

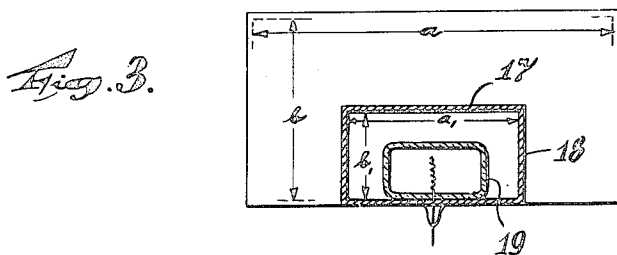
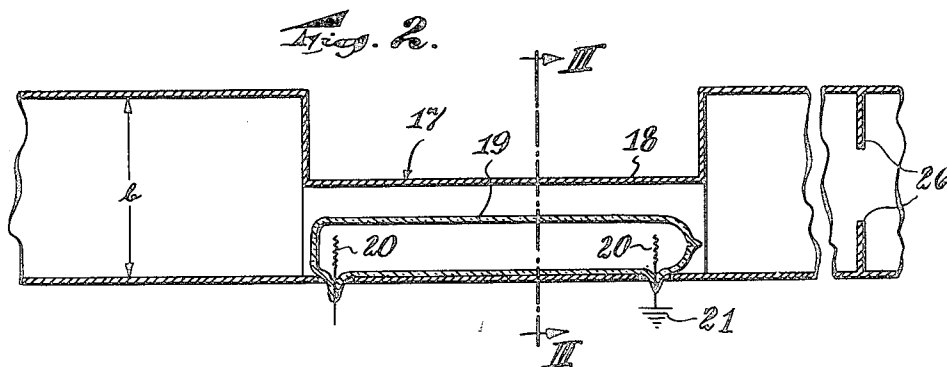
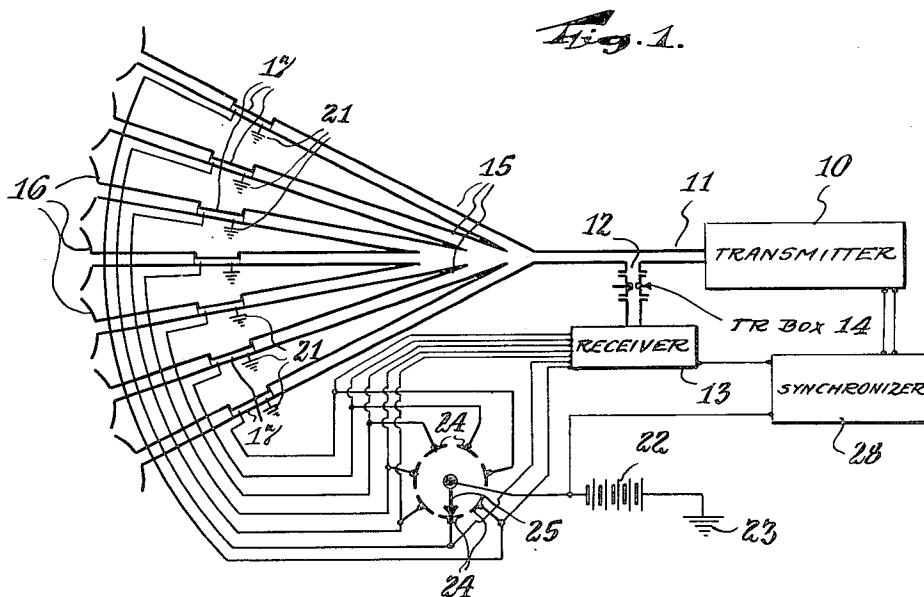
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ELECTRONIC CUTOFF SWITCH

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1

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ELECTRONIC CUTOFF SWITCH

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In the electronic art, there are occasions where it is desirable or necessary to pass a limited number of ultra high frequency wave pulses intermittently with complete interruption of passage of any pulses whatever. An instance of this character is in connection with radar scanning with fixed instead of rotating antennas. In such a system the beam is sequentially emitted from successive antennas necessitating that only one at a time shall transmit and all others not transmitting or receiving.

The switch of the present invention can accordingly be situated one in series with each antenna to pass the wave energy at the moment that antenna is to operate and to prevent passage of wave energy during the period in which all other antennas are operating. While the switch has other uses, it is not deemed necessary to elaborate thereon, it being sufficient to indicate the one use as evidence of the utility of my invention.

Primarily the invention proposes a switch having direct and positive control of wave energy in a waveguide to fully pass or fully interrupt the wave energy as desired.

Other objects of the invention are to take advantage of large mode separation; to avoid bulky transformers; to provide for wide band operation and avoid structure that is frequency-sensitive; to hold insertion losses during transmission and reception to a minimum; to enable use of low D. C. control voltage; to secure simplicity and efficiency of construction and operation; and to obtain other advantages and results which will become apparent to persons skilled in the art to which the invention appertains as the description proceeds, both by direct recitation thereof and by implication from the context.

Referring to the accompanying drawing, in which like numerals of reference indicate similar parts throughout the several views:

Fig. 1 is a somewhat diagrammatic representation of a radar system wherein each of a plurality of waveguides to fixed antennas includes a switch of the present invention;

Fig. 2 is a longitudinal sectional view of the switch of the present invention; and

Fig. 3 is a cross-section on line III—III of Fig. 2.

In the specific embodiment of the invention and one use thereof illustrated in the drawing, a radar system is shown providing a transmitter 10 with an output waveguide 11 for the pulsed energy therefrom. Laterally from the waveguide 11 is a branch line 12 to a receiver 13 protected by a TR-box 14 in the branch line. Further from the transmitter than said branch line, the waveguide is split into a plurality of feeder lines 15 to a like plurality of antennas 16. In each of these feeder lines 15 is an electronic switch 17 of the present invention. It is to be understood that waveguide 11 and lines 12 and 15 above referred to are all rectangular waveguides, preferably having cross-sectional shape such that long dimension a is greater than half the length of the characteristic wave length and short dimension b is less than half of that typical wavelength.

The switch, as shown particularly in Figs. 2 and 3, also includes a length of rectangular waveguide 18 the cross-sectional dimensions of which, a_1 and b_1 , are respectively approximately one half of said dimensions a and b , and dimension a_1 is less than one half wavelength of the characteristic wave of the main wave guide 15. Within this switch section 18 of wave guide, is longitudinally disposed an elongated tubular envelope 19 of substantially rectangular cross-section, the cross-sectional dimensions of which are approximately one half of the

2

corresponding cross-sectional dimensions of the switch waveguide section. Said tubular envelope is preferably of glass and contains an ionizable gas, of which argon, neon, krypton and the like are examples. Within, and near the ends of said envelope 19, are electrodes 20, 20 between which a difference in potential may be applied for obtaining a glow or arc discharge in the ionizable medium included in the envelope.

According to the present showing, one electrode of the switch is grounded at 21 and the other electrode is connected to some suitable mechanism by which periodic connection may be made to one terminal of a voltage source, such as battery 22, the other terminal of which is shown grounded at 23. The arbitrarily selected mechanism here illustrated comprises a series of fixed contacts 24 circularly disposed and adapted to be engaged successively by a rotating rotor 25 which is in electrical connection with said battery or voltage source 22. With each fixed contact connected to an electrode of a different switch 17, the gas in the several switches will be successively ionized during the sequential contacting of the rotor with the fixed contacts.

In addition to the dimensional relationships of the main wave guide 15, switch section wave guide 18, and tubular envelope 19, relative locations of the waveguides and envelope are of importance. As here shown, the switch section wave guide has what may be termed for convenience a bottom wall in the same plane as the corresponding wall of the main waveguide, and has its side walls equally inset from the planes of the side walls of the main waveguide so that, viewed from the top, the switch section of waveguide is symmetrically disposed with respect to the main waveguide. The top wall, however, of the switch waveguide section is at a plane substantially half way between the planes of the top and bottom walls of the main waveguide, and thus, viewed from the side, the switch section of waveguide is at the bottom half of the main waveguide. In like manner, the envelope 19 is at the bottom half of the switch section of waveguide and in plan is symmetrically disposed thereto.

By virtue of the dimensional relationship of the cross-section of the switch section of waveguide to the cross-section of the main waveguide, and with slight correction to compensate for the presence of the glass of envelope 19, the switch section 18 of waveguide is beyond cutoff with dimension a_1 approximately one half of dimension a of the main waveguide, and therefore the wave energy from the main waveguide will be stopped by the switch section of waveguide when no discharge is taking place in tube envelope 19. However, when the gas in envelope 19 is ionized, that is, during discharge, very little electric field of the wave energy in the waveguide will penetrate the ionized region in the envelope. The ionization constitutes a conductive path for the electric field at the envelope boundary and thus, because of the ionization, the resultant cross-sectional area for the electric field is then the area of the switch section of waveguide minus the cross-sectional area of the ionized gas in the envelope. This resultant area is of a shape like a wicket or inverted U, and in effect the two leg dimensions b_1 add onto dimension a_1 , making $b_1 + a_1 + b_1$ greater than half the wave length and the wave from the main waveguide may then pass through the switch section of waveguide with negligible attenuation. In other words, the cutoff frequency of the switch wave guide section is lowered comparable to that of the main wave guide as a result of surface conduction afforded at the three sides of the tube envelope by the ionization or discharge occurring in said tube envelope.

While the sudden transition or change of size or cross-section from the main waveguide to the reduced size of the switch section of waveguide and back again to the main waveguide might present an objectionable discontinuity under some conditions, it is rendered ineffective in my structure by spacing the transitions about 90° apart (in phase) or an odd multiple of this distance and providing apertured partitions 26 at 90° spacings or quarter wavelength from each other, in the main waveguide in both directions from the switch. The partition nearest the transition from large to smaller waveguide is a quarter wavelength, or odd multiple, therefrom.

3

The reflections at these partitions will be cancelled over a broad band of frequencies and the more partitions used, the broader will be the band.

I claim:

1. An electronic cut-off switch comprising a main wave guide dimensioned for transition of a characteristic wave, a smaller wave guide in continuation from the main wave guide, said smaller wave guide being dimensioned to be beyond cut off of the main waveguide, and ionization means having cross sectional area substantially half of that of said smaller wave guide for lowering cut-off frequency of the said smaller wave guide and permit passage of characteristic waves from said main wave guide during periods of ionization.

2. An electronic cut-off switch comprising a main wave guide dimensioned for transition of a characteristic wave, a smaller wave guide in continuation from the main wave guide, said smaller wave guide being dimensioned to be beyond cut-off of the main wave guide, and means for effectually increasing the cut-off controlling dimension of the smaller wave guide comparable to that of the main waveguide and passing said characteristic wave during the period of effectual increase of dimension of said smaller wave guide.

3. An electronic cut-off switch comprising a main wave guide having a transverse dimension at least as great as a half wave length of a characteristic wave adapted to be passed by said wave guide, a smaller wave guide connecting with the main wave guide and having a cut-off controlling dimension less than said half wave length, and means in said smaller wave guide for changing boundary conditions therein to substantially that of the main wave guide and adapted thereby to effectually increase said cut-off controlling dimension comparable to said transverse dimension of the main wave guide.

4. An electronic cut-off switch comprising a section

4

of rectangular wave guide, one wall of said wave guide having operational surface-increasing means longitudinally thereof and spaced from all other walls of said wave guide section.

5. An electronic cut-off switch comprising a section of rectangular wave guide, one wall of said wave guide having operational surface-increasing means longitudinally thereof and spaced from all other walls of said wave guide section, said surface-increasing means comprising a substantially rectangular closed glass tube containing an ionizable gas.

6. An electronic cut-off switch comprising a section of rectangular wave guide, one wall of said wave guide having operational surface-increasing means longitudinally thereof and spaced from all other walls of said wave guide section, said surface-increasing means comprising a substantially rectangular closed glass tube of substantially one half cross sectional area of the said section of wave guide and containing an ionizable gas, and electrodes in said tube for setting up an electric discharge in said gas and thereby obtain surface conductivity along the tube within said wave guide section.

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