[Second Edition.]

PATENT SPECIFICATION

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163,741

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COMPLETE SPECIFICATION.

Improvements in the System and Apparatus for Enabling a Movable Object to Pursue an Electrically Staked Out Route in a more Precise way than by Means of Visual Points of Reference.

I, WILLIAM ARTHUR LOTH, of Rond Point Bugeaud, Paris, France, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The present invention relates to the system for enabling a movable object to follow a route electrically staked out by means of a conducting cable or cables which are traversed by electric currents, of the type in which the cable or cables are provided with metallic plates resting on the bed of the sea in the case of a submarine cable, or embedded in the ground in the case of a land cable, or in which there is a metallic return.

In connection with signalling from the shore to a light-ship it has been proposed to lay a telegraphic cable from the shore and form a cable-ring around the light-ship. By sending discontinuous currents into this cable ring, alternate currents are induced in a telephone connected in a secondary circuit carried on the ship. In another indicating arrangement the current sent into the submerged cable produced differences of potential in the neighbourhood of the light-ship, which produced a current in a conductor on the ship, the ends of which were let down into the water.

In the detection of electrical impulses sent into a cable laid along a predetermined route, by a movable object following the said route, it is known to employ a pair of coils at right angles and connected to telephones or relays. Indicating means has also been proposed in which two parallel coils are arranged with their axes at right angles to the direction of travel of a ship moving over a track, the coils being situated one at each side of the ship, and the induced currents being reinforced by known means and indicating by their joint action upon galvanometer needles.

The present invention has for its object improvements in the method and apparatus which allows the movable object.

a. To follow exactly a predetermined route when knowing at each moment the angle which the direction of route to be followed makes at the point where the movable object is situated with a predetermined axis of the latter, for instance, the fore and aft axis of a vessel;

b. To know its situation to the right or to the left relatively to the said route;

c. To know its position on the said route, that is, at what distance it is situated from a point, for instance, starting or arriving points.

The invention consists in an improved system for enabling a movable object to follow a route electrically staked out, of the type described, which comprises the use of a conducting cable having a loop formed at the end thereof, also in which there are two parallel branches fed by the same generator, and also variants as hereinafter described and claimed.

The invention further consists in the arrangements of receiving circuits as described and claimed.

In the diagrammatic drawings appended:

Figure 1 represents a cable, staking out the route to be followed by the movable objects, and terminating in a loop.

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Figure 2 shows the arrangement of the cable returning to its point of departure, laid out on the return parallel to its first direction, and formed with a loop at the further end,

Figure 3 represents two parallel cables with common earthing.

Figure 4 is a view with separate earthing of two parallel cables.

Figure 5 shows the arrangement of the cable, forming a frame-work which is closed by the conductive medium (earth or water) on which it is laid or in which it is embedded or sunk.

Figure 6 represents a cable to which are connected other cables which are perpendicular to it.

Figures 7, 8 and 9 are variants of the arrangement of Figure 6.

Figures 10 and 11 are views of the receiving apparatus.

Figures 12 and 13 represent receivers formed by perpendicular bases.

Figures 14, 15, 16 and 17 show receivers in the form of frames.

Figure 18 represents a receiver composed of radiating bases.

Figures 19 to 26 represent the arrangements which may be utilised for the purpose of application to a movable object navigating on the surface of the water or submerged (reception by induction).

Figures 27 to 31 show the arrangement of the system, which is the subject of the invention, on board an air-travelling object.

Figure 32 represents a movable object taking its course between two cables tracing out its route.

Figure 33 shows the movable object, indicated by broken lines, perpendicularly crossing the cable staking out its route.

Figures 34 and 35 are diagrams showing the variation of intensities of the currents received by the detectors receiving.

According to the present invention the route cable has its end formed into a loop as indicated by Figure 1 or other similar shape.

The cable may be continued in itself and when it has once reached the point to be attained may be brought back in the opposite direction (after having made a loop or knot) following the route which it already traced out in its outward course, but leaving between the same cable outward and return, a space variable at will and determined on the one hand by the preciseness which it is desired to obtain in following the traced out route and on the other by the facilities of manœuvring of the movable objects which are to follow the routes traced out by the cable outward and return (Figure 2). The end of the cable in this case comes back quite near to the point of departure, either to the other pole of the electric current generator, if the current is sent direct into the cable, or to the other terminal of the secondary circuit of the transformer, if the current is sent indirectly into the cable.

There may be several cables thus arranged, receiving similar or different currents.

Instead of sending the current into one cable, it may by means of one and the same current generator, be sent either directly or indirectly into several cables.

In the case of two conducting cables for instance, both these latter start as in the case of a single cable and by means of a switch either from one of the poles of the generator or from one of the terminals of the secondary circuit of the transformer. They are laid down parallel to each other at a distance varying at will according to the route which the movable objects are to follow and they end as previously stated in one or more metallic surfaces (common or separate).

By means of a switch the current can for equal or unequal times be directed alternately into the one or the other cable and then into both simultaneously and the rhythms of emission and the alternations can be changed at will. The means is thus obtained of distinguishing two parallel cables from each other while utilising the same emitter (Figure 3).

The other pole of the current generator or the other terminal of the secondary circuit of the transformer is connected by insulated conducting cable to a metal surface immersed or embedded in the same medium as those terminating the cables tracing out the route. Also a frame may be constituted with a return which is not metallic, but through the conductive medium in which are immersed or embedded the terminal surfaces of the metal circuit (Figure 5).

Instead of connecting up several cables either directly or indirectly with metallic return or return by conductive water or by earth on to the same generator, separate circuits may be utilised, each cable having its generator as shown in Figure 4. The cables may then no longer be distinguished from each other by rhythms or emissions, alternating and successive and then simultaneous, for instance, but by currents of different frequency.

The return mediums may be common. Separate metallic return mediums may also be utilised.

At wide intervals, at known distances other cables may be joined on to the route cables.

For instance, there may be laid down right and left of one (or several) main cables at known and varying distances, other cables of small lengths connected to said main cable and arranged perpendicularly thereto (Figure 6) terminating in metallic surfaces immersed or embedded in the usual manner.

These small conducting insulated transverse cables may terminate no longer in metallic surfaces embedded or immersed in a conductive medium, but either by another cable (Figure 7) itself terminating in a metal surface or by another current return cable, thus forming an entirely metallic circuit and ending at the other pole of the electric generator or the other terminal of the transformer at the station of emission (Figures 8 and 9).

Naturally in each case these transverse cables are provided with suitable resistances in order that the current should not pass almost entirely through the transverse cables which are nearest electrically to the point where the generator is situate.

There may be inserted in the staking cable or cables preferably at the centre of a loop which may be formed in the cable or cables, or in a right angle formed in the track, an apparatus for producing vibrations, the frequency of which is preferably equal to that of the current which traverses the said cables. This apparatus may consist of a simple electro-magnet or coil which is connected in a branch circuit taken off the loop, the other end being earthed. The electro-magnet acts upon a plate which is in contact with the environing medium (water or air) and adapted to vibrate with the pulsations of the sending current. If direct current is sent into the cable there is added to the apparatus an interrupter, such as a coil and trembler which latter imparts its frequency to the vibrating plate. This has the advantage of enabling the movable objects if thought necessary :—

(1) To find, far from the cable, coming from any direction, the end of the cable (or cables) in order to follow it afterwards.

(2) When, having followed the cable, they approach its end, to know the place where the cable ends or the extreme point which it reaches before its return to the emission station.

It will be remarked that particularly if alternating current is employed the resonance of the emitting electric circuits may be determined by known methods.

The receiver consists of two or more insulated conducting cables, the elements of each pair being at right angles to each other.

Any known form of detector or indicator interposed in the receiving cables, either directly or through the agency of a transformer (with or without an amplifier) may be employed which is suitable to the current to be received.

At each end each of the receiving cables is :

(1) Either cut and terminated by two metallic surfaces (Figure 10) thus constituting a receiving base.

(2) Or else not cut and taken back in the opposite direction towards the other pole of the current detector after having effected an entirely metallic circuit presenting a surface variable at will, constituting a sort of frame (Figure 11).

These open or closed circuit cables arranged perpendicularly of each other, must be of equal sizes if bases are employed ; of equal lengths and surfaces if entirely metallic circuits are used forming frames. If on the contrary they are of unequal size they must be compensated so as to present the same qualities from the electric point of view, that is to say that, placed at the same distance from the same circuit of emission, under the same conditions and in the same situation, the like detectors (or the same current detector) interposed in both must indicate currents of equal value (after compensation). This compensation may easily be obtained by interposing in the more favoured base or frame, a suitable resistance or if a transformer is employed by making variation in the coupling up of the primary with the secondary circuit to which is connected the current detector proper, with or without amplifier.

Figures 12 and 13 represent receivers formed by perpendicular bases.

Figures 14, 15, 16 and 17 represent the same receiving arrangements with entirely metallic circuits forming frames instead of bases, perpendicular to each other.

Instead of having only two rectangular bases or frames we may have (Figure 18) several bases or frames perpendicular to each other or radiating about a point where lies the current detector which is interposed at will and successively by means of a switch, in each of the bases.

If instead of having two or more bases or frames perpendicular to each other, only a single base or frame is used, instead then of being able to operate statically (without moving the receiving bases or frames) we are compelled to operate dynamically and to make the single base or frame which is used, movable about an axis so as to enable it to occupy all positions around this axis and in particular so as to be able to bring it into the two positions perpendicular to each other, occupied previously and permanently in the static receiver by the bases or frames catching the current.

The current detector (galvanometer or telephone with or without amplifier) is as previously inserted either directly or by means of a transformer in the movable base or frame.

In the case of a movable object which is submerged or moving on the surface of the water, if bases are used, the metallic surfaces terminating these latter must be submerged, but if frames are used for receiving instead of bases, these frames may be immersed or emerging fitted on the hull of the ship or on the deck or towed vertical or horizontal or inclined to the vertical; they may also be aerial supported by the masts for instance, but they are always compensated. Figures 19 to 26 inclusive give some examples of the mounting of frames on ships.

If, instead of it being desired to know at each moment the angle formed by the direction of the cable at the point where the movable object is situate with an axis of the movable object (the travelling axis for instance) whatever the movements of the latter it is simply desired to make the axis of travel of the movable object coincide with the direction of the cable tracing out the route to be pursued at the point where the movable object is situate, a single base or frame placed along the travelling axis of the movable object for instance, is sufficient.

It is possible to combine bases and frames and also to establish the resonance of the electric receiving circuits, if variable current is used.

OPERATION :—

The case of a single cable :

Into this cable terminated by a metallic surface or coming back to the other pole of the electric generator or of the transformer, current is sent as has been said.

With a receiver constituted by two bases (insulated cables terminated by metallic surfaces) these plates being immersed in a conductive medium, the current detector which is interposed between the bases will mark the passage of a current caught by conduction which will be all the greater in as much as the resistivity of the cable is lower relatively to that of the medium surrounding the cable and as the bases themselves are larger. This current will be at its maximum in a base when the latter is parallel to the emitting cable at the point where the receiving base lies and this current will be *nil* when the receiving base is perpendicular to the emitting cable at that point.

If the direction of the emitting cable forms equal angles with the direction of the two (or more) bases perpendicular to each other, the currents in these compensated bases will be equal.

Furthermore these receiving bases, if an alternating, vibrating or interrupted current is used for emission, likewise receive by induction. The induction is again at its maximum when a receiving base is parallel to the direction of the emitting cable at that point. The induction is *nil* in a base when this base is perpendicular to the direction of the emitting cable at that point. The two phenomena, conduction and induction are therefore in this case superposed in the reception.

If instead of perpendicular bases, rectangular frames be used, for instance perpendicular to each other, the reception then takes place by induction only, but the reception takes place in the same way by inserting current detectors in each of the frames.

The receiving frame parallel to the staking cable evidently receives the maximum current. The current detector placed in the frame perpendicular to the former indicates or records a zero current.

A single frame if fixed can only, as a single fixed base, give the coincidence of the two directions (emission cable and travelling axis) of the movable object at a given moment and that only by making the movable object manœuvre specially for that purpose. When once this coincidence is destroyed the movable object is once more compelled to manœuvre in order to restore it, as it is no longer known what angle its axis of travel makes with the direction of the emitting cable from the moment when there is no longer a coincidence of the two directions. If the receiver is at sea (submerged or not) or on land it is possible to receive by induction or by conduction or by induction and conduction combined, using the conductivity of the soil. If the movable object is an air traveller it is only possible to receive by induction.

In aerial navigation when the distance from the transmitting cables to the movable object is not too great it will be possible to constitute the receiver of an insulated conducting wire hanging outside the air-craft (aeroplane) hydro-aeroplane or dirigible (Figure 28) or by two wires at a distance from each other on the right and the left of the route made by the movable object by the aid of divergent planes (Figure 27) under the action of the pressure of the air developed on them by the speed. Under these conditions an alternating vibrating or interrupted current will develop induced charges in these wires (the other terminal of the current detector being earthed in the case of Figure 28). An induced current will likewise be received by the aid of a frame formed by the two wires themselves connected by a third wire (Figures 29 and 30). It will be seen that there is thus formed a frame of large dimensions towed by the aeroplane.

Beneath the wings (aeroplane, hydro-aeroplanes) it will be possible to arrange a receiving frame perpendicular to another frame disposed along the fuselage (Figure 31). The same would be the case by arranging the frames parallel to the longitudinal and transverse axis of air-ships.

Finally in the case of the staking cable forming a frame, if the receiver is also constituted by rectangular frames and if direct current is utilised for emission, it must not be forgotten that reception no longer takes place by conduction and that on the other hand one is not dealing with a variable field but with a magnetic field of a constant value at a given point. It is therefore necessary to utilise with the current detector, an arrangement by which it may be known when the frames are traversed by a flux increasing very slowly and even continuing to operate for a constant value of this flux greater than that for which the current detector was regulated at zero. For this purpose there may be used for example an arrangement similar to " Hughes' Balance " by utilising vibrating current in the receiving frames. This balance is regulated for a zero current received or if a telephone is employed for silence, away from the influence of any emitting frame. The flux in the frames of the receiver connected to the coils of the balance vary as soon as the emitting frame is approached and therefore the sound rises and grows in proportion as the emitting frame comes nearer. It is thus possible to detect the very slow variation and the new values of the field to which the receiving frames are subjected when approaching the frame-forming emitting cables.

As regards the current detectors:

(1) There may be inserted in each base or frame permanently (Figures 12, 14 and 15) a small frame. Inside these two small frames perpendicular to each other there may revolve, about an axis passing through its centre, a third small frame carrying an index which is displaced on a circumference graduated in degrees. At the terminals of this small frame there is placed in a circuit (with or without resonance) if it is a question of a variable current) either directly or through the intermediation of an amplifier a suitable telephone (tuned or not) or a galvanometer either thermic or electro-magnetic, frame or core or an electrometer *etc.*

Where it is a question of receiving alternating current for instance, the latter may be rectified (for instance by a " galena ") if desired before it is directed into the galvanometric detector.

Thus it is possible either to listen to, record or close relays indicating automatically the route correction to be made at any moment to bring the travelling axis of the moving body into coincidence with the direction of the emitting cable or cables laid down along the route to be pursued at the point where the movable object is situate.

When the small frame has its plane parallel to the plane of the frame placed in the base or the receiving frame parallel to the emitting cable at that point, the reception of the telephone or of the galvanometric receiver is the maximum. When, on the contrary, the small frame has its plane parallel to the plane of the frame placed in the base or the receiving frame placed perpendicularly to the direction of the staking cable at that point, it is found that the current traversing this small frame is zero.

In a general way with this arrangement, the two (or more) receiving bases or frames compensated perpendicular to each other each comprise a small frame. These frames are perpendicular to each other. Inside these small frames perpendicular to each other a third small movable frame can rotate and it is found that whatever the path of the movable object, the plane perpendicular to that of the small frame indicates at each instant, at the moment when the current received is cancelled, the direction of the emission cable or cables at the point where the movable object is, therefore the angle which the route of the movable object makes with the direction of the staking cable or cables, that is to say with the direction of the route to be followed at that point.

If instead of keeping two fixed rectangular bases or rectangular frames they are made movable about an axis, the same result is obtained as with the perpendicular fixed bases, namely, that it is possible at each moment to have the direction of the staking cables relatively to the route pursued by the movable object whatever the movements of the latter.

In point of fact it is sufficient when revolving the bases for the current detector of one of the frames or one of the bases to indicate a maximum current while the detector in the other perpendicular frame or base indicates the zero current. The direction of the staking cable is then perpendicular to that of the base whereof the current detector indicates a zero current.

Therefore it is seen that a single base or a single frame may suffice on condition that the latter is movable. At the moment when the detector interposed in it indicates a zero current received its direction is perpendicular to that of the staking cable.

There will be used as detector, either a telephone or a galvanometer inserted in the base or frame with or without transformer, with or without amplifier. On the other hand a fixed base or frame can only indicate the moment when in making the movable object manœuvre its travelling axis is made to coincide with the direction of the staking cable, that is to say with the route to be followed at the point where the movable object is situate.

The advantage of two fixed rectangular bases or frames each comprising one or more small rectangular frames between them in which the small receiving frame revolves, is that while having at each moment the angle which the direction of the frame makes at the point where the movable object is with an axis of the latter, it allows of dispensing with the use of movable bases.

It is also possible to utilise (Figures 13 to 16) the physiological sensation of the passage of sound from one ear into the other in the case where an alternating current is used as the emission current (or the equality of reception in the windings of a differential galvanometer, each of the windings of which is in one of the perpendicular bases or frames). With that object a telephone is placed in one of the bases for instance, another telephone in the other base, either directly or through the intermediation of a transformer with or without amplifier. It is then found on making the aggregate represented by two bases, rotate, that the sound passes from one ear into the other (the sound being at its maximum in the telephone inserted in the base parallel to the staking cable) and that equality of the sound in both ears is obtained at the moment when the directions of the rectangular bases (or frames) make equal angles with the direction of the staking cable. Instead of having two perpendicular bases or frames there may be several (Figure 18.) In this case by means of a suitable switch the current detector (telephone or galvanometer) is introduced directly or indirectly in each of the bases (or frames) and it is observed in which base (or frame) the reception is the minimum or *nil*. This base is then perpendicular to the direction of the staking cables at the point where the receiver lies, that is to say, movable.

To sum up, in order to have at each moment on board the movable object, the angle made by the direction of travel of the movable object with the direction of a cable traversed by a current and indicating the route to be followed at this point, it is necessary either:

(1) To have at least one movable base or frame the movement of which is independent of that of the movable object.

(2) To have at least two fixed bases or frames, perpendicular, comprising each:

(*a*) Either a small frame; inside these perpendicular frames there revolves another smaller frame connected up, with or without amplifier, into a circuit in resonance or otherwise with the current detector (telephone tuned or not, or galvanometer), the movements of which can be recorded and which can close circuits thus indicating, thanks to the sight signals controlled by the latter, the manœuvres to be done by the person in charge of the movable object in order to bring the direction of his route into coincidence with the direction of the staking cable with that of the route to be followed.

(*b*) Or a telephone or electro-magnet inserted directly or indirectly in a circuit in resonance or not, with or without amplifier. The direction is then given by comparing the receptions in the two perpendicular bases or frames as was said above.

With a single fixed base or frame, without movement independent of that of the movable object, it is only possible to cause to coincide and endeavour to maintain the axis of travel of the movable object parallel to the direction of the staking cable at the point where the movable object is situate. As soon as these directions make an angle between them, the value of the latter is unknown; this arrangement therefore only admits of being used with movable objects endowed with great facilities of manœuvre.

SITUATION OF THE MOVABLE OBJECT RELATIVELY TO THE CABLE.

On board the movable object it must also be known whether the latter is to the right or to the left of the route to be pursued. As the cable or cables trace out the route to be pursued it all amounts to knowing on which side of the cable or cables it lies at each instant.

(*a*) There may be placed to right and left of its axis of travel or perpendicular to that axis two receiving bases (or frames), compensated. The base which receives the strongest current for instance is on the side where the staking cable lies relatively to the movable object (the base or frame receiving the smallest is the one farthest away from the staking cable). The current is detected by means of one of the detectors already described (Figure 32).

(*b*) Two cables at least may be used each traversed.

(1) By a current giving a determined frequency, differing from one cable to the other and characteristic of each of them.

(2) By a current alike for each but which is interrupted by a suitable manipulation, which allows of making in each cable emissions which are characteristic as regards their rhythm or their successions, these differentiated emissions being simultaneous or successive in the two cables.

In the latter system the movable object lies between the cables.

(*a*) If it has parallel receiving bases (or frames) on either side of its axis of travel or perpendicular to the latter it travels so as to receive equally in each base or frame the emissions produced in the two cables between which it travels and which it must keep to right and left of itself.

(*b*) If it has a single receiving system and does not possess two bases or frames on either side of its axis of travel or perpendicular to the latter, it maintains itself between the two emitting cables so as likewise to receive in its compensated receiving bases or frames the two differenttiated currents either direct or of equal frequency (alternating, vibrating, interrupted or different) or different in respect of the characteristic cadences and rhythms or differentiated by the successions of emissions made alternately in the one and the other cable.

POSITION OF THE MOVABLE OBJECT ON THE ROUTE TO BE FOLLOWED.

The transverse bases which were referred to when describing the methods of emission serve to fix the position of the movable object on the route traced out by the cables.

In point of fact when the movable object passes above a transverse base (terminated by a metallic surface or returning to join on to a cable as was said) it is found that at the moment when the middle of the frame for instance placed along the axis of travel of the movable object passes above the transverse base (Figure 33) the current received becomes *nil* in the frame and immediately afterwards assumes a high value which undergoes diminution inversely to the cube of the distance in proportion as the movable object recedes from the base. The means is thus supplied for knowing the exact moment when one is passing above one or several cables traversed by currents.

As on the other hand the actual distances between the bases are known, by keeping the speed of the movable object as constant as possible, it is known on board the movable object by counting the periods of time which elapse between the cancellations of the current at what point of the route traced out by the cables, the object lies.

Use may also be made in order to ascertain the position of the movable object on the route to be followed, of the phenomenon already described which allows of obtaining the direction of one or more cables traversed by currents.

In point of fact on passing over a transverse base the receiver (bases or frames) indicates the direction of the transverse base, perpendicular at this point to the cable traversed by a current and tracing out the route to be followed. There is likewise counted the time which elapses between the successive indications of transverse bases given by the receiver. As on the other hand the distances separating these successive bases and also the speed of the movable object are known, it is possible to know at what point of the harmonic scale of transverse bases one lies and therefore at what point of the route to be followed one is situate. These transverse bases may even take the form of a simple loop made by the cable tracing out the route. The cable afterwards continues the route which the movable object is to pursue.

Figure 34 indicates the variations of current on reception for a staking cable placed along the axis A—A.

Figure 35 indicates the increase of current received when approaching a transverse base, the cancellation of this current when passing above the cable and the resumption of reception after passing, as well as the diminution in proportion to the recession from the emitter. The intensities of current on receipt are set down along the axis of the ordinates and the displacement of the movable object takes place along the axis of the abscissæ.

On board the movable objects it is also possible to make use of receiving bases or frames as emission bases or frames. There is then passed into one of the receiving frames (or bases), selected and forming a known angle with the axis of travel of the movable object, either directly or indirectly an alternating, vibrating or interrupted current (direct current may also be used).

The movable object can thereby emit bring about by induction or conduction or by induction and conduction combined, a current in the cable. This current will be received at the station of emission of the current in the cable, by means of a telephone for instance, or to a suitable galvanometer applied to the secondary circuit of a transformer, the primary of which is in the cable. If the movable object has access to the cable it can connect up its emitter to the latter either directly or through a transformer and thus communicate with the station emitting the current in the cable which traces out to it, on the other hand, its route.

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

1. An improved system for enabling a movable object to follow a route electrically staked out of the type described, which comprises the use of a conducting cable having a loop formed at the end thereof.

2. In the system as first referred to forming a loop that retraces the original outward course of the staking cable.

3. The system as first referred to in which the staking cable comprises two parallel branches fed by the same current generator.

4. The system as first referred to in which two separate parallel cables are each fed by an independent current generator.

5. The system as first referred to in which branch cables led off perpendicularly from the main at predetermined distances apart.

6. The system as first referred to in which parallel cables connected with one source of current are connected by transverse or branch cables.

7. In the arrangement of route cables as claimed in Claims 1 to 6 the combination therewith of receiving bases or frames for ships, as described and with reference to Figures 19 to 26 of the drawings.

8. In the arrangements of route cables as claimed in Claims 1 to 6 the combination therewith of receiving bases or frames for aircraft or hydroaeroplanes, as described with reference to Figures 27 to 31 of the drawings.

9. In the combinations according to Claims 7 or 8 the use therewith of detector means arranged with reference to Figures 12 to 18 of the drawings.

10. In the systems according to the previous claims, arrangements wherein the detector in the base or frame on the movable object is substituted by a current generator, in order that electric impulses produced in the said base or frame may act by induction, or conduction or by induction and conduction combined, upon the staking cable.

Dated this 19th day of December, 1919.

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[Wt. 33A.—50/6/1930.]

2nd Edition

Fig. 1.

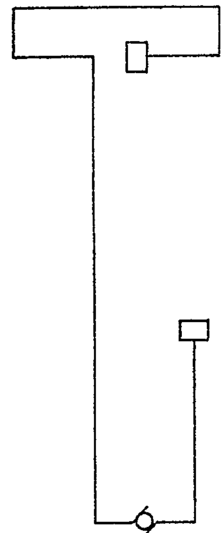


Fig. 3.

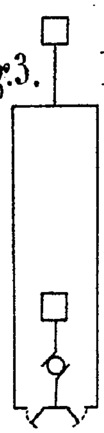


Fig. 4.

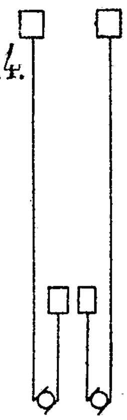


Fig. 5.

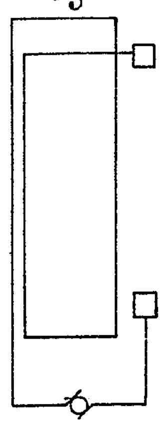


Fig. 6.

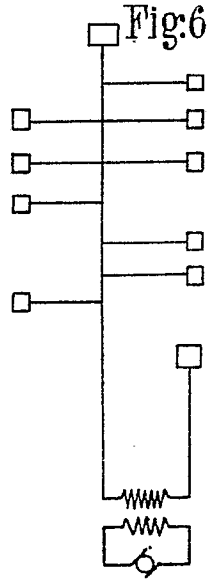


Fig. 7.

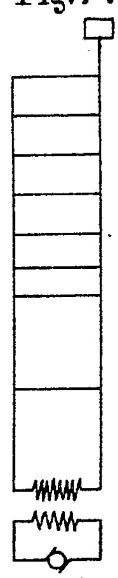


Fig. 8.

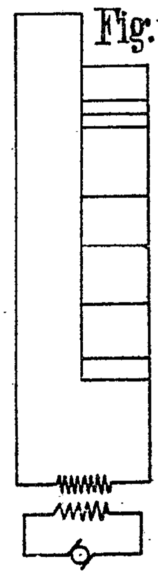
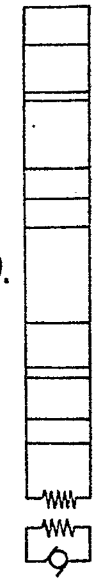


Fig. 9.



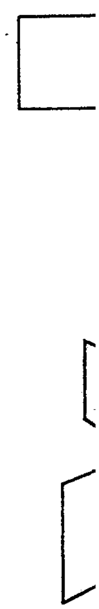
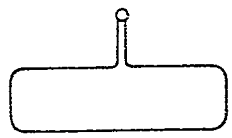


Fig. 10.

Fig. 11.



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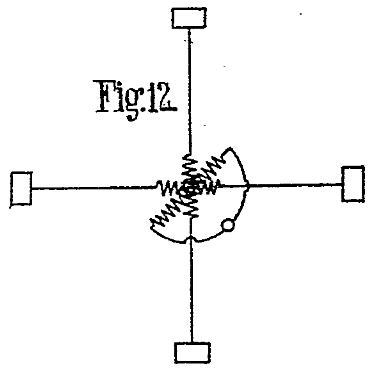

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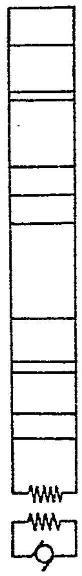

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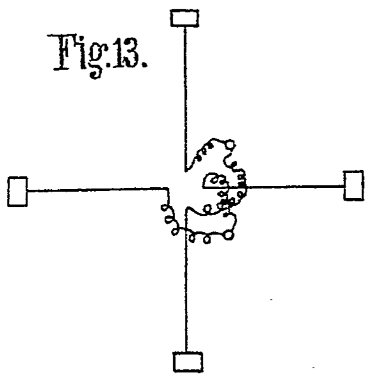

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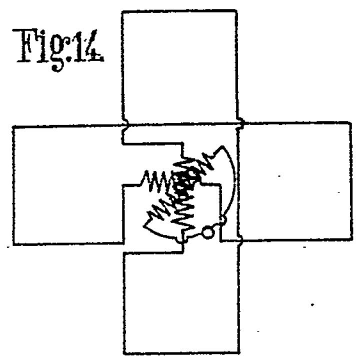

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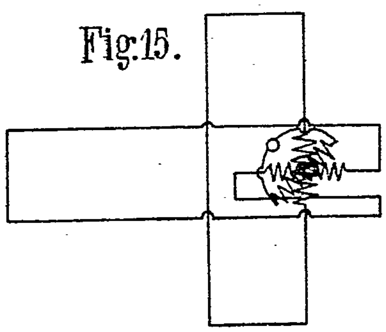

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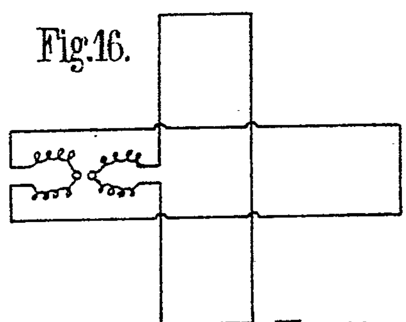

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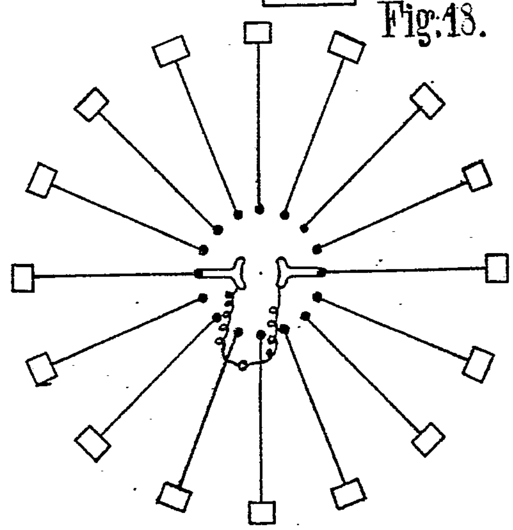

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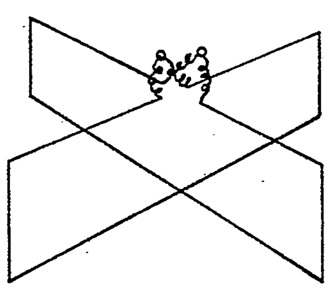

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SHEET 1

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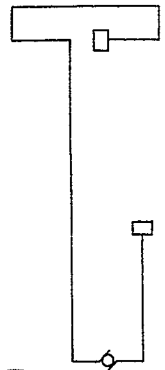

Fig. 3.

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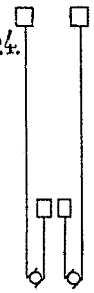

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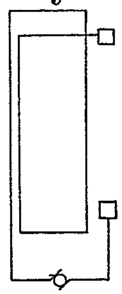

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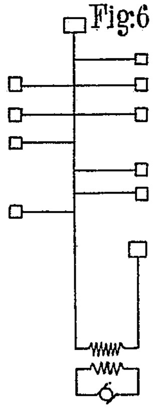

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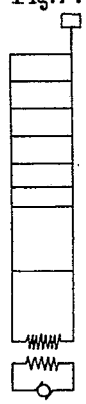

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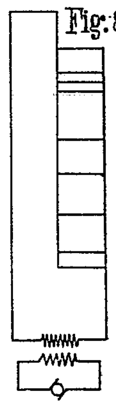

SHEET 2

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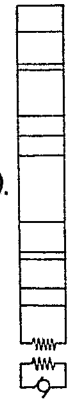

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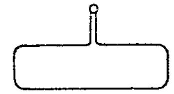

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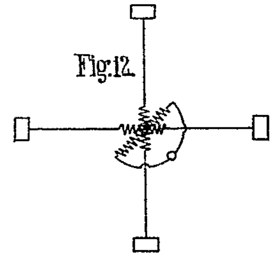

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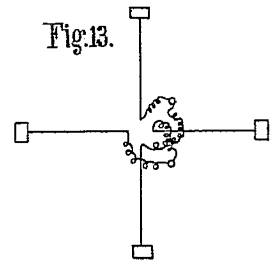

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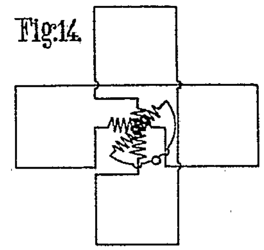

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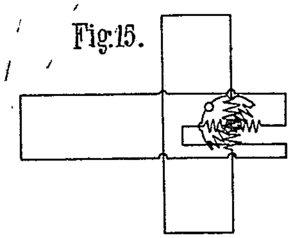

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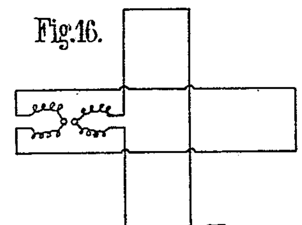

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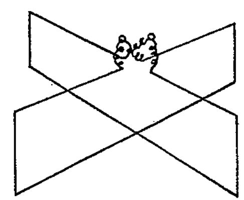

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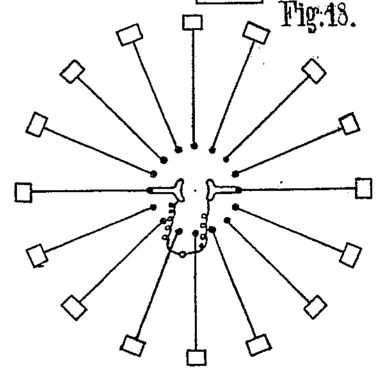

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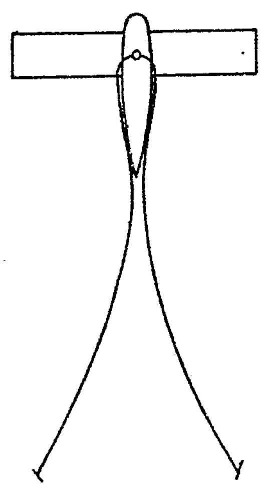

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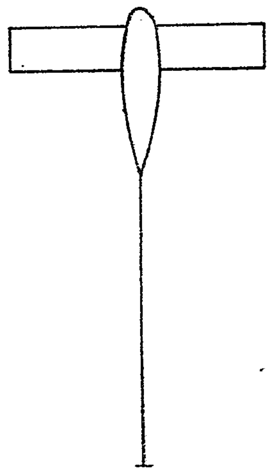

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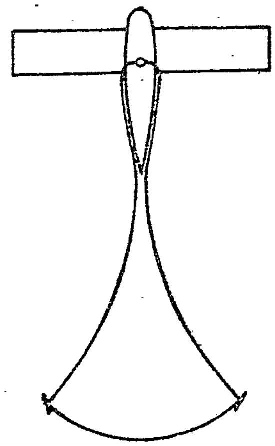

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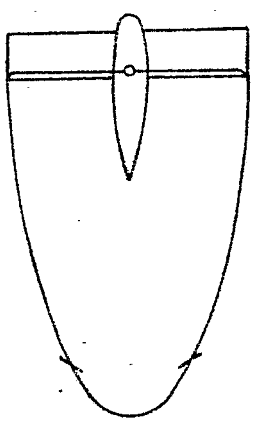

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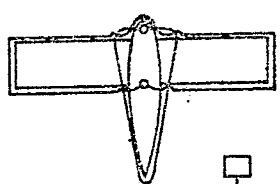

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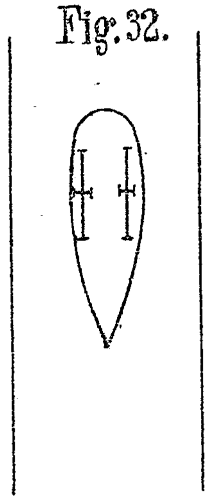

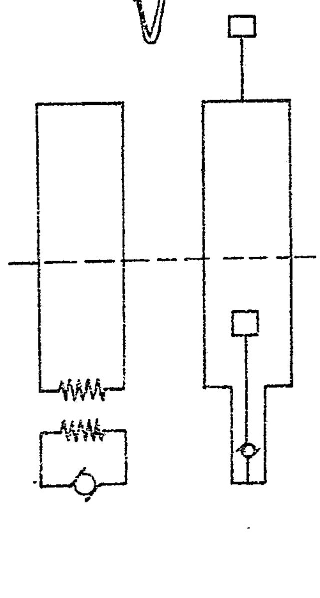

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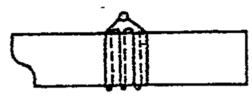

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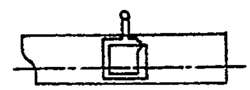

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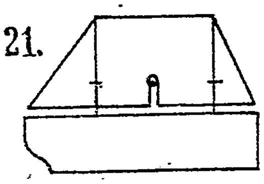

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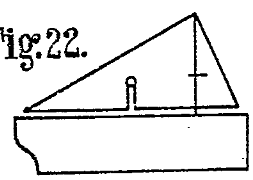

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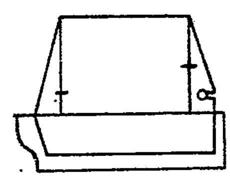

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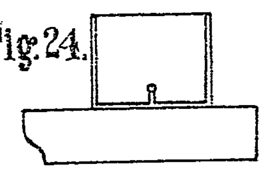

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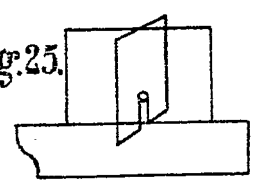

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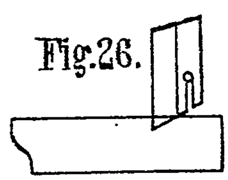

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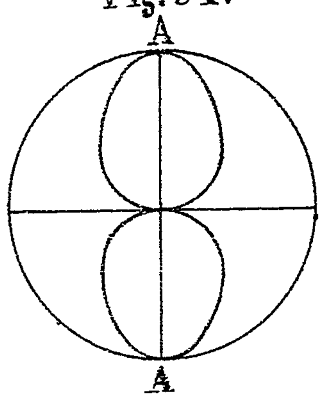

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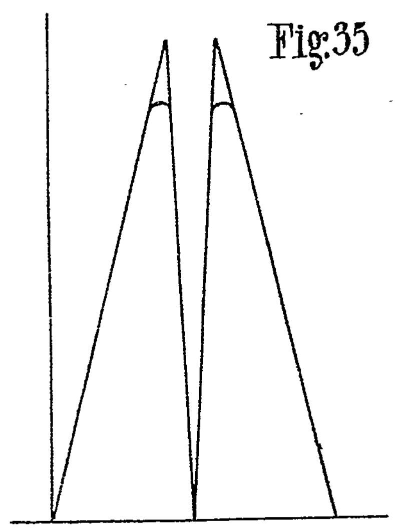

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SHEET 3

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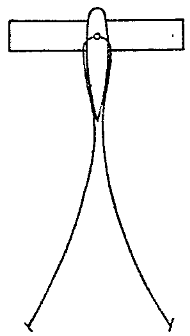

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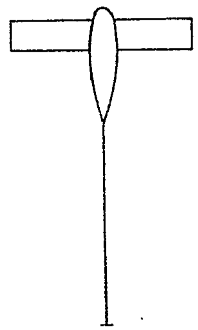

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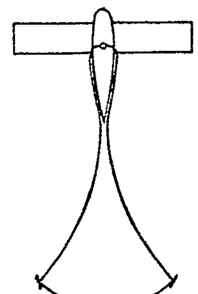

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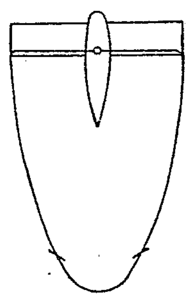

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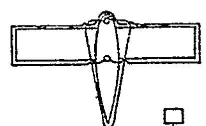

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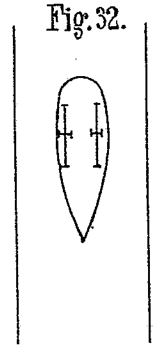


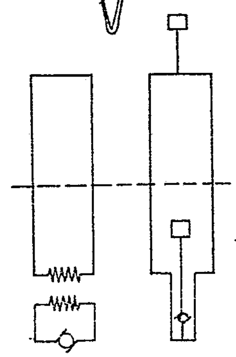
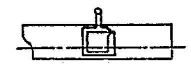


Fig. 33.

SHEET 4

Fig. 19.

Fig. 20.



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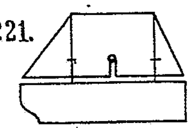

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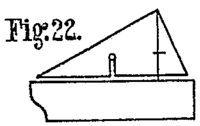

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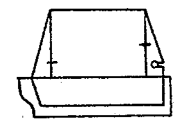

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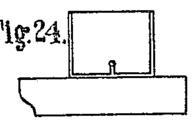

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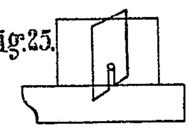

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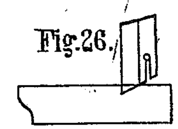

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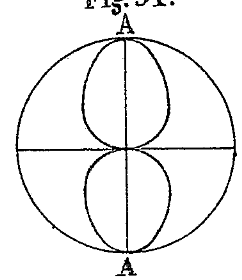

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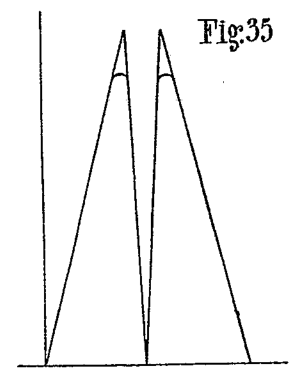

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