Sept. 20, 1960 CARL-ERIK GRANQVIST 2,953,785

ARRANGEMENT FOR RADIO DIRECTION FINDING

Filed June 24, 1957

Fig. 1.

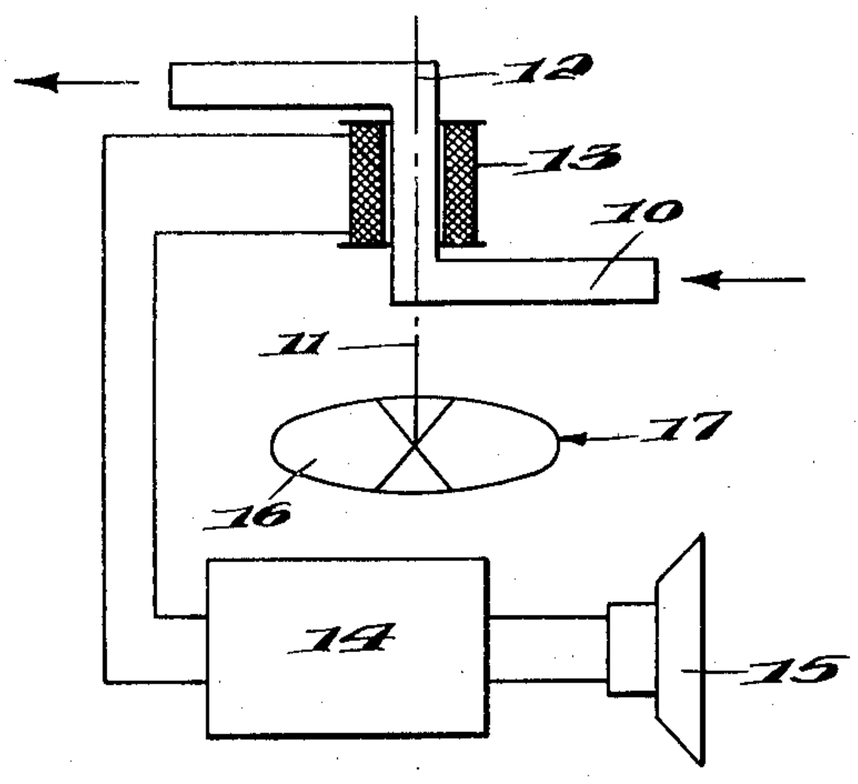
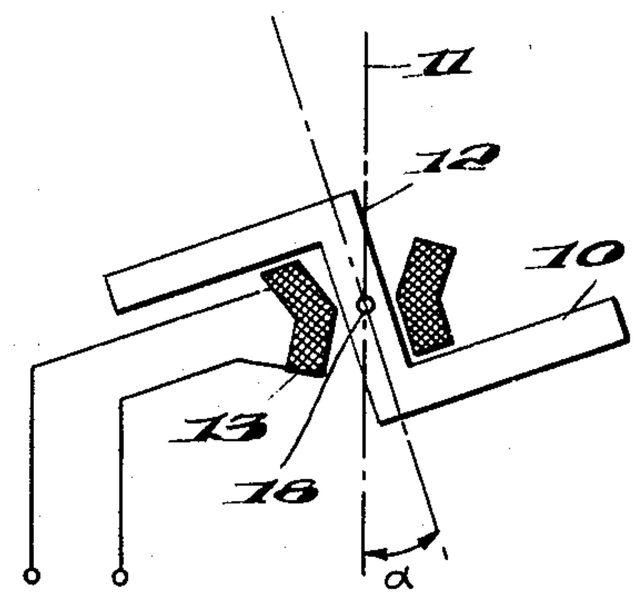


Fig. 2.



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ARRANGEMENT FOR RADIO DIRECTION FINDING

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3 Claims. (Cl. 343—788)

The traditional way of finding the direction by radio is to use a strongly directed antenna system, for instance a frame antenna, which is either turned in material respect under observation of the maximum or minimum voltage, or the turning of which is instead simulated by connecting a pair of mutually crossing antennas to a radio goniometer, the reading coil of which being turned in a corresponding way. Both of these arrangements, however, suffer from a disadvantage often observed. In turnable frame antennas, which are controlled by hand, it has been usual to limit the total turning angle of the frame to a little more than one turn. It has then been possible to connect the frame antenna with the receiver by means of a flexible conductor without slip contacts. However, it has proved, that such a small turning is very often insufficient for a quick and easy handing, and one has in some cases by a specially expensive arrangement increased the total turning angle of the frame up to two turns, but thereby an expensive and complicated stop device has been necessary, and the flexible conduits also become more complicated and expensive. Finally this arrangement causes that part of the conductor to hang down freely, whereby it has been sensitive to mechanical disturbances. Even the best ground mantled coaxial cables are to a certain degree sensible to electro-magnetic disturbances, and the longer the conductor is, the stronger these disturbances will be. In direction finding with a radio goniometer one has always had to use slip rings for transferring the received signal voltage to the receiver, and the same has been the case in automatic direction finding, which requires, continuously rotating direction finding antennas. Slip ring contacts, however, always cause disturbances due to the weak currents to be transferred, the so called contact noise.

In order to avoid the above disadvantages and to provide an arrangement of a direction finding antenna, in which neither flexible conductors, nor slip ring contacts are required, one has therefore proposed to arrange the direction finding antenna for electro-magnetic waves in such a way that it is influenced by the magnetic field. It contains for this purpose a turnable so called **Z**-armature of a material with high conductive property for this field.

In induction compasses one has already used **Z**-armatures, but these have thereby been kept in rotation with a very high speed, whereby they induced a voltage dependent upon the horizontal component of the earth-magnetical field. Thus the magnetical field is uni-directional, and the **Z**-armature rotates in this field for creating an alternating voltage. Such an arrangement can be compared with a synchronous generator. In the arrangement according to the invention, on the other hand, a **Z**-armature is used in a way, which could better be compared with the relations in a transformer. The armature is normally not in rotation, but can of course be turned in two different positions, representing different directions of the input field. This, however, is an alternating field per se, and in the winding about the stem of the **Z**-armature therefore an electric voltage will be created

the same way as the voltage in the secondary winding of a transformer, when the magnetic field in its armature or core is made the object of a periodical variation. The state of voltage thus occurring in the winding of the **Z**-armature then will form a measure of the direction of the input field, or in other words: The **Z**-armature can be used as an antenna with a strong directional action.

Tests have proved that the signal intensity achieved in this way is fully sufficient for direction finding purposes, and that this signal intensity is in no way weaker than the field intensity in a normal frame antenna device, measured as the output voltage from the antenna. On the other hand, slip ring contacts and long freely hanging conductors have been avoided, and also all of the disturbances occurring in all frame antenna systems, and therefore the received signal will be more pure and easy to understand.

The earlier known arrangement, however, is not perfect, because it is sensible to input waves with horizontal polarization. It should be remembered that the force lines of the input field as a rule not only contain an horizontal component but also a distinct vertical component.

The purpose of the present invention is to do away with this disadvantage. According to the invention the turning axis for the **Z**-armature is inclined relative to the central line of the stem of the said armature. Thereby the angle of inclination between the turning axis of the **Z**-armature and the central line of the stem of the said armature can be adjusted.

The invention will now be further described in connection with the attached drawing, which shows a form of execution of the invention. Thereby further advantages with the invention will also be mentioned. In the drawing Fig. 1 shows in strongly schematical form a complete system according to the known form of execution, partly in block diagram. Fig. 2 shows an arrangement according to the invention for improving the antenna, provided with **Z**-armature.

In Fig. 1 a **Z**-armature is indicated by **10**, said armature being of the kind, which is known from the induction compass technics. The armature **10** is turnable in about the same way as a normal frame antenna, about an axis **11**, which in this case coincides with the centre line of the stem **12** of the **Z**-armature. This stem is surrounded by a winding **13**, which is connected with the direction finding receiver **14**, shown in block diagram, and with the loudspeaker **15**. On the shaft **11** a scale disc **16** with a reading mark **17** is provided. This can for instance be provided with all kinds of different means for improving the reading, known from usual direction finding systems with frame antenna, such as for instance a vernier for correcting the reading angle and so on. It should, however, be observed that even if here and in the following the arrangement has been described in connection with a system for manual direction finding, the invention is of course also possible to use in automatic direction finding, where it will get its most important advantages.

The arrangement according to Fig. 1 functions in the following way:

When the **Z**-armature is directed with its one leg onto the transmitting radio beacon and with its other leg in the exactly opposite direction, the armature will receive a magnetic field, which is conducted through the winding **13** with the same action as if a frame antenna had been arranged with its plane exactly perpendicular to the direction of the horizontal component of the input wave. In a corresponding way, the arrangement according to Fig. 1 acts when the legs of the **Z**-armature are directed perpendicularly to the direction of the

horizontal component of the input wave in substantially the same way as if a frame antenna had been set with its level in the direction of the input wave. The characteristic will be almost the same as that for a frame antenna. One can consequently turn the Z-armature in the same way as one used to do in traditional systems with a frame antenna, and listen to the field intensity in the form of the sound intensity on an interference tone in the loudspeaker **15**. Suitably the direction finding should be made on a minimum of received signal electric field or in other words in parallel with the

The inconveniences present in this arrangement, however, are done away with by directing the arms of the antenna perpendicularly to the direction of the input electric field or in other words in parallel with the plane in which the magnetic field lines are closed. The stem of the Z-armature should be inclined to the vertical level by an angle α, as shown in Fig. 2. In this figure, as before the Z-armature is indicated **10**, its stem **12**, its turning axis **11** and the winding surrounding the stem **13**. It should be observed that in this case the turning axis **11** does not coincide with the centre axis of the stem **12**. The Z-armature can be arranged in such a way in connection with the shaft of the turning axis **11**, that the angle α can be set to a value suitable in each separate case by turning about an axis **18**, running perpendicularly to the level of the paper in Fig. 2.

The winding **13** should be so big, that sufficient space is present in its interior for turning the stem **12** of the

Z-armature **10**. Making the winding cylindrical would cause unnecessary high ohmic resistance, and the arrangement therefore can be made double conical or diabolo formed, as shown in Fig. 2.

Of course, this invention is not limited to the specific form of execution described above and shown in the drawing, but different modifications may occur within the frame of the invention.

What is claimed is:

1. A directional antenna having a Z-armature magnetic core, a coil disposed about said core, means for rotating said core, and means for tilting said core with respect to said coil whereby the rotational axis of said core forms an angle with the center line of said core.

2. A directional antenna according to claim 1 wherein said means for tilting said core are adjustable.

3. A directional antenna according to claim 1 wherein the inner walls of said coil are in the form of a double cone whereby the inner walls of said coil are aligned with the center line of said core.

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