

July 6, 1954

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2,683,255

SWITCH ATTENUATOR FOR WAVE GUIDES

Filed May 16, 1950

5 Sheets-Sheet 1

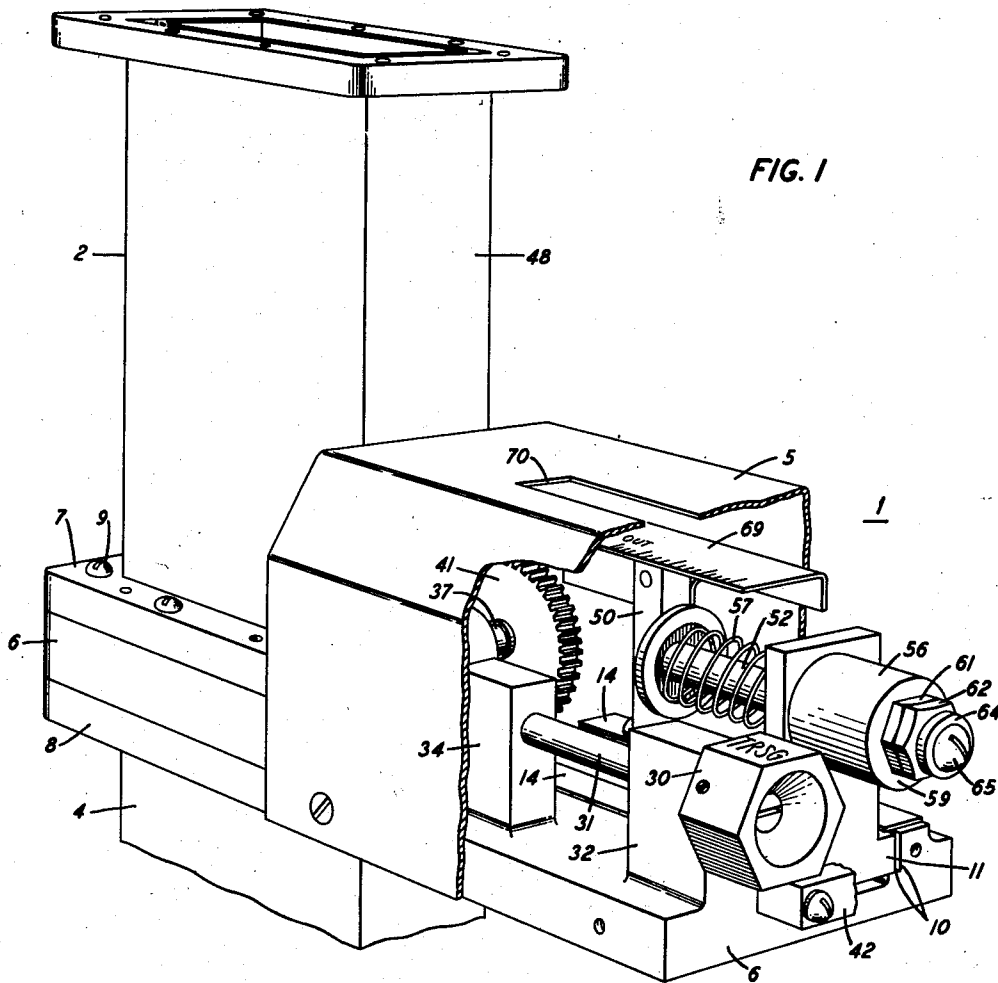
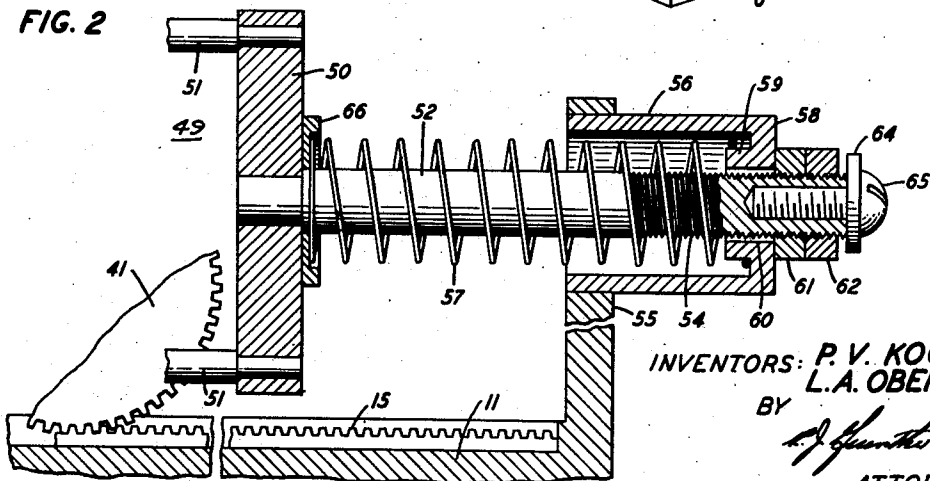


FIG. 2



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FIG. 5

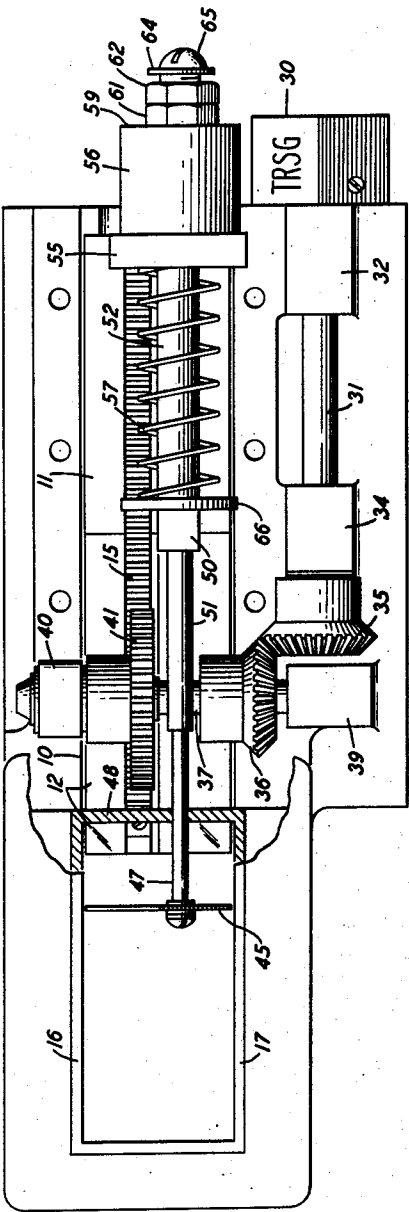
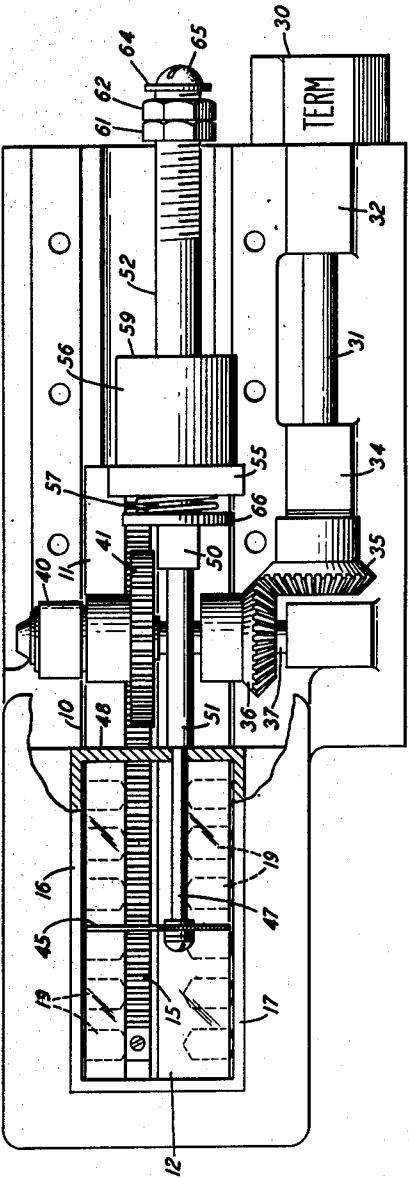


FIG. 6



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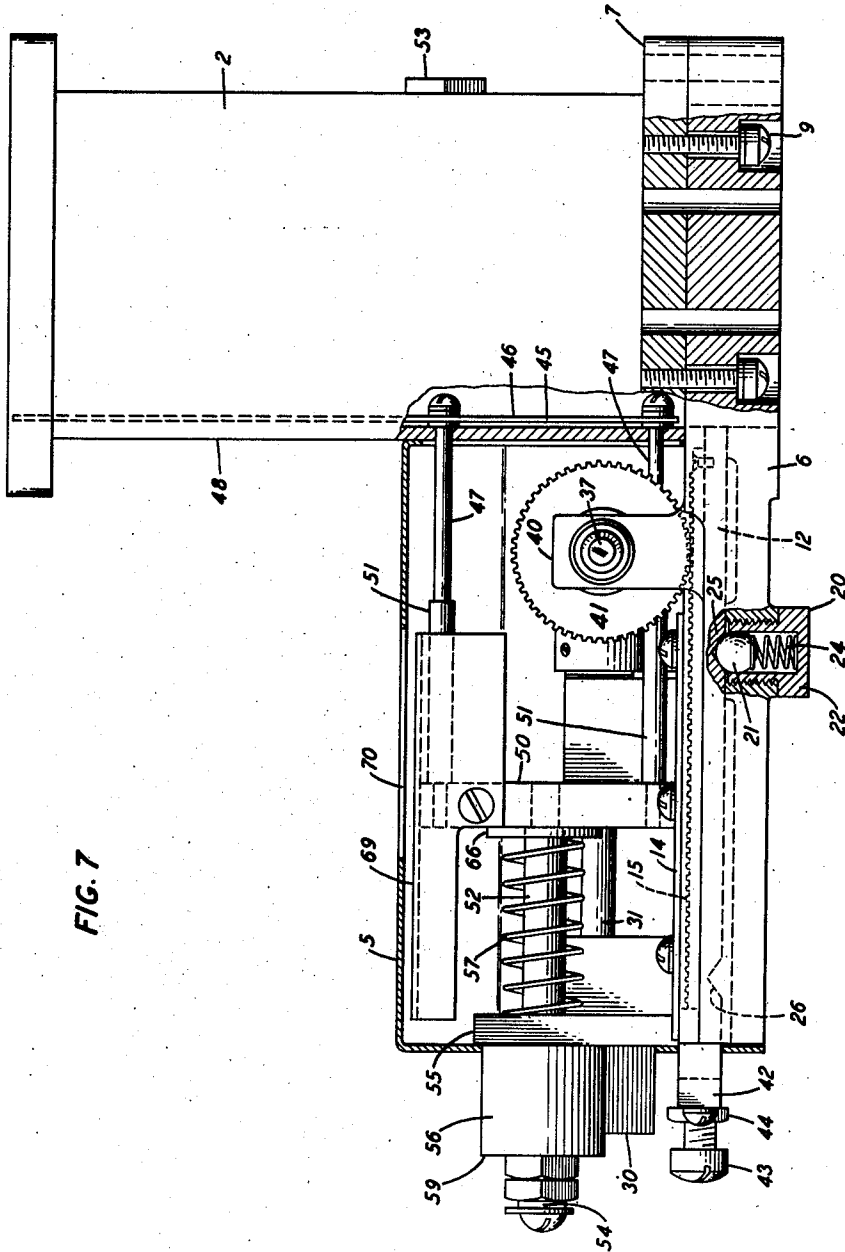


FIG. 7

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FIG. 9

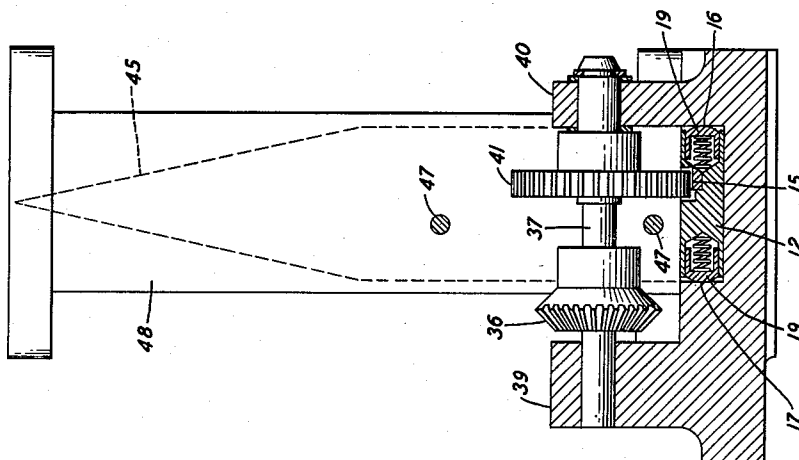
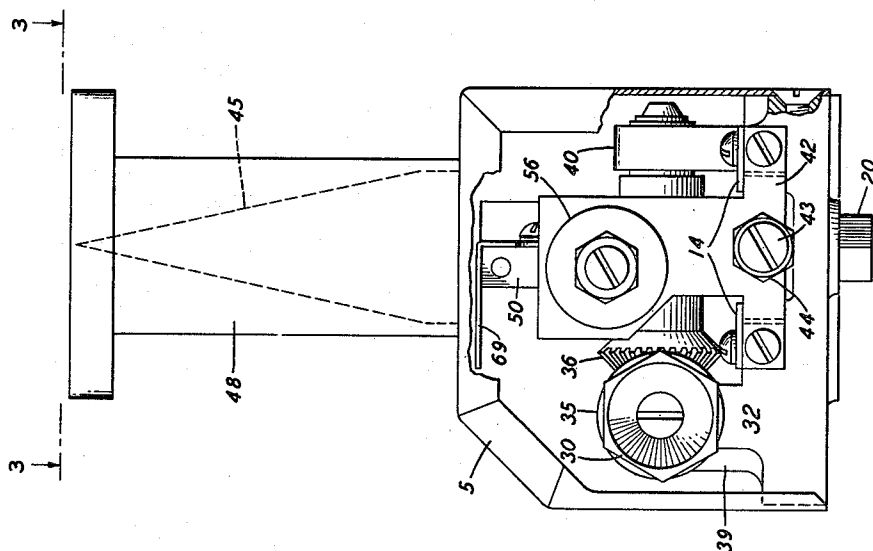


FIG. 8



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SWITCH ATTENUATOR FOR WAVE GUIDES

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Application May 16, 1950, Serial No. 162,312

10 Claims. (Cl. 333—81)

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This invention relates to wave-guide switches and, particularly, to mechanisms for terminating a section of wave guide and for introducing a controllable loss during transmission.

In the transmission of ultra-high frequency electromagnetic energy, dielectric guides and wave guides have been widely used. The wave guide may conveniently take the form of a rectangular conduit having its longer sides constituting the top and bottom of the guide. The terms "longer side" and "shorter side" refer, in connection with wave guides, to the cross-sectional dimensions. With the usual modes of transmission, the regions of greatest intensity of the electrical field within the guide are disposed centrally of the cross section thereof with the portions of the cross section adjacent the shorter sides of the guide having a minimum of electrical field intensity.

The problem of shutting off the flow of energy through a section of guide without producing reflections or setting up standing waves which will interfere with the proper functioning of the line has been met in the past by means such as providing a dummy line section in which impedance elements, usually resistive in character and graduated in value, were arranged to absorb all the incoming energy, and shifting the flow of energy from the main line to such a dummy line by means of a spigot-type rotary switch or the equivalent. The necessity for setting up a dummy section of line and a switch introduced undesirable complications in arranging the wave-guide structures and in the use of available space within the equipment. Also, the design of such a switch involves complications concerning impedance matching and leakage.

The present invention involves the provision of means for cutting off the flow of energy through a line without requiring the use of a switch and an auxiliary stub or dummy line, so that the arrangement of the parts and utilization of the space are improved. Also, the impedance match and leakage are improved. In addition, the invention provides for the introduction of a controllable amount of loss when the assembly is in the transmitting position, without interfering with adjustments for the terminating position.

In one embodiment of this invention these results are realized by use of a shorting shutter made of brass, or equivalent material of good electrical conductivity, which is formed as part of a gate assembly and arranged to slide across the wave guide to provide low resistance short-

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ing. This gate assembly is operated by the mechanism to be described hereinafter, in conjunction with a resistance or impedance element, the position of which is controllable independently of the gate assembly when the shutter is open but which is automatically moved into the position for maximum absorption of energy, and hence for termination, when the gate assembly is closed. Ordinarily the element used for the absorption of energy will be purely resistive in character, but in some situations it may be desirable to introduce reactive characteristics as well.

The details of construction of the shutter and gate assembly, including the means by which it is possible to secure sufficiently high conductivity electrical connection between the shutter and the wave guide, are described in the application of G. R. Frantz and J. J. Strodt, Serial No. 162,314, filed May 16, 1950.

It is thus an object of the invention to provide improved means for terminating a wave guide.

Another object is to provide means for introducing a controllable amount of loss in a wave guide, using the same resistance element.

A further object is to coordinate the use of a shorting shutter and terminating resistance with the utilization of the resistance as an adjustable loss element in the transmitting position.

A still further object is to provide means for controlling the amount of resistance which may be introduced into a wave guide without affecting the termination in terminating position.

A further object is to simplify the mechanism required for the termination of wave guides.

These and other objects will appear from the discussion following in connection with the drawing showing details of a device constructed in accordance with the invention, in which:

Fig. 1 is a perspective view, partly broken away to show inner details of construction of the traversing mechanisms of the switch;

Fig. 2 is a fragmentary view in section, taken as indicated by line 2—2 of Fig. 4, to show details of the means for adjusting the fixed loss;

Fig. 3 is a top view, of the assembly of Fig. 1, partly in section and with the cover for the traversing mechanism removed, with the shutter and resistance element in position for maximum transmission;

Fig. 4 is a view similar to that of Fig. 3, but with the resistance element adjusted to produce maximum fixed loss in transmitting position;

Fig. 5 is a view similar to that of Fig. 4, but with the shutter and the resistance element ba-

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ginning to move toward the terminating position;

Fig. 6 is a view similar to that of Fig. 5, but with the shutter fully closed and the resistance element in position for maximum attenuation as a termination;

Fig. 7 is a side view, partially broken away and in section, of the assembly, taken as indicated by line 7—7 of Fig. 3;

Fig. 8 is an end view, partially broken away and in section, taken as indicated by line 8—8 of Fig. 3; and

Fig. 9 is a view, partially in section, taken as indicated by line 9—9 of Fig. 3.

It is to be understood that the embodiments shown are illustrative only of the principles of the invention and that other embodiments and arrangements of parts and all equivalent structures and materials are intended to be included within the scope of the invention.

In the drawings, Fig. 1 is a perspective view of the switch-attenuator unit, indicated generally as 1, assembled with one section of wave guide 2 and joined to another wave-guide section 4. The cover 5 has been partly broken away in order to show the details of the mechanism for traversing the shutter and for adjusting the amount of loss in transmitting position. The shorting shutter, not visible in Fig. 1, is mounted for traversal in a housing 6. The housing 6, which extends between the end shoulders 7 and 8 of the wave-guide sections 2 and 4, respectively, and is secured thereto by conventional means such as screws 9, has formed therein a guide way 10 in which the gate assembly, indicated generally as 11, may travel from closed to open position. The gate assembly is held slidably in guide way 10 by means such as conventionally secured slide plates 14, best seen in Figs. 3 and 8, removed in Figs. 4 through 6 and 9 for clarity in illustration.

The gate assembly 11 is seen best in Figs. 3 through 6 and 9. It has a shutter 12 and a rack 15 through which movement of the gate is controlled. The shutter 12 makes a sliding fit with the longer wave-guide walls 16 and 17 and obtains a low-resistance electrical contact therewith by means of a plurality of spring-loaded contact pins 19 which are recessed in the longer sides of the shutter 12. The details of this construction, shown in Figs. 6 and 9, are more fully set forth in the Frantz-Strodt application referred to above.

Means are provided for particularly positioning the gate assembly 11 at each end of its traverse, comprising of a detent which will lock it resiliently in either the "open" or the "shut" position, details of which are seen best in Fig. 7. The detent 20 may comprise a ball 21 set in a hollow screw plug 22 threadably inserted in the underside of the gate housing 6. A spring 24 within the screw plug 22 forces the ball 21 against the lower side of the gate assembly 11. The gate assembly is notched at 25 and 26 so that the ball 21 will seat therein to position the gate assembly in the open or in the closed position, respectively; the assembly may be released by the application of moderate traversing force through the rack 15.

Traversing of the shutter is effected by turning a positioning knob 30 disposed at the one end of the housing 6. Knob 30 is mounted on a positioning shaft 31 which is journaled in two positioning shaft standards 32 and 34, extending upwardly from the housing 6. Positioning

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shaft 31 carries opposite knob 30, a driving bevel gear 35, which engages a similar driven bevel gear 36 mounted on a transverse shaft 37. Transverse shaft 37 is journaled in transverse shaft standards 38 and 40, and carries, in addition to the driven bevel gear 36, a rack-engaging pinion 41. When the positioning knob 30 is turned half a revolution, a complete traverse of the gate from fully open to fully closed position is obtained. The gate assembly 11 is prevented from sliding beyond the open or "transmitting" position not only by the detent arrangement 20 but also by a U-shaped end closure 42 secured to the end of the housing 6. Closure 42 has a stop screw 43 therein which may be adjusted to define the precise limits of the gate traverse and then fixed by means such as a lock unit 44.

Movement of the resistance element 45 within the wave-guide section 2 is also effected by movement of the positioning knob 30 through means which will be described in detail below. The resistance element 45 comprises a thin strip of insulating material such as Bakelite coated with a layer of graphite 46 or equivalent resistance substance. The strip is tapered to a point in the direction from which energy is being transmitted. The resistance element 45, commonly called a "vane" or "card," is carried by two parallel vane support rods 47 which extend slidably through the shorter wave-guide wall 48 and constitute a part of the yoke 49. Assembly of the resistance element 45 to the rods 47 is facilitated by providing a screw plug closure 53, seen in Figs. 3 and 7, which may be removed for entry of a screw-driver or other tool into the wave guide 2.

Yoke 49, as seen fragmentarily in Fig. 2 with details of the yoke adjusting means, and as seen from the side in Fig. 7, has a cross member 50 to which are directly secured the support and stop rod portions 51, of which the parallel support rods 47 are continuations, but of lesser diameter. The stop rod portions 51 engage the side wall 48 of the guide to limit the movement of the resistance card 45 into the guide. Fig. 6 shows rods 51 acting as stops at the point of maximum inward movement of card 45. Centrally of the yoke cross member 50, as seen in Figs. 2 and 7, there is fixed a vane-positioning shaft 52 which extends in a direction opposite to that of the support and stop rods 51 and 47, and is threaded at its free end, as shown at 54. The vane-positioning shaft 52 passes through a vane-traversing arm 55, which extends upwardly from the gate assembly 11. Vane-traversing arm 55 is bored to receive fixedly a cylindrical housing collar 56. Collar 56 acts as a housing for a coil spring 57 disposed around the vane-positioning shaft 52 and centered within the collar by an annular end closure portion 58 introverted to form an inner annular shoulder 59 about its central bore 60. Annular end closure portion 58 permits the free axial movement of the threaded vane-positioning shaft 52 through its bore 60. On the threaded portion 54 of shaft 52 are disposed an adjusting nut 61 and a lock nut 62. A washer 64 and set screw 65 are provided to prevent the lock nuts 61 and 62 from being unintentionally removed from shaft 52. The annular closure portion 58 of the housing 56 acts not only to restrain the spring 57 axially of shaft 52 but also in cooperation with the adjusting and lock nuts 61 and 62 to determine the amount of loss in the transmitting position by controlling the distance by which the vane 45 extends into the wave guide 2.

This arrangement permits adjustment of the vane 45 to introduce a desired loss during transmission to be made independently of its position for maximum absorption loss as a termination, as will appear hereafter. Traversal of the vane 45 toward the center of the guide is accomplished by means of pressure exerted by spring 57 through a seat 56 against the yoke cross member 59. Compressive stress is produced in spring 57 by the pressure thereagainst of the annular end closure 58 of the collar 56. As the shutter 12 is moved inwardly from the open or transmitting position by rotation of the rack-engaging pinion 41, driving rack 15 of gate assembly 11, the vane-positioning standard 55, formed integrally with the gate assembly 11, draws the hollow collar 56 with it and compresses spring 57 therewithin. This compressive stress reacts against the yoke 50 to cause movement of the vane 45 away from the wall 48 of the wave guide and toward a more central position. Fig. 3 shows the vane against the side wall, spring 57 being under an initial compressive stress. Fig. 4 shows the vane moved into the guide to introduce the maximum possible loss in the transmitting position, that is, while the gate is still wide open. Fig. 5 shows the gate and the vane beginning to move from the position of maximum attenuation for transmitting position toward the position for maximum attenuation in terminating position. As soon as vane 45 starts to move, its rate of traverse is the same as that of shutter 12 until stop portions 51 hit against the guide wall 48. Thereafter, gate 12 continues its traverse toward closed position, and the vane remains stationary. Fig. 6 shows the gate shut and the valve in the central position, that is, the position for maximum attenuation in terminating position.

As long as the shutter remains entirely open, the position of vane 45 is responsive solely to the position of adjustment and lock nuts 61 and 62. Turning nut 61 clockwise, as seen from the right-hand end in Fig. 4, returns the card toward the right for minimum attenuation, compressing the spring 57 within the collar 56. Turning the adjusting nut 61 in a counter-clockwise direction in Fig. 3 permits the reaction of the spring against the end of the collar to adjust the position of the vane by forcing it toward the center of the guide up to the limit shown in Fig. 4.

When the positioning knob 30 is turned from the transmitting toward the terminating position, the rack 15 traverses the hollow collar 56 toward the left, increases the compression in the spring, and compels the card to move into the more central position within the guide.

When movement has proceeded far enough for the expanded diameter stop portions 51 to strike against the side 48 of the wave guide, the vane can continue its movement no further; during the rest of the traverse of the gate assembly, the spring 57 is being compressed within the hollow collar. This over-riding action permits the rack to move as far as necessary for the traverse of the shutter, which is twice as far as the distance through which the vane must be traversed.

A conventional scale 69 may be mounted on the yoke 49 and observed through a window 70 in the cover 5 to determine the exact position of the resistance element at any time. It will be observed that the maximum open and closed positions are fixed by the detent, but that the position of the card when the shutter is open may be adjusted entirely independently of that of the shutter.

From the discussion above, it may be seen that a mechanism is presented to accomplish wave-guide termination and to introduce a controllable amount of loss during transmission in an improved and simplified manner.

What is claimed is:

1. In combination with a wave guide, means for controlling the flow of electromagnetic energy therethrough, comprising a shutter traversable across said guide to effect closure thereof, an impedance element disposed movably in said guide, means for traversing the shutter, means for moving the impedance element, connecting means between the traversing and the moving means for coordinating the traversal of said shutter and the movement of said impedance element, and means for adjusting the position of said impedance element when said shutter is not across said guide independently of the position of said impedance element when said shutter is across said guide.

2. A wave-guide switch-attenuator assembly, comprising a wave-guide section; a switch-attenuator assembly housing having a wave-guide portion therein adapted to be secured to, and form inwardly a continuation of, said wave-guide section; a shorting gate disposed within said housing, means for traversing said gate from a transmitting position to a terminating position relative to said wave-guide portion, a resistance element disposed for movement within said wave-guide section, means for moving said element, connecting means between the traversing and the moving means for coordinating the movement of said resistance element with the traversal of said shorting gate, and means for adjusting the position of said resistance element within said wave-guide section independently of the position of said resistance element when said shorting gate is in closed position.

3. A wave-guide switch-attenuator assembly, comprising a wave-guide section; a switch-attenuator assembly housing having a wave-guide portion therein adapted to be secured to, and form inwardly a continuation of, said wave-guide section; guide ways formed in said housing, a gate assembly including a shorting gate slidably disposed in said guide ways for movement between a transmitting and a terminating position, a yoke having portions extending slidably into said wave-guide section and other portions including stop means external to said section, a resistance element comprising a vane disposed within said wave-guide section and secured to said yoke; and means for coordinating the movements of said gate assembly and said resistance element, comprising a vane traversing arm extending from said gate assembly, a vane-positioning shaft extending from said yoke, and means interconnecting said arm and said shaft for positively engaging said vane-traversing arm at both the terminating position and the transmitting position of said gate assembly.

4. A wave-guide switch-attenuator assembly, comprising a wave-guide section; a switch-attenuator assembly housing having a wave-guide portion therein adapted to be secured to, and form inwardly a continuation of, said wave-guide section; guide ways formed in said housing, a gate assembly including a shorting gate slidably disposed in said guide ways for movement between a transmitting and a terminating position, a yoke having portions extending slidably into said wave-guide section and stop means for limiting the extent thereof, a resistance element comprising a vane disposed within said wave-guide sec-

tion and secured to said yoke; means for coordinating the movements of said gate assembly and said resistance element, comprising a vane-traversing arm extending from said gate assembly, a vane-positioning shaft extending from said yoke, and connecting means between said arm and said shaft for positively engaging said vane-traversing arm at both the terminating position and the transmitting position of said gate assembly; said connecting means including means for effecting resilient engagement between said vane-positioning shaft and said vane-traversing arm intermediate the transmitting and terminating positions of said gate assembly.

5. A wave-guide switch-attenuator assembly, comprising a wave-guide section; a switch-attenuator assembly housing having a wave-guide portion therein adapted to be secured to, and form inwardly a continuation of, said wave-guide section; guide ways formed in said housing, a gate assembly including a shorting gate slidably disposed in said guide ways for movement between a transmitting and a terminating position, a yoke having portions extending slidably into said wave-guide section and stop means external to said section, a resistance element comprising a vane disposed within said wave-guide section and secured to said yoke; and means for coordinating the movements of said gate assembly and said resistance element, comprising a vane-traversing arm extending from said gate assembly, a vane-positioning shaft extending from said yoke, a collar fixed in said vane-traversing arm arranged for sliding passage therethrough of said vane-positioning shaft, means on said vane-positioning shaft for limiting the passage thereof through said collar in one direction, and spring means between said collar and said yoke to inhibit the movement thereof in an opposite direction.

6. A wave-guide switch-attenuator assembly, comprising a wave-guide section; a switch-attenuator assembly housing having a wave-guide portion therein adapted to be secured to, and form inwardly a continuation of, said wave-guide section; guide ways formed in said housing, a gate assembly including a shorting gate slidably disposed in said guide ways for movement between a transmitting and a terminating position, a yoke having portions extending slidably into said wave-guide section and stop means, a resistance element comprising a vane disposed within said wave-guide section and secured to said yoke; and means for coordinating the movements of said gate assembly and said resistance element, comprising a vane-traversing arm extending from said gate assembly, a vane-positioning shaft extending from said yoke, a collar fixed in said vane-traversing arm arranged for sliding passage therethrough of said vane-positioning shaft, means on said vane-positioning shaft for limiting the passage thereof through said collar in one direction adjustable for varying the limiting position of said vane-positioning shaft relative to said collar and resilient means disposed in compression about said vane-positioning shaft and extending between said collar and said yoke.

7. A wave-guide switch-attenuator assembly, comprising a wave-guide section; a switch-attenuator assembly housing having a wave-guide portion therein adapted to be secured to, and form inwardly a continuation of, said wave-guide section; a shorting gate disposed within said hous-

ing means for traversing said gate from a transmitting position to a terminating position relative to said wave-guide portion, a resistance element disposed for movement within said wave-guide section, means for moving said element, connecting means between the traversing and the moving means for coordinating the movement of said resistance element with the traversal of said shorting gate, means for adjusting the position of said resistance element within said wave-guide section independently of the position of said resistance element when said shorting gate is in closed position; and means for effecting traversal of said gate, comprising a rack associated with said shorting gate, a pinion rotatably mounted in said housing and engaging said rack, and means for effecting controlled rotation of said pinion.

8. Means for adjusting the position of a resistance element disposed within a wave guide provided with a traversable shorting gate assembly, without interference with the portion assumed by said element for maximum attenuation in coordination with a terminating position of said gate assembly, comprising means associated with said shorting gate assembly for effecting traversal thereof, and connecting means between said shorting gate assembly and said resistance element, said connecting means including resilient means for effecting traversal of said resistance element in one direction to an intermediate position within the wave guide, and for permitting continued movement of said connecting means beyond said intermediate position of said resistance element.

9. Means for controlling the flow of energy in a wave guide comprising a short-circuiting shutter, an impedance element, means for traversing the shutter across the wave guide, means for adjustably positioning the impedance element within the wave guide including means for adjusting this element independently of the shutter when the shutter is open, and means for interconnecting the traversing means and the positioning means for placing the impedance element in a position of maximum energy absorption when the shutter is closed.

10. Means for controlling the flow of energy in a wave guide comprising a short-circuiting shutter, an impedance element, means for moving the shutter to closed or to open position, means for positioning the impedance element in a location for maximum, minimum or intermediate values of energy absorption when the shutter is open, and a connecting means between the shutter moving means and the impedance-element-positioning means for placing the impedance element in a location of maximum energy absorption when the shutter is closed.

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