Aug. 30, 1949. R. E. KESTER 2,480,140

ANTENNA SWITCHING DEVICE

Filed Aug. 2, 1945 3 Sheets-Sheet 1

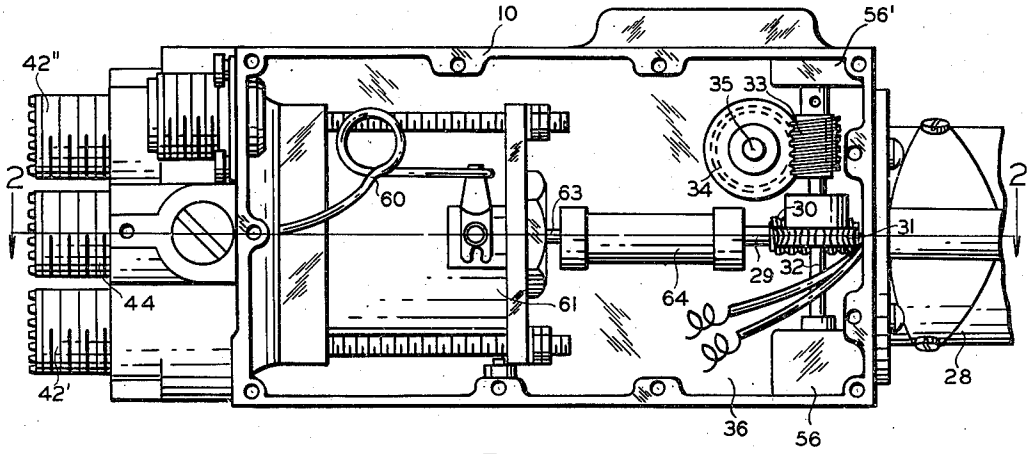


FIG. 1

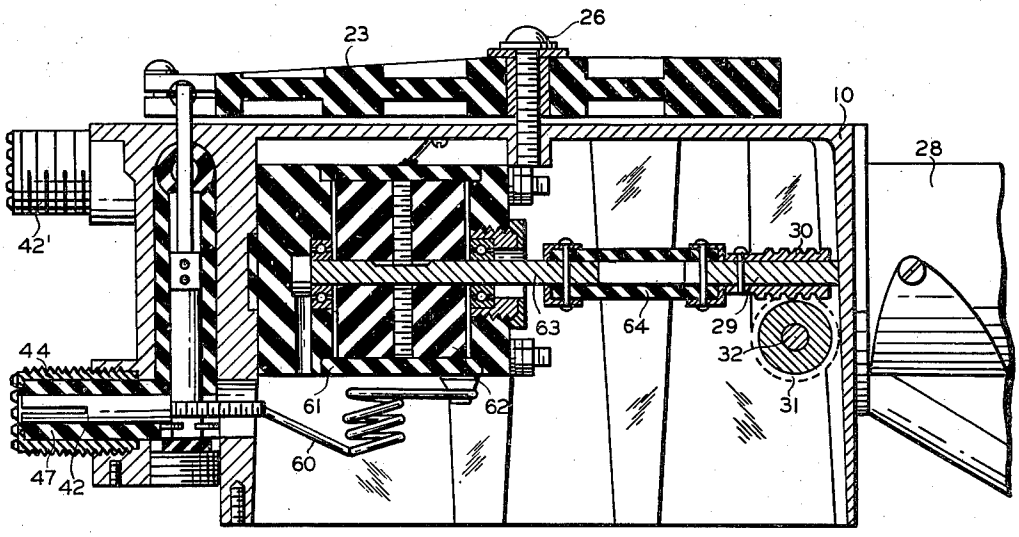


FIG. 2

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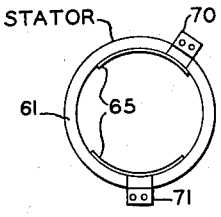


FIG 11

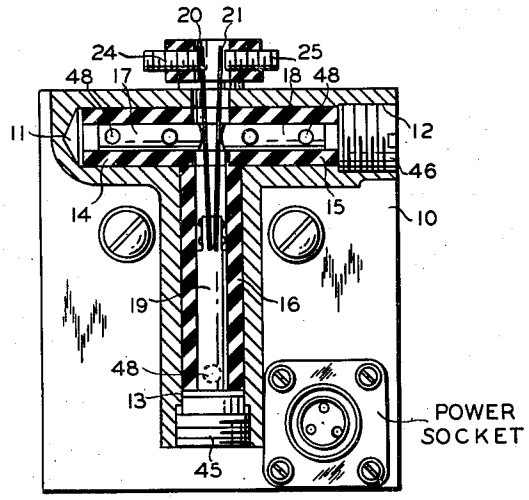


FIG. 3

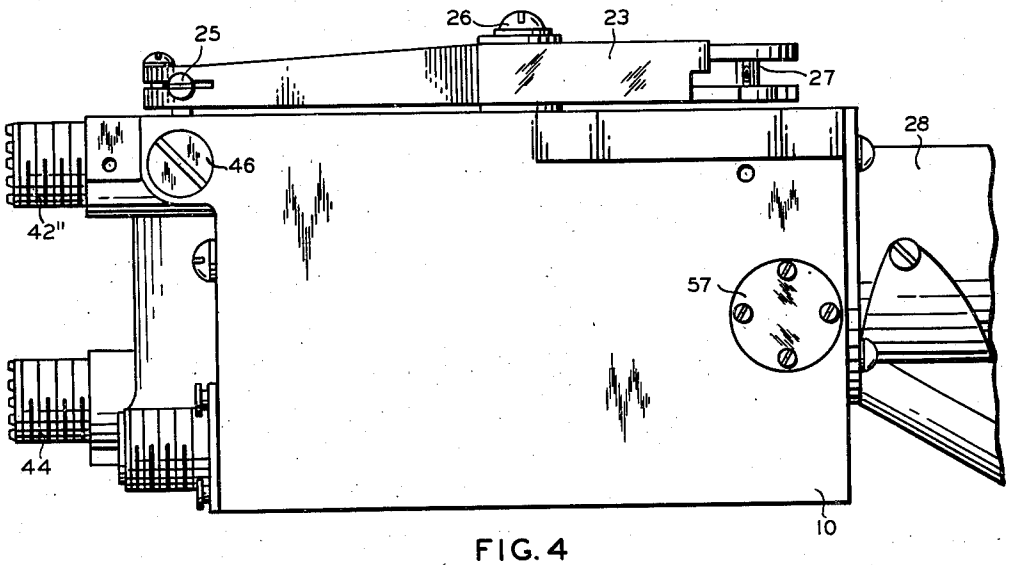


FIG. 4

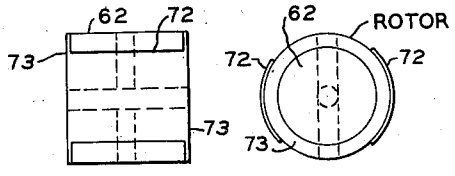


FIG. 9

FIG. 10

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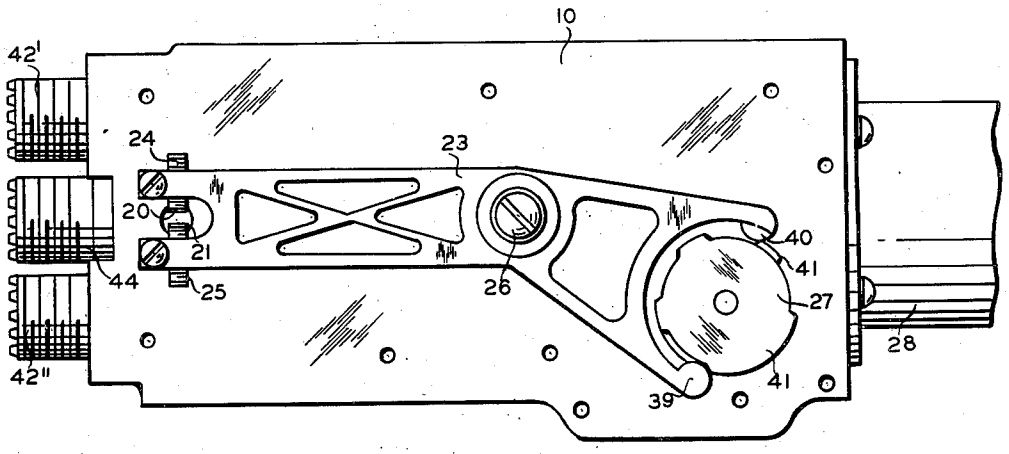


FIG. 7

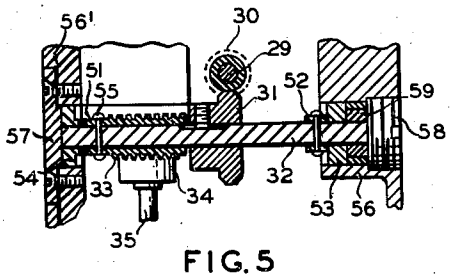


FIG. 5

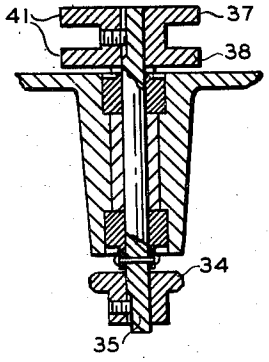


FIG. 6

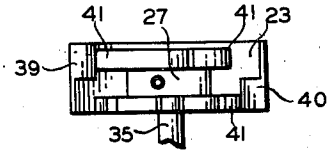


FIG. 8

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Patented Aug. 30, 1949 2,480,140

UNITED STATES PATENT OFFICE

2,480,140

ANTENNA SWITCHING DEVICE

Robert E. Kester, Dayton, Ohio, assignor to the United States of America as represented by the Secretary of War

Application August 2, 1945, Serial No. 608,567

2 Claims. (Cl. 178—44)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

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The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

The present invention relates to antenna switches and particularly switches employed in radio direction finding systems for aircrafts, boats, etc. One such system is described in a co-pending application of Robert J. Kemper, Serial No. 601,274, filed June 23, 1945, for Wide band homing system, wherein a pair of quarter wave antennae are placed side-by-side, spaced a short distance apart, and a coaxial phasing cable connects them at their base. A half wave section of coaxial cable also extends from the base of each antenna to a switching device which forms the subject matter of the invention herein described.

By switching one of the antennae alternately out of the circuit of the common conductor leading to a radio receiver, a sequence of signals reaches the receiver which may be of equal or unequal intensity, depending on the angle which the common plane of the antennae forms with a straight line pointing from the antennae to the distant beacon. Such a system results in directional signals indicating the heading of the vehicle with respect to the beacon, as will be readily understood by reference to said Kemper application.

For antenna switching purposes, conventional types of switches have proven ineffectual for use at very high frequencies because of their conventional make-break construction, and lack of impedance-matching characteristics.

A suitable coaxial switch construction for use in such a system at very high frequencies such as above the 100 megacycle range is described in a co-pending application of Henry R. Smith, Serial No. 603,393 filed July 5, 1945, for Coaxial switch, issued as Patent Number 2,425,010, August 5, 1947. This type of switch is incorporated in the present switching unit and makes possible the maintenance at all times of a continuous connection between either one or the other of the antennae and the receiver because of the overlap sequence of the swinging described in said application.

Common switch-actuating mechanisms for automatically actuating the pole of a two-way or double throw switch utilizing rotary cam and spring returned lever devices have also been found to be unsatisfactory because of the unequal loading of the actuating motor during the rise and fall cycles of the cam lobes. This unequal loading causes speed variations throughout the switch

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mechanism and consequent instability of the system. Especially where a rotary capacitor audio modulator is employed, these speed variations produce such pronounced variations or "wows" that the signals tend to become confusingly similar.

In order to utilize the advantages of such a homing system to the fullest extent, homing must be accomplished on any type of available radio frequency signals such as continuous wave hereafter referred to as C. W., modulated C. W. or pulsed. Where only a C. W. radio frequency signal is being received, for instance, local modulation of the signals is necessary to utilize normal head-phone right-left flying procedures. Local modulation may be derived through a high speed rotary capacitor such as that described in the Kemper application above referred to. The capacitor, however, must rotate at the very high speed of 10 to 12 thousand revolutions per minute in order to produce the desirable audio modulation tone on the incoming switched or keyed signals. In contrast to this, the keying or switching of the antennae is accomplished at the much slower rate of about 150 switching cycles per minute.

Speed reduction from the speed of the rotary capacitor to the slower speed at which the switch is oscillated is herein accomplished through a double reduction train of gearing, and is so arranged that a single motor serves both to drive the capacitor and a cam which oscillates the switch lever.

Since the high speed of the motor tends to set up inductive interference in the received signals, it is necessary to properly space the capacitor from the motor to avoid mutual capacitance between them, and to mechanically connect the rotating shafts by proper flexible dielectric couplings, and which permit easy removal of the motor if necessary.

Accordingly an object of the invention is to provide a light, portable, self-contained, self-powered antenna switching unit adaptable for use in a switched cardioidal field antenna radio homing system.

Another object is to provide such a self-contained unit which may be easily replaced in the system and which itself may be easily repaired and serviced.

A further object is to provide an antenna switching unit which, because of its arrangement and construction of component parts, requires no additional weighty or bulky devices for speed stabilization.

Another object is to provide a highly efficient and compact antenna switching and audio modulating unit, which is simple in character, designed for manufacture by mass production technique and which will operate accurately and efficiently over long periods of use and under diverse operating conditions.

These and other objects will appear throughout the specification and will be particularly pointed out in the claims.

For a better understanding of the invention, reference is had to the following description, taken in connection with the accompanying drawings wherein

Fig. 1 is an interior bottom view of the switch unit of the invention;

Fig. 2 is a side sectional view of the switch unit shown in Fig. 1, the section being taken along line 2—2 of Fig. 1;

Fig. 3 is an end view of the switch unit, partly in section, showing the arrangement of the switch contacts;

Fig. 4 is a side elevation of the switch unit sectionally shown in Fig. 2;

Fig. 5 is a fragmentary, sectional rear view of the speed reduction transmission of the switching unit;

Fig. 6 is a fragmentary sectional elevation of the double periphery cam drive assembly;

Fig. 7 is a top plan view of the switching unit with the lever compartment cover removed as in Fig. 4 to show the interrelation of the switch pole, switch lever, and cam;

Fig. 8 is a right end view of the cam end of the switch lever showing the pallet arrangement of the lever and the double periphery cam.

Referring more particularly to Figs. 1, 2, and 3, the entire switch is arranged in a housing 10 together with the pole actuating mechanism. The housing 10 is illustrated as having a pair of horizontally opposed bored sections 11 and 12 and an intermediate, vertically disposed, bored section 13. Each of the bored sections is provided with a diametrically uniform tubular dielectric element 14, 15 and 16, respectively, for retention of the switch contact members 17, 18 and 19, respectively, and are made preferably of polystyrene material. For convenience, the dielectric elements 14 and 15, inserted in the horizontally bored sections 11 and 12, are combined into a single piece, and an opening extends transversely of its axis to permit bifurcated legs 20 and 21 of a switch pole 19 of which they form a part, to extend therethrough. It will be understood, therefore, that the horizontal and vertical switch contacts are effectively arranged in T fashion, with the resilient legs 20 and 21 of the switch pole 19 extending beyond the horizontal dielectric members 14 and 15 and the surface of the housing 10 through opening 22. The projecting portions of legs 20 and 21 are suitably actuated by a reciprocable lever 23 so that overlapping switching cycles are achieved. Proper adjustment of studs 24 and 25 on lever 23 by increasing or decreasing the gap width between the two legs 20 and 21 will provide the desired amount of switching overlap. That is, one contact may be made to open at the instant the opposite contact is closed, or it may be made to open before or after the other closes.

Referring now to Figs. 1, 2, 3, and 7, lever 23 is illustrated as being pivoted on a stud 26 attached to the switch housing 10. A double periphery, follower type cam 27, driven by a suitable motor 28 through reduction gearing 30 to 35, inclusive, oscillates lever 23. Motor 28 is secured

to the switch housing 10, with its drive shaft 29 extending through the mounting wall of the housing 10 into a chamber 36 effectively forming a gear housing. The worm 30, mounted on the motor shaft 29, is in driving engagement with worm gear 31 pinned to countershaft 32, also carrying the worm 33 in driving engagement with the worm gear 34 pinned to the cam shaft 35, which shaft has pinned thereon the cam 27 for actuating the switch lever 23.

The cam 27, shown in detail in Figs. 4, 6, 7 and 8, is provided with separate cam peripheries 37 and 38, each provided with lever-actuating cam lobes 41 cooperating with respective pallets or ears 39 and 40 on the lever 27 to sequentially cycle the oscillations of switch lever 23 in predetermined signal cycles, such for instance, as the two short and a long interval of the Morse code letter "U" on one cam periphery, and a long and two short intervals of the Morse code letter "D," these letters preferably being chosen because they form a complementary signal pattern over the two cam surfaces, as is more fully described in said copending application of Kemper Serial No. 601,274.

When cam 27 is rotated through the gearing 30—35 by motor 28, a cam lobe 41 on one cam periphery 37, for instance, actuates the lever 23 in one direction, and the lever 23 is caused to return in the opposite direction by a succeeding lobe 41 on the other cam periphery 38. As will be understood from the above description, the oscillations of lever 23 will alternately break first one circuit between one leg 21 of the switch pole 19 and its switch contact 18, and then the circuit of the other leg 20 with its contact 17; the variable amount of lost motion allowed by the spacing between studs 24 and 25 permitting the desired degree of overlap switching.

For convenience, the switch contacts 17, 18, 19 are provided with female type extensions 42, so that common male type coaxial plug connectors may be removably secured to the switch, the left connector 42' and right connector 42'' serving to connect the switch contacts 17 and 18 to a pair of antennae (not shown), and the center conductor 44 serving to connect the switch to a receiver. After the switch parts are assembled within the bored sections of the housing 10, the openings are sealed by plugs 45 and 46 which are threaded to facilitate removal of the contacts for replacement due to wear.

The polystyrene tubular dielectric members 14, 15 and 16 are provided with perforations 48 for insertion of the threaded shanks of the contact extension members 42, which are threaded into respective contact members 17, 18, and 19 thereby forming a continuous electrical circuit. These extension members are likewise uniformly and continuously encased within dielectric retainers 47.

Fig. 5 illustrates in detail the method of reducing the speed of the motor through the double reduction worm gearing. Motor shaft 29 has pinned thereon the worm 30 which meshes with worm gear 31, the latter being pinned on countershaft 32. Countershaft 32 has pinned thereon a spacing collar 52 to take up side thrust against bronze bearing member 53 in which the countershaft 32 is journalled. Collar 51 on worm gear 33 serves as an anchoring surface through which to insert a pin 55 for assembling gear 33 to shaft 32 and serves also as a thrust member against bronze bearing 54 similar to collar 52 on the opposite end of shaft 32. To facilitate removal or replacement of the countershaft assembly, housing 10 is

provided with bearing retaining bosses 56 and 56' to retain the bearings 53 and 54 respectively. The bosses are bored through to provide openings on the opposite walls of housing 10 and the openings are covered by cover cap 57 and screw plug 58. Felt wick 59 is provided for feeding lubrication to shaft 32 and bearing 53.

It will be understood that induction coil 60 together with capacitor 61 (see Figs. 1 and 2) form the local modulating unit for superimposing tone modulation on the received signals. The rotary capacitor shown in Figs. 1 and 2, the function of which is fully described in said Kemper application, is composed of a stationary or field housing 61 and a rotor 62. The rotor 62 is pinned to its shaft 63. A flexible coupling member 64, preferably of rubber or other insulating material, couples rotor shaft 63 with motor shaft 29 so that motor 28 drives rotor 62 directly at its own speed of rotation, about 12,000 revolutions per minute, to impart the proper audio modulation tone on the received signals through coil 60 and connector 42.

The rotor 62 is made of solid construction to withstand the centrifugal force due to the high rotative speed. It is formed preferably of some molded plastic dielectric material, as, for example, phenol formaldehyde. The details of construction of the rotor and stator of the rotary capacitor are shown in Figs. 9, 10 and 11. The outer surface of the rotor body is provided with diametrically opposite metallized conducting areas 72, Figs. 9 and 10. Additional metallized surfaces 73 are provided at each of the rotor to form a low impedance connection between the metallized surfaces 72. The stator is provided with diametrically opposite surfaces 65, Fig. 11 on the inner surface of the stator body 61 to match the external metallized surfaces 72 of the rotor. Terminals 70 and 71 are brought out from the stator surfaces and connected to ground and inductance coil 60 respectively as shown in Figs. 1 and 2. The electrically conducting metallized surfaces may be applied to the dielectric material of the rotor and stator in any suitable manner, as by spraying or electroplating, such that it will have sufficient adhesive power to withstand windage and centrifugal force. The rotor revolves within the stator with a small clearance between corresponding metallized surfaces thus forming a capacitor whose capacity varies from maximum to minimum during each half revolution and provides the desired tone modulation.

In operation, motor 28 through its shaft 29, flexible coupling 64 and rotor shaft 63 drives rotor 62 directly. Through worm gear 30, gear 31, countershaft 32, worm 33, gear 34 and camshaft 35, cam 27 is driven at a much slower speed. Rotating cam 27 oscillates lever 23 thereby switching switch pole members 20 and 21 with respect to contact members 17 and 18.

Thus a unitary device is provided which may be attached to any receiver in circuit with a pair of cardioidal field pattern homing antennae for directional homing purposes. The construction and arrangement of parts is such that the strength of incoming signals will be attenuated

at a minimum and the device may be inserted in the circuit of the receiver at a remote point on the vehicle to avoid local noise interference. Likewise, the spacing and arrangement of the capacitor with respect to the motor is such that motor noise is effectively shielded from the switch circuit.

While the invention has been shown and described in its preferred embodiment, it is anticipated that changes in the details thereof may be made without departing from the spirit or scope of the invention as claimed.

Having thus described the invention, what is claimed is:

1. A radio high frequency switching device for use in a switched-antenna direction-finding radio system, comprising a motor, a switch housing supporting said motor, speed-reduction power transmission means in said housing and actuated by said motor, said transmission means including a reduced speed shaft, a rotary capacitor having a high speed rotor mounted in said housing, a flexible drive coupling inserted between the drive shaft of said motor and of the shaft of said rotary capacitor for driving the capacitor rotor at the speed of the motor, a double periphery cam mounted on said reduced speed shaft, said cam having lobes arranged on its double peripheries in a predetermined sequence, a lever pivoted on said housing and positively oscillated by said cam whereby said lever is positively oscillated in opposite directions, and a double throw pole switch mounted on said housing, the pole thereof being mounted to be oppositely thrown in accordance with the oscillations of said lever.

2. A radio high frequency switching device for use in a switched-antenna direction-finding radio system, comprising a motor, a housing supporting said motor, a rotary capacitor having a high speed rotor, power transmission drive means having fast and slow speed shafts mounted in said housing, said fast speed shaft driving the rotor of said rotary capacitor at the speed of said motor so that said rotor provides fly-wheel speed stabilization of said drive means and said slow speed shaft having associated therewith a lever actuating cam, a coaxial switch including a double throw pole and a switch lever pivotally mounted on said housing, said lever being formed of a light dielectric material and yoked at opposite ends to straddle said actuating cam at one end and said switch pole at the opposite end.

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REFERENCES CITED

The following references are of record in the file of this patent:

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