Oct. 29, 1957 H. W. WALLACE 2,811,719

DOUBLE-UNIVERSAL NOD MECHANISM

Filed April 28, 1953

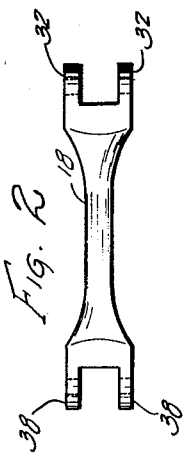


FIG. 2

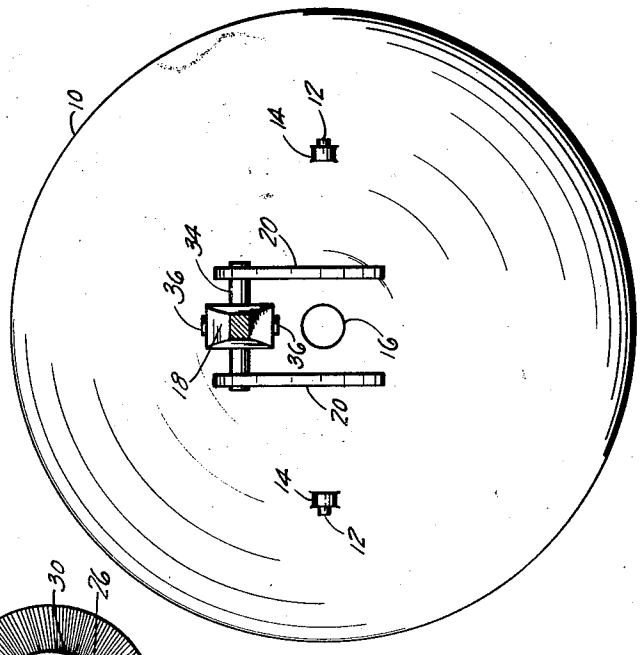


FIG. 4

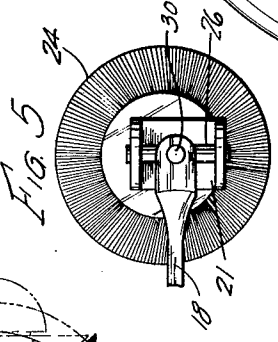


FIG. 5

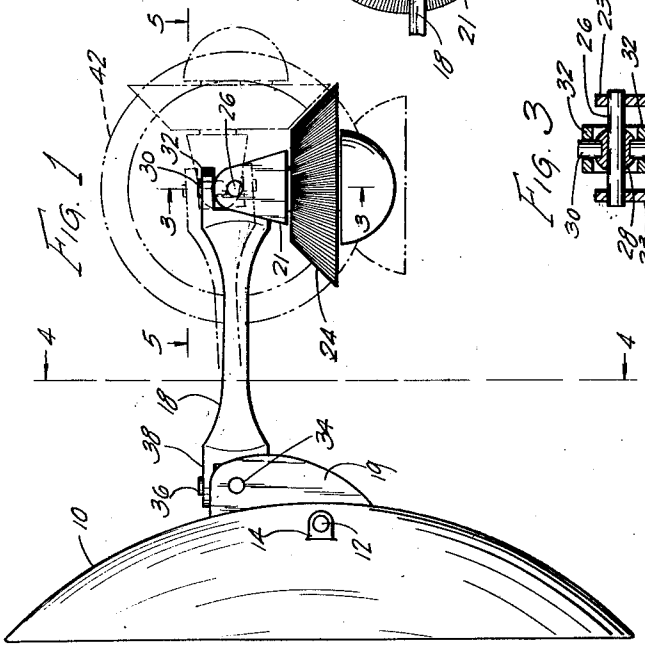


FIG. 1

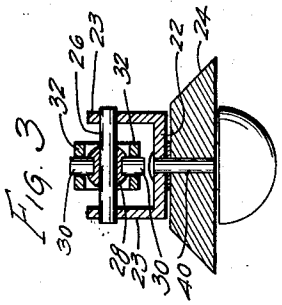


FIG. 3

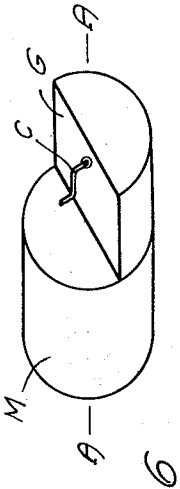


FIG. 6

INVENTOR.
HENRY W. WALLACE
BY
ATTORNEYS

United States Patent Office 2,811,719 Patented Oct. 29, 1957



2,811,719

# DOUBLE-UNIVERSAL NOD MECHANISM

Henry W. Wallace, Asheboro, N. C., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Application April 28, 1953, Serial No. 351,662

1 Claim. (Cl. 343—761)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to a radar antenna device and particularly relates to a reflector used in conjunction with such an antenna.

It is well known that when the antenna is directed toward an object or group of objects, if the radiant energy developed in the antenna is directed to the reflector in such a way that a narrow beam is produced from the reflector, if this beam is nutated, or in other words, if its axis is made to describe a conical surface, the beam will explore the object or group of objects and, in this manner, indicate the characteristics thereof. This has previously been accomplished through the oscillation of the antenna. This, however, requires the antenna to be moved from the point at which it picked up the object and, if the object is small, it may be difficult to pick it up again.

It is, therefore, one object of this invention to provide a means for oscillating a radar antenna reflector.

Another object of this invention is to provide a means for imparting a substantially pure sinusoidal motion to the reflector.

Another object of this invention is to provide a means for locking the reflector against oscillatory motion.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Fig. 1 is a side elevational view of an embodiment of the invention.

Fig. 2 is a side elevational view of the crank connecting rod.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1.

Fig. 4 is a rear view of the reflector taken on the line 4—4 of Fig. 1.

Fig. 5 is a top view taken on the line 5—5 of Fig. 1.

Fig. 6 is a schematic representation of a modified form of a second embodiment of the device.

Referring now in greater detail to the drawing wherein similar reference characters refer to similar parts, there is shown a dish-shaped reflector 10 which is adapted to be pivotally mounted on a support, not shown, by means of a pair of journal pins 12 projecting from ears 14, these journals being adapted to be held within bearings on the support. The reflector is rockable about its pivot axis relative to an antenna projecting through an opening 16 in the reflector by means of the connecting rod 18.

The connecting rod 18 extends between a bracket 19 comprising a pair of ears 20 fixed on the rear of the reflector and a bracket 21 having a base 22 and a pair of ears fixed on the top surface of a bevel gear 24. A universal joint is formed between each end of the connecting rod and its respective bracket. One such universal joint



is formed by a shaft 26 extending between the ears 23, a ball 28 rotatably mounted on the shaft 26, a pair of oppositely extending pins 30 fixedly projecting from opposite sides of the ball, and a pair of apertured ears 32 on the rod 18 through which the pins 30 extend to rotatably support that end of the rod.

A similar universal joint is formed between the connecting rod 18 and the bracket 19 on the reflector by means of a shaft 34 and pins 36 extending through ears 38 of the connecting rod and fixed in a ball, not shown. It should be noted that the joint between the bracket 19 and the rod 18 is off-set from the pivot axis of the reflector at 12.

The joint between the connecting arm and the bracket 21 is mounted off-center on the bevel gear, as best shown in Fig. 5, this attachment being by means of a pivot pin 40 fixed to the gear and rotatably holding the base 22 to the gear. This construction enables the bracket 21 to be used as a crank arm since during the rotation of the gear 24 by the motor 42 through appropriate gearing, not shown, the bracket 21 will move toward and away from the reflector. This crank movement, thereupon, acts through the connecting rod 18 to oscillate the reflector 10 about its axis at 12.

In some instances it may be desirable to lock the reflector against oscillation. This is accomplished by rotating the driven bevel gear 24 counter clockwise about the pivot 26 by an angle of 90 degrees to the position indicated in outline in Fig. 1. Any ordinary manual or mechanical means may be used to move the gear to this position and since such means forms no part of this invention it is not illustrated in the drawing. In this position of the bevel gear the axis of the connecting rod moves in a path describing the surface of a cone, the vertex of the cone being located at the center of the universal joint connecting the connecting rod to the reflector. The locked position of the reflector exists in this case because there is no axial movement of the connecting rod. Any intermediate position of the driven bevel gear 24 between the position shown in full line and the position shown in outline in Fig. 1 results in an oscillation of the reflector about the axis 12 which is proportionally intermediate in amplitude between a maximum at the full line position of the bevel gear and zero at the outline position thereof.

This kinematic linkage is essentially a constant-frequency, variable-amplitude mechanism. It is designed to be driven by a synchronous motor supplied by a constant frequency power source. The physical frequency of this linkage including the respective oscillations of the reflector will therefore bear a fixed phase relation with the electrical frequency of the power supply. The associated radar circuitry, which generates the radar pips guided by the aforesaid reflector, is also driven by the same power supply. There may be said to exist then, a fixed phase relation between this oscillating reflector and the radar pips emanating from this oscillating reflector.

The phase relation between the outgoing radar pips and the oscillating reflector will be altered for every change in amplitude of the reflector, employing the technique described above. This phase relation can be kept constant, however, regardless of the amplitude of the reflector oscillations by observing the following rule. The angular relationship between all axes of rotating shafts and gears from the armature of the synchronous drive motor to, and including, the crank arm of the double-universal nod mechanism must remain fixed regardless of the angular relationship between the axis of the aforesaid crank arm and the axis about which the reflector oscillates, this latter relation being a measure of amplitude adjustment. Another way of stating this rule is to

say that an integral chassis must support all shafts from armature to crank and that it will be necessary to move this chassis with respect to the chassis supporting the reflector in order to change the amplitude of reflector oscillation. A mechanism obeying this rule may be fabricated as readily as one utilizing a shifting bevel gear linked to a stationary drive unit. It will also require no greater displacement in space. A schematic representation of such a mechanism is depicted in Fig. 6.

The synchronous motor is depicted diagrammatically at M and connected thereto is the gear housing G. A crank mechanism C extends from the gear housing and is provided for a purpose similar to that of the crank mechanism formed by the bracket **21** in the first embodiment of the invention. The whole mechanism illustrated in Fig. 6 is rotatable around the axis A—A.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claim the invention may be practiced otherwise than as specifically described.

What is claimed as the invention is:

A device for oscillating a pivotally mounted radar antenna reflector comprising a bevel gear adapted to be driven by a motor, a crank arm mounted off-center on one face of said bevel gear, and a connecting rod extending from said crank arm, said connecting rod and said crank arm being connected by means of a universal joint; said bevel gear being adapted to swivel on said universal joint, and means coupling said connecting rod to said reflector, off-set from said pivotal mounting.



**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 1,548,958 | Sperry | Aug. 11, 1925 |
| 2,257,320 | Williams | Sept. 30, 1941 |
| 2,273,447 | Ohl | Feb. 17, 1942 |
| 2,415,103 | Langstroth | Feb. 4, 1947 |
| 2,537,822 | Fritts | Jan. 9, 1951 |
| 2,555,101 | Alvarez | May 29, 1951 |
| 2,585,579 | Norden | Feb. 12, 1952 |
| 2,629,828 | Cady | Feb. 24, 1953 |
| 2,713,121 | Lyman et al. | July 12, 1955 |