^r** which supply two respective circuits including to one a rectifier **66^l** associated with a condenser **67^l** and a resistance **68^l**, the other a rectifier **66^r** associated with a condenser **67^r** and a resistance **68^r**. Both rectifiers **66^l** and **66^r** are arranged in reverse connection, in such a way that the continuous voltages across resistances **68^l** and **68^r** have reversed polarity as indicated in Fig. 10. Likewise with the winding **64^r** are coupled two windings **69^l** and **69^r** which supply two respective circuits including the one a rectifier **70^l** associated with a condenser **71^l** and a resistance **72^l**, the other a rectifier **70^r** associated with a condenser **71^r** and a resistance **72^r**. Both rectifiers **70^l** and **70^r** are arranged in reversed connection, so that the continuous voltages across resistances **72^l** and **72^r** are reversed polarity as indicated in Fig. 10. The connection **73^l** supplies with current the clutch **50**, of Fig. 9, which causes the orientable frame-work **1** to be moved towards the left hand, and the connection **73^r** supplies with current the clutch **49** of Fig. 9, which causes the orientable frame-work to be moved towards the right hand. If an electric impulse translated by the photo-electric cell **6^l** has as a result to make a voltage of value A appear across the resistance **68^l**, on contrary a voltage of value $-A$ appears across the resistance **68^r**. Likewise, if an electric impulse translated by the photo-electric cell **6^r** to the winding **64^r** has as a result to make a voltage of value B appear across the resistance **72^r**, on contrary a voltage of value $-B$ appears across the resistance **72^l**. The connection **73^l** thus applies to the clutch **50** a differential voltage of value A—B, and the connection **73^r** applies to the clutch **49** a differential voltage of value B—A. For instance, if $A=10$ and $B=1$, figures which correspond approximately to the case in which the frame-works to be oriented each on other are remote, and that clutches **49** and **50** be settled in order to work at **2**, the clutch **50** only works, when the photo-electric cell **6^r** is excited by the luminous beam from the remote projector, and that as with as without use of the differential detector device. But if both orientable frame-works are near, that is $A=10{,}000$ and $B=1{,}000$, each of photo-electric cells **6^l** and **6^r** would supply without the differential device a sufficient current for simultaneously exciting the clutches **49** and **50**, and consequently the system would be inoperative. On contrary with use of the differential detector device the difference between A—B and B—A, which was 18 in the first instance, becomes in the second instance 18,000, namely excessively greater, so that the accurate working of the system, which would be already ensured without use of the differential device in the first case for a difference of 18, is ensured a fortiori in the second case for a difference of a thousand time greater.

The differential detecting device for exciting the clutches **49** and **50** is associated with the respective exciting circuits of the slow speed clutch **45** and the high speed clutch **47** so as to obtain the working of these clutches as for the right-hand displacement as for the left-hand displacement of the mechanism **18** of Fig. 5. In this purpose windings **63^l** and **64^r** supply with current, through respective windings **74** and **75**, two rectifiers **76** and **77** in parallel connection in a circuit including a condenser **78** and a resistance **79**, which circuit delivers, through the connection **80**, the exciting current necessary to the high speed clutch **47**. Likewise the windings **63^l** and **64^r** supply simultaneously, through respective windings **81** and **82**, two rectifiers **83** and **84** in parallel connection in a circuit including a condenser **85** and a resistance **86**, which circuit delivers, through the connection **87**, the exciting current necessary for the slow speed clutch **45**.

Instead of two photo-electric cells enclosed in receiving device for controlling the right-hand and left-hand movement of the orientable frame-work it is possible to utilize only one photo-electric cell associated with rotative obturating disc and a distributor. This modification is illustrated in Figs. 11 and 12. The orientable frame-work having any suitable form, is provided with an aperture in which is mounted the lens **4** for directing and condensing the incident beam **88** on a single photo-electric cell **89**, through a rotative obturating disc **90**. The latter, which is rotating by an electric motor not illustrated, is mounted within a follow ball bearing **91**, the internal ball of which **91^1** is driven by the electric motor with help of a belt not illustrated; the external ball race is fitted in a support **92**. The obturating disc **90** comprises a massive part occupying the most area of the disc and a perforated part **90^1** in sector form. The photo-electric cell **89** is facing to the disc and picks-up infra-red rays which are travelling through the sector aperture **90^1**. This aperture, the surface of the photo-electric cell and the position of the same are arranged in such a way that said cell receives the infra red rays having passed through the aperture **90^1**, whatever may be the position of this latter. The cell **89** is connected to an amplifier **93**, the onput of which is connected to a rotative brush **94** fastened on a support **94^1** integral with the rotative disc **90** and driven simultaneously with him. The current is applied to the brush **94** through a fixed ring **95** upon which is rubbing another brush **94^2** fastened and electrically connected to the support **94^1**. The brush **94** is rubbing upon fixed sectors **96**, **97**, **98** and **99** connected with a mechanism **100**, which may be the mechanism **18** with clutches **27** and motor **28** illustrated in Fig. 5. This mechanism is fastened to the ship **101**.

Normally, that is when the axis of the lens **4** coincides with the direction of incident infra-red rays, the image of the distant source is formed on the massive central part of the rotative disc **90**, namely the part **102** illustrated in dotted line in Fig. 12. In these conditions no light impinges on the photo-electric cell **89** and no current is applied to the mechanism **100**; the frame-work **1** remains in the desired position.

If, in consequence of any exterior impulse, such as the wind effect and the oscillations being transferred by indesirable friction to the mechanism **100**, the frame-work **1** is rotating, or if the remote source is displaced, the image is no longer formed exactly at **102**, but at a distance of this circle. At the instant when the sector **90^1** passes in front of the luminous spot formed by the image, the photo-electric cell **89** delivers a current which, after amplification, is applied to the mechanism **100** through either of connections **103**, **104**, **105** and **106**, in accordance with the position of the luminous spot on the obturating disc **90**. This, for instance, if the frame-work is pointed too high in relation to the direction of incident infra-red rays 88, the image of the distant luminous source is produced underneath the circle 102, and when the aperture 90[1] is below, the photo-electric cell 89 furnishes a current. At this instant the brush 94 is rubbing on the fixed sector 98 and this current is applied to the mechanism 100 through the connection 105, which has as a result to make the axis of the optical system to turn towards the bottom and the luminous spot to move towards the circle 102. When the luminous spot has reached this circle 102, the current is interrupted and, at this instant, the frame-work is accurately pointed. If, on contrary, the frame-work is pointed too low in relation to the direction of incident infra-red rays 88, the image of the remote source produced by the lens 4 is over the circle 102, and when the sector aperture 90[1] passes at the top, the photo-electric cell delivers a current. At this instant the brush 94 is rubbing on the fixed sector 96, and this current is applied through the connection 103, to the mechanism 100, which moves the frame-work 1 until the luminous spot falls again on the circle 102. Similarly, if the direction of infra-red rays is too on the left or right in relation to the optical axis of the lens 4 the photo-electric cell delivers a current through either of sectors 97, 99, and either of connections 104 or 106, to the mechanism 100.

Thus the system maintains the axis of the optical device in coincidence with the direction of incident infra-red rays and consequently the frame-work 1 is continuously pointed on the distant luminous source.

Instead of using a gyroscope for ensuring the stabilization of the frame-work in a horizontal plane, it is possible to suspend the orientable frame-work by means of three axis perpendicular on each other, arranged in such a manner that the common intersection point forms the center of suspension, and one make this center of suspension to coincide with the center of gravity, so that the orientable frame-work is in indifferent equilibrium and totally insensible to ship acceleration. In these conditions the pointable frame-work is at all times horizontably maintained and photo-electric cells control the orientation in the manner above described and illustrated in fig. 5.

An example of such a suspension or triple cardan suspension is represented in fig. 13. The ship supports a pedestal base 107 terminated by a vertical spindle 108 around which a metallic mass 109 is pivoting in horizontal plane. This mass has a horizontal axis 118 which supports a frame 111 pivoting round said axis. This frame 111 has a horizontal axis 112 which supports a frame-work 113 pivoting round said axis 112. The axis of pivots 108, 118 and 112 are perpendicular to each other, and the frame-work 113 is for instance similar to the frame-work 1 of fig. 4. By suitable balancing, the center of gravity of the frame-work 113 is brought to pass through the intersection point of axis 108, 118 and 112, so that the whole remains in indifferent equilibrium. Advantageously this balancing may be obtained by a judicious arrangement of the projecting optical system and adjacent receiving optical system. Lenses of both optical systems are indicated by 4 and 12. In this embodiment, four photo-electric cells 114, 115, 116, 117 are conjugated to four mirrors 118, 119, 120 and 121, as illustrated in fig. 14, in order to ensure the control of the frame-work 113 in all direction.

In the described examples of realization, one can take advantage of the automatic pointing of the frame-work on a moving distant projector, for determining in all times, the position and particularly the azimuth of this projector. For this purpose, with the frame-work is coupled, electrically or mechanically, an indicating instrument, the moving element of which, for instance a index or a luminous spot, will follow in front of a divided dial the movements of the frame-work and will indicate the position of same.

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