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Primary Examiner—T. H. Tubbesing

[54] **DIRECTION INDICATING BEACONS**
 16 Claims, 8 Drawing Figs.

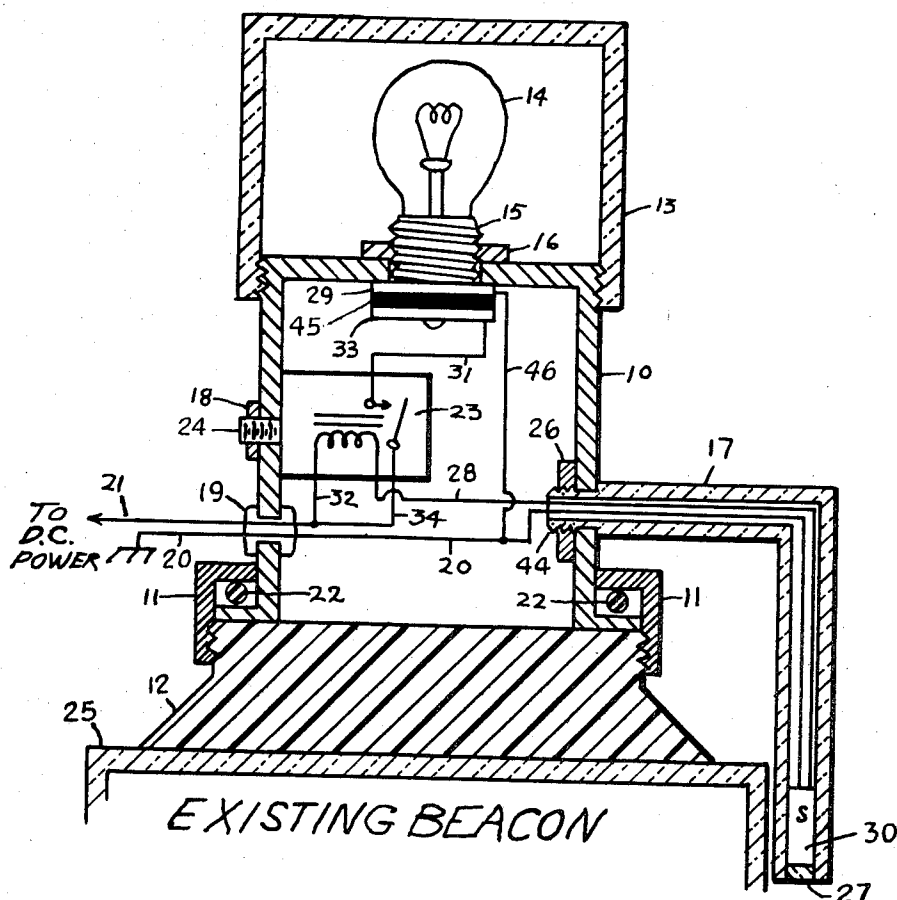
[52] U.S. Cl.....	340/25, 343/106
[51] Int. Cl.....	G08g 5/00
[50] Field of Search.....	340/25, 50; 343/106

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ABSTRACT: A new way is disclosed for generating azimuth-dependent time intervals between flashes or signals from rotating beacons employing directable radiation. An omnidirectional index flash is generated each time the beacon rotates past a fixed point. Resulting flash patterns convey to any observer his azimuth about the beacon. Apparatus is described to adapt existing beacons or new designs to produce the intervals automatically.



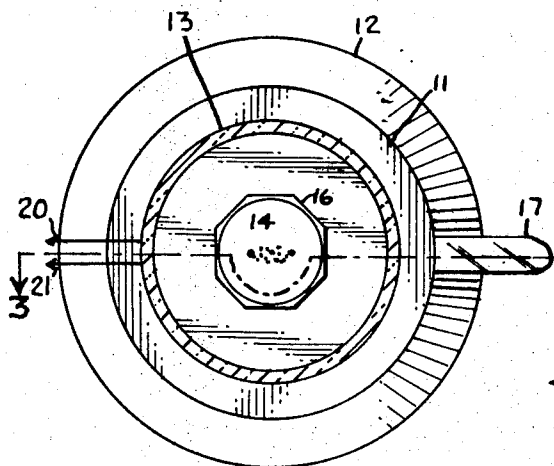


FIG. 2

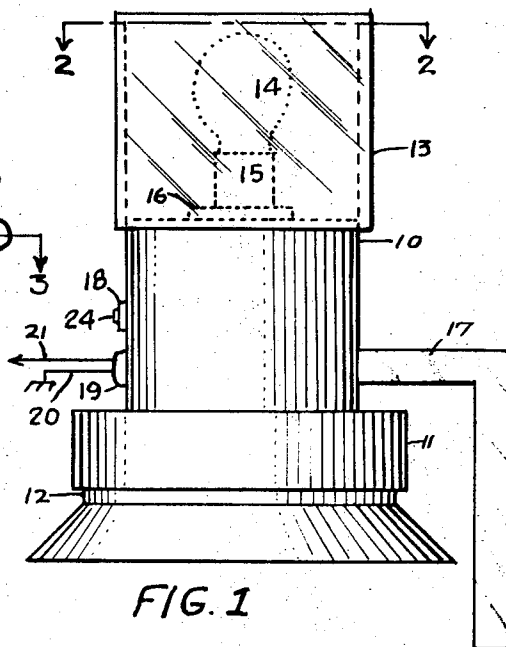


FIG. 1

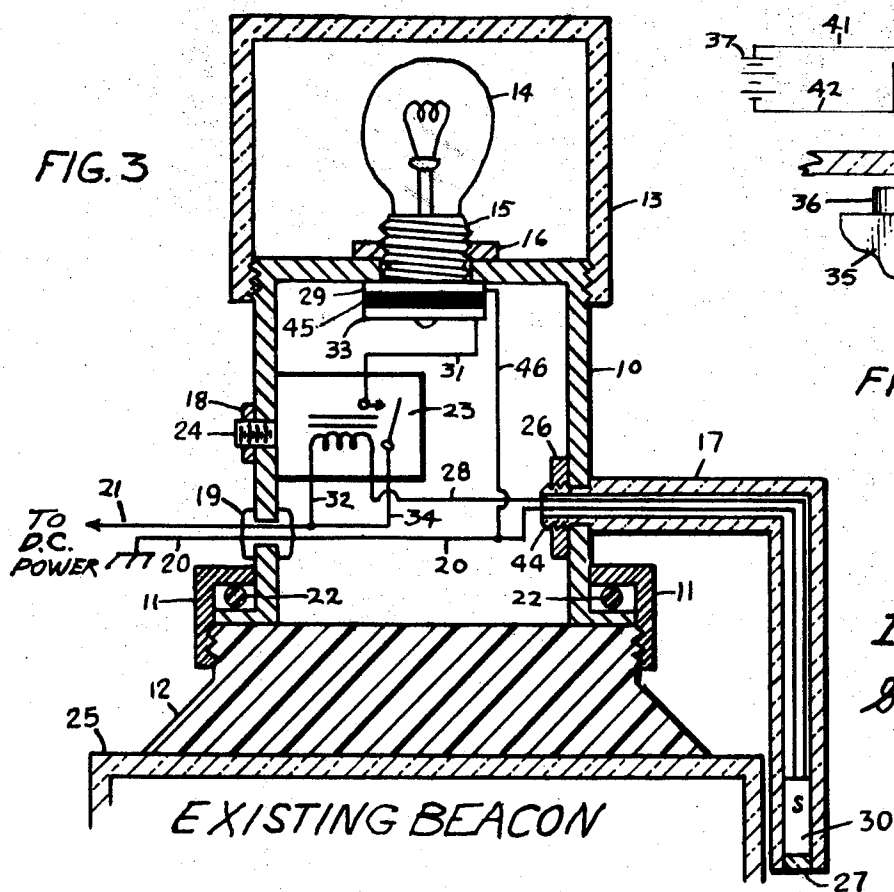


FIG. 3

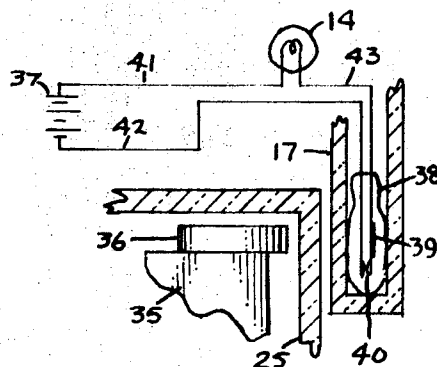


FIG. 4

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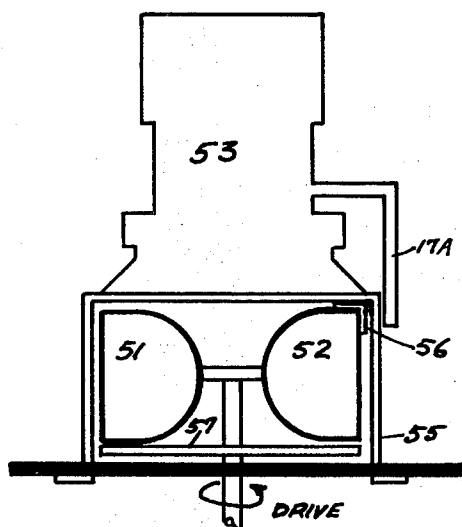
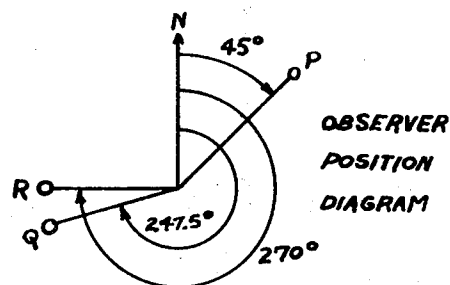


FIG. 5



FLASHES RECEIVED
BY OBSERVERS

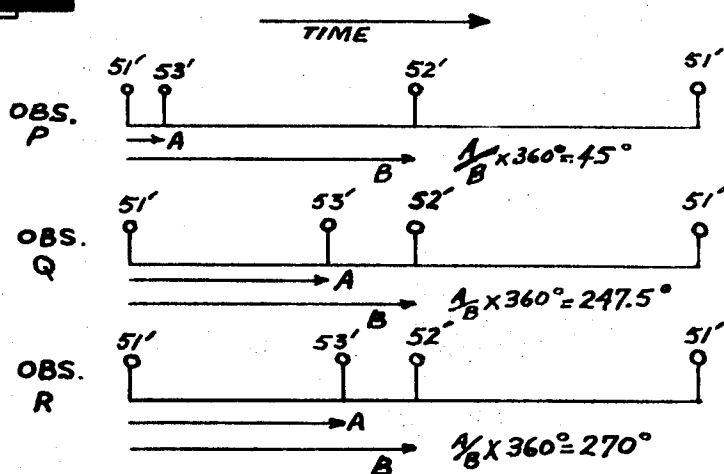


FIG. 8

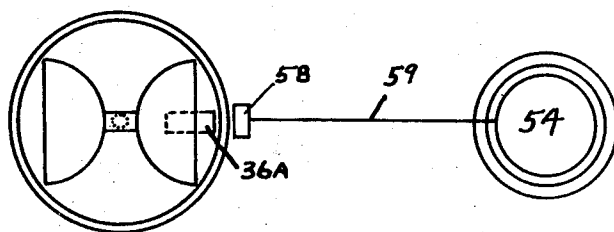


FIG. 6

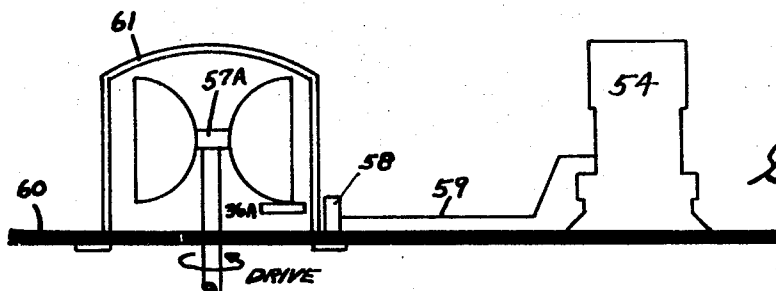


FIG. 7

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DIRECTION INDICATING BEACONS

This invention relates to automatic signalling beacons and warning beacons. More particularly, it relates to warning beacons which automatically transmit more information than the mere presence of aircraft, boats, land vehicles, airports, points on a seacoast, and the like.

Ordinary beacons used in the above applications convey only position information, that is, the position of the vehicle or point. It is most desirable to know more than just the position, however, particularly if the observer or receiver of the beacon signals is also moving. For instance, one aircraft, upon approaching another from a distance, would like to know not just the position, but also the heading of the other. Similarly, in rough water, and poor visibility conditions, a boat approaching a point of land would benefit from knowledge of his compass bearing from a lighthouse, as would be available if the lighthouse flash pattern were a function of angular position about it. In the past, heavy reliance has been placed upon color as a bearing or heading indicator. Unfortunately, the human eye responds to color only at relatively high light intensities, so the color system does not provide reliable direction indication under poor conditions.

Flash-pattern systems are therefore more efficient, especially for marginal conditions, and they can be made simply to provide better definition of direction even in close approaches than can color systems. One such system is the subject of U.S. Pat. No. 3,133,263 issued to this same inventor, which shows simple structure for producing flash patterns which are a continuous, single-valued function of the angular position of the observer or receiver about the beacon. Many presently used beacons of the visual, radio, and sound varieties, employ rotating directed beams of light, sound, and electromagnetic energy, to produce repeated flashes or signals. It would be desirable to adapt such beacons simply and inexpensively to produce angular position-dependent patterns of the type shown in the aforementioned patent.

Therefore it is an object of this invention to provide a simple structure to adapt existing beacons, employing all types of radiation, for the transmission of angular-dependent flash patterns or pulse patterns.

It is another object of this invention to show novel beacon structure for automatically producing flash patterns or pulse patterns which vary as a function of the position of any receiver or observer about the beacon.

Another object of this invention is to provide existing rotating beacons of the white or colored light variety, with the ability to transmit angular information as well as position information.

These and other objects of the invention are accomplished as described in the following specification.

Referring now to the drawings,

FIG. 1 shows an elevation of a preferred embodiment of the invention.

FIG. 2 shows a sectional view of FIG. 1 as designated in FIG. 1, looking down from above the invention. Similarly, FIG. 2 designates the sectional view shown in FIG. 3.

FIG. 3 is a detailed view of the device combining mechanical and schematic representation for clarity.

FIG. 4 shows one variation of a sensor used in the device, again combining mechanical and schematic representation for clarity.

FIG. 5 shows the structure of FIG. 3 as applied to a common type of beacon which generates two opposed beams of radiation. It illustrates one of many novel modes of operation possible with this invention. The structure of FIG. 3 is shown in outline for simplicity.

FIGS. 6 and 7 illustrate top and side views of another configuration combining the features of FIGS. 4 and 5, but with the apparatus of FIG. 3 (again shown in outline) positioned remotely.

FIG. 8 diagrammatically illustrates the direction-indicating properties of the configurations of FIGS. 5, 6, and 7, as well as the method of signalling and determining direction which results.

Returning now to FIG. 1, a hollow cylindrical metal body 10 in the shape of an inverted cup flanged outward at its open end, is clamped by retainer ring 11 to plastic foot 12, which is molded in the shape of a cylinder with a frustoconical skirt issuing outwardly at its bottom. The periphery of body 10 is threaded near the top to receive transparent cover 13, which is molded in the form of an inverted cup and threaded on its inside periphery near its bottom to mate with the threaded portion of body 10.

Shown in dotted outline and visible through cover 13, light bulb 14 is received in socket 15, which is in turn retained in a hole in the closed end of body 10 by retainer nut 16.

Protruding from the right side of body 10 is sensor arm 17, which is a hollow tube of transparent or translucent material bent downward to bring its end below the level of foot 12. Protruding from the left side of body 10 are a mounting stud 24 with its nut 18, and an insulating feed-through grommet 19. Extending through grommet 19 from the interior of body 10 are two wires 20 and 21 for connection to a suitable external power source.

A sectional view looking down from just inside the top of cover 13 is shown in FIG. 2. Here bulb 14 and octagonal nut 16 are more clearly shown, as is the contour of sensor arm 17. It should be clear from FIG. 2 that the sectional view of FIG. 3 is not a straight planar section, but detours around socket 15. Since socket 15 is a component well known in the art, it was not felt necessary to show it in section.

More detail of the interaction of body 10, ring 11, and foot 12 is shown in FIG. 3, as well as methods of mounting the components and their electrical interconnections. In this view, a very important point shown is the mounting of the entire device upon an existing rotating beacon 25. Foot 12 is cemented, clamped, or otherwise mounted on the top of the stationary dome of existing beacon 25, so as to bring sensor arm 17 near a vertical face of the beacon.

Plastic foot 12 is threaded on its outer periphery near the top to receive similar threads on the inner periphery of the bottom of retainer ring 11, revealed here to be an inverted shallow cup having a hole in its closed end large enough to pass the cylindrical portion of body 10, but not its flanged open end. Rubber O-ring 22 is placed between the flange of body 10 and the semiclosed end of retainer ring 11. In assembly, the flange of body 10 is placed on foot 12 and retainer ring 11 is screwed tightly on to foot 12 so as to squeeze O-ring 22 between itself and the flange of body 10. A weatherproof, high friction seal is thereby formed by O-ring 22. An important point to note is that the device may be rotated independently from foot 12 simply by unscrewing ring 11 to relieve the pressure on O-ring 22, rotating the body to the desired position, and tightening ring 11 again.

Sensor arm 17 has a narrow threaded portion 44 at its one end extending through a hole in body 10, where it is secured by nut 26. Arm 17 is tubular and made of some transparent plastic such as Lucite. A sensor 30, which will be discussed in detail later, is received in the tube and retained by plug 27 cemented into its bottom end. Wires 28 and 20 pass from the sensor through the tubular portion of arm 17 to the interior of body 10. Wire 20 passes further out of body 10 through grommet 19 to become the ground connection to the external power source.

Socket 15 is a common type having a threaded body and a connection 29 for the base shell of bulb 14 and a second connection 33 for the tip of bulb 14, the two connections being insulated from each other by insulator 45.

Relay 23 is also a common SPST-type well known in the art, mounted by passing its stud 24 through a hole in the side of body 10 and securing it with nut 18 on the outside of the device. It is shown schematically for the sake of clarity and simplicity.

Power is supplied to the actuator coil of relay 23 via line 32 and line 21 connected externally to the power source, and is effectively switched by the action of sensor 30 via wires 28 and 20.

The contacts of relay 23 switch the ungrounded power supply wire 21 via wire 34 and wire 31 to socket contact 33. The return circuit for bulb 14 is made through base shell contact 29 and wire 46 connected to wire 20 and ultimately grounded. It should be noted that the source of power may be included inside body 10 in small versions of the invention.

Sensor 30 may be any of a number of devices, but is shown here as a photoresistive semiconductor device well known in electronics. In darkness, a photoresistor has very high electrical resistance, but when it is illuminated, its resistance falls to a low value.

The operation of the invention can now be made apparent. Photoresistor 30 is positioned in the path of illumination of the existing rotating beacon, so that it is actuated only when the beam of the existing beacon passes its position. When not illuminated, its resistance is high and relay 23 is not actuated, so light 14 receives no power. But for the brief period when it is illuminated by the beam of the existing beacon, photoresistor 30 assumes a low-resistance state, allowing current to flow through the coil of relay 23 and actuating it. This action closes the contacts of relay 23 briefly, causing light 14 to flash.

In effect, light 14 becomes a "slave," flashing only at one point in the rotation of the existing beacon, but visible from all directions. It provides an index flash at one point of rotation of the existing beacon. This action produces a pattern of light flashes as seen by an observer which is a function of the angular position of the observer about the common axis of the combined rotating beacon and added flasher.

Assuming for example that the invention were applied to an existing beacon that rotates once each 10 seconds, a coherent, angular-dependent flash pattern can be described. An observer at the angular position of the sensor would see only one bright flash, resulting from his coincident seeing of the flash from the beacon and that from the added flasher. If he moves away from that position, however, the single flash resolves into two distinct flashes, one from the beacon and one from the flasher, the time-separation of the flashes being dependent upon his angular position. His position is given by the formula $A=36T$, where A is his angular position away from the sensor position in degrees and T is the time of separation of the two flashes in seconds.

Of course many patterns of flashes are made possible by simply changing the sensor configuration or the existing beacon. For example, a beacon with two opposed beams generated by a single rotating member 57 carrying beam generators 51 and 52, might have an obstruction 56 mounted on one beam generator 52 so as to block that beam from actuating the photoresistor inside sensor arm 17a of index flasher 53. But the beam from generator 51, being unobstructed, would still actuate it through transparent housing 55. A three-flash pattern very similar to that of the device disclosed in the aforementioned patent would result. Similarly, the index-flasher could be made to flash more than once per revolution of the beacon, if so desired.

The flash pattern seen by three observers about the configuration of FIG. 5 is illustrated in FIG. 8. Assuming sensor arm 17a is at north, three observers P, Q, and R at bearings 45°, 247½°, and 270° respectively, would receive flashes as a function of time shown in their corresponding time diagrams below the observer position diagram. The beacon rotational sense of FIG. 5 is assumed.

At a distance, this pattern is identical to that of the beacon of the aforementioned patent and the reader is referred to it for more detail. FIG. 8 is included only to illustrate the roles of flasher 51'52', and 53' from beam generators 51 and 52 and index flasher 53, respectively. Salient features worth noting are: that for each observer the intervals A and B of FIG. 8 bear the relationship A/B times 360° equals the observer's bearing from north; and that a "dead" cycle, wherein 53 does not flash, occurs between flashes 52' and 51'.

This invention is easily adaptable to other forms of radiation. For example, if relay 23 were made a coaxial relay of a common type, and if bulb 14 and its socket 15 were replaced

by an ordinary quarter-wave long vertical radio antenna, and if an ordinary coaxial cable were substituted for wires 31, 32, and 34, and connected to an external source of radio frequency power, the beacon would operate at radio frequencies, producing a burst of signal when the sensor is briefly actuated. The sensor might also be chosen to respond to the mechanical rotation of a directional antenna or to be sensitive to radio waves. A pattern of wave flashes at radio frequencies would result.

FIG. 4 shows a variation of the sensor adaptable to most any rotating beacon, regardless of radiation type or frequency, with only minor modification needed. A strong magnet 36 is cemented or otherwise mounted on the rotating member 35 of an existing beacon, possibly protected by a nonmagnetic cover 25. Sensor arm 17 contains a magnetic reed relay 38 commonly known in the electronic art, having a set of contacts 40 and a piece of magnetic material 39 attached to the contact farthest away from the cover 25. As the magnet 36 is rotated past reed relay 38, material 39 is attracted to magnet 36, closing contacts 40. This momentarily energizes light 14 from power source 37 via wires 41, 42, and 43 in the simple circuit shown. Thus it is seen that an auxiliary relay 23 is not needed and that the sensor may take many forms, not necessarily related to the emissions of the existing beacon. A magnet only on one side of the opposed-beam beacon mentioned earlier, and as shown at 36b in FIGS. 6 and 7, would produce a three-flash pattern also mentioned earlier.

The simplicity of adjustment of the angular position of the sensor made possible by O-ring 22 and retainer ring 11 allows adjustment of the pattern if so desired. It is also contemplated that the sensor could be removed to some distance away from the main body of the flasher, by means of flexible long wires or cables, for convenience or in case the mounting of foot 12 was difficult in a particular case.

This situation is illustrated in FIG. 7, where rotating assembly 57a carries magnet 36a, which activates reed relay 58 upon passing it. Index generator 54 located remotely on surface 60 because beacon housing 61 is dome shaped, or because some other purpose may be served thereby, is actuated by reed relay 58 via control lines 59. Any means of mounting reed relay 58 at various points in or about the beacon where magnet 36a can actuate it would be suitable.

The advantages of this invention are manifest. Existing beacons can be given direction indicating properties in a simple manner, often without modification of the existing structure. The device is easily adjustable to change indicating directions, and is simple in construction. It is adaptable to any rotating beacon, and has no moving parts other than the relay armature. It can be used on any vehicle, point of land, airport, or the like, and consumes little power. Beacons of new design and manufacture can incorporate this invention as well, and would cost little more than presently available ones.

Having thus described a new, simpler, inventive structure to produce angular-dependent direction indicating flashes of light or other radiation, I claim:

1. Beacon index signal-generating apparatus to impart direction-indicating properties to simple rotating warning beacons comprising:

- a mounting foot, for attachment to a beacon dome, having a cylindrical portion threaded on its periphery near its top;
- a hollow body formed in the shape of an inverted cup having a flange protruding outward at its open end, the flange resting on the top of the mounting foot, and the hollow body further having a first hole in its closed end, a second hole in its side, and threads on its cylindrical periphery near its closed end;
- a light source mounted in the first hole so as to extend its connections into the hollow body;
- a light-transmitting cover for the light source in the shape of an inverted cup threaded on its inner periphery near its open end to mate with the threads on the hollow body;

- e. retaining means threaded on its inner periphery to mate with the threads on the mounting foot and having a flange overlapping that of the hollow body;
 - f. sealing means clamped between the flange of the hollow body and the flange of the retaining means when the retaining means is screwed on to the mounting foot;
 - g. a sensing arm mounted on the second hole in the hollow body and extending down to below the mounting foot;
 - h. a sensor means received in the sensing arm, detecting the passage of one or more points of the rotating member of the rotating beacon;
 - i. power control means capable of turning the light source on and off and connected to a suitable power source and mounted in the hollow body;
 - j. and control wires connecting the sensor means to the power control means so as to actuate the power control means momentarily when the sensor means detects the passage of a desired point of the rotating beacon member and to flash the light source.
2. The apparatus of claim 1 wherein the sensor means comprises a photosensitive device and the sensor arm comprises light transmitting material.
3. The apparatus of claim 1 wherein the sensing means comprises a relay actuated by an external magnetic field produced on at least one point in the rotation of the beacon.
4. The apparatus of claim 1 wherein the functions of the power control means are performed by the sensor means, the sensor means is a single component, and the source of radiated signals is powered directly through the control communicating means.
5. Apparatus to impart direction-indicating properties to simple rotating beacons having rotating internal beam producing structure and a housing comprising:
- a. signal emitting means capable of transmitting signals simultaneously in all directions substantially radial to an axis parallel with that of the rotating beacon;
 - b. Signal control means linking the signal emitting means to a source of power and capable of connecting and disconnecting the source of power from the signal emitting means;
 - c. Sensing means outside the housing of the beacon, connected to the signal control means, detecting at least one particular angular position of the rotating beam-producing structure by means of signals penetrating said housing, and actuating the signal control means momentarily to produce a short burst of signals from the signal emitting means when each such angular position is detected, to produce a pattern of signals from the combined signal emitting means and rotating beacon;
 - d. sensor driving means fixedly attached to the internal beam producing structure, directing signals outwardly penetrating said housing and effective to actuate the sensing means upon passage of said sensor driving means past the sensing means; and
 - e. easily adjustable mounting means, supporting the sensing means at desired points about the periphery of the beacon housing, to permit the entire pattern of signals to be changed by changing the angular position of the sensing means.
6. Beacon slave adapter apparatus to impart direction-indicating properties to simple rotating beacons without substantial attachment to the mechanism of the beacon to be adapted comprising:
- a. sensing means responsive to the actual emissions of the beacon to be adapted and actuated by the passage of a beam radiated by the beacon past said sensing means;
 - b. signal-emitting means capable of transmitting signals simultaneously in all directions substantially radial to an axis parallel with the axis of rotation of the beacon;
 - c. and signal control means operated by said signal-sensing means and linking said signal emitting means to a source of power and capable of connecting and disconnecting the source of power from said signal emitting means, the

- combination cooperating to produce a short burst of signals from said signal emitting means upon said passage, to produce from the combined beacon and slave adapter a pattern of signals which is a function of angular position of an observer about the combination.
7. The beacon slave adapter apparatus of claim 6 comprising in addition easily adjustable mounting means fixedly supporting said sensor means in one of a variety of angular positions about the axis of the beacon for the purpose of adjusting the pattern of signals generated by the combined beacon and slave.
8. Apparatus to impart direction-indicating properties to simple rotating beacons comprising:
- a. a hollow body having a major axis;
 - b. mounting means adjustably retained about the periphery of said hollow body and adapted to attach said body to a surface with said major axis substantially perpendicular thereto;
 - c. an omnidirectional source of radiated signals received in one end of said hollow body, said source emitting signals only when powered, said signals being radiated primarily radial to the major axis;
 - d. actuatable power control means applying power from a power source to said source of radiated signals only when actuated;
 - e. a sensor responsive to certain beacon-emitted signals supported remotely proximate to the simple rotating beacon to be adapted and detecting the passage of the beacon past a particular point, said sensor producing upon such passage brief actuation control signals suitable for transmission to the power control means; and
 - f. control-communicating means carrying said actuation control signals from said sensor to said power control means to actuate it.
9. The apparatus of claim 8 wherein the functions of the power control means are performed by the sensor, the sensor is a single component, and the source of radiated signals is powered directly through the control communicating means.
10. The apparatus of claim 9 wherein the sensor is a relay actuated by an external magnetic field produced on at least one point in the rotation of the beacon to be adapted.
11. Direction indicating apparatus comprising:
- a. beacon signal-generating means producing one or more beams of signals, said beams rotating about an axis as a function of time;
 - b. intermittently actuatable index signal-generating means transmitting signals simultaneously in all directions substantially radial to said axis when actuated;
 - c. control means linking the beacon signal generating means with the index signal generating means, the control means sensing the position of said beams of signals about said axis and actuating the index signal-generating means during specific portions of the rotation of said beams of signals about said axis;
 - d. said control means comprising power control means sensitive to emitted beacon beam energy, sensing; the passage past at least one particular point of the beams of signals generated by the beacon signal generating means, the power control means being effective to actuate the index signal-generating means briefly upon such passage.
12. A direction-indicating beacon comprising in combination:
- a. opposed-beam beacon means comprising a member rotating about an axis and producing a first and a second beam of radiation, said beams rotating with the member in a fixed relationship and always held pointing in opposite directions, said beams further being directed substantially radial to the axis of rotation so as to produce periodic flashes in a zone of coverage about said axis;
 - b. beacon index signal generating means associated with said opposed-beam beacon means, producing radiated signals simultaneously throughout the zone covered by said opposed-beam beacon means when actuated;

- c. selectively driven sensor means briefly actuating said beacon index signal generating means at a desired point in the rotation of said beams about said axis;
- d. means carried by said rotating member selectively driving said sensor means upon passage of said first beam of radiation through one particular point and selectively not driving said sensor means upon passage of said second beam through said particular point, the combination producing a self-calibrating three-flash pattern of signals to any observer in the zone of coverage, which pattern communicates the observer's bearing about the combination with respect to said particular point independently of the speed of rotation of said member.
13. The direction-indicating beacon of claim 12 wherein;
- a. the selectively-driven sensor means is sensitive only to the actual emissions of the opposed-beam beacon means;
- b. said sensor means is mounted so as to intercept only part of the beams of the opposed-beam beacon means; and
- c. the means carried by the rotating member is an obstruction mounted so as to block the second beam of radiation from actuating the sensor means and not to block the first beam of radiation.
14. The direction-indicating beacon of claim 12 comprising in addition easily adjustable mounting means fixedly supporting said selectively driven sensing means in one of a variety of angular positions about said axis for the purpose of adjusting the pattern of signals generated by the combination.
15. A method of signalling direction comprising the steps of:
- a. rotating two always opposed directed beams of radiated

- signals about an axis in a time-dependent manner so as to produce a series of flashes at all points about said axis which are equally spaced in time;
- b. flashing an omnidirectional signal source upon the transit of only a first particular one of said directed beams past a predetermined point, and not upon transit of the second;
- c. observing the time of occurrence of the omnidirectional signal at a point remote from the sources of beams and omnidirectional signals;
- d. observing the times of passage of each of said opposed beams past said remote point;
- e. determining the bearing of said remote point about the axis with respect to said predetermined point as that fraction of a circle represented by the ratio of the interval between the omnidirectional flash and the passage of the first beam and the interval between the passage of the first beam and the passage of the second beam.
16. The method of modifying the flash patterns of beacons which employ beams of radiation directed substantially perpendicular to an axis and rotated about the axis in a time-dependent manner to impart to them direction-indicating properties comprising the steps of:
- a. sensing the actual emissions of the beacon to be adapted as the beams thereof sweep past a particular sensing point;
- b. actuating briefly an omnidirectional generator of radiation upon sensing said passage.