

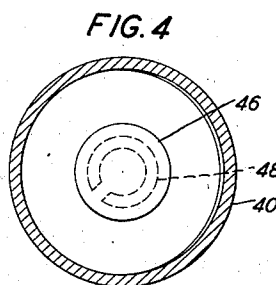
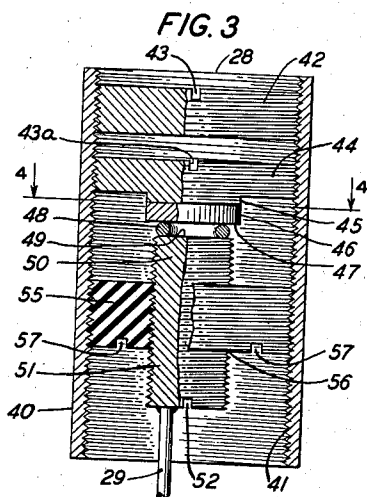
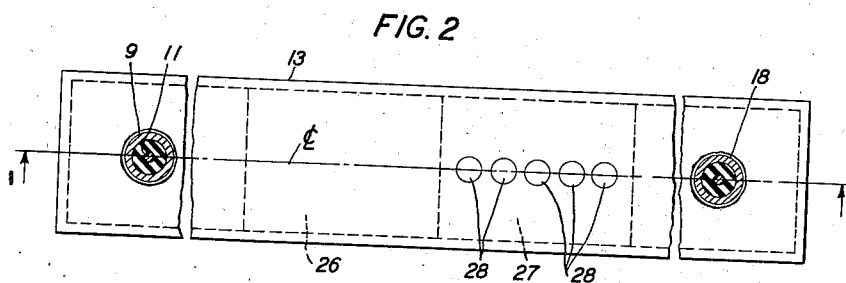
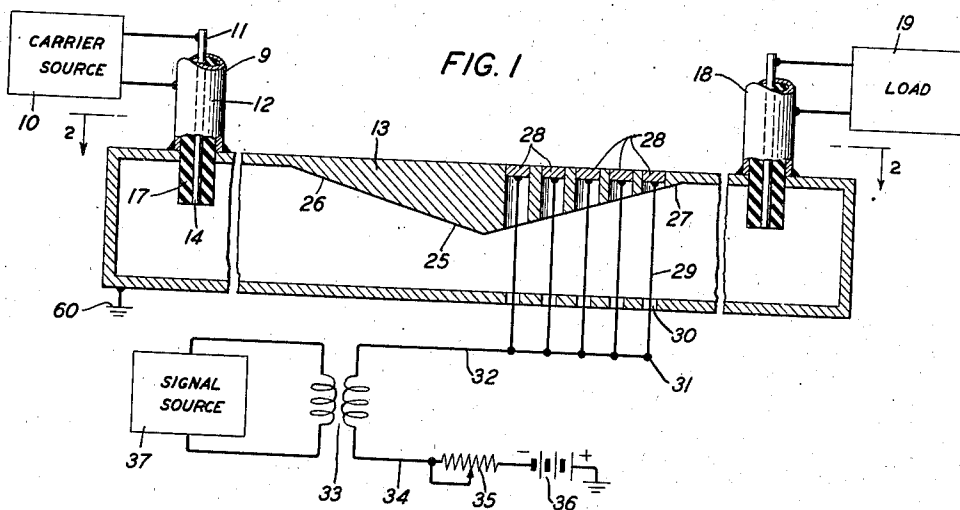
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WAVE TRANSLATING DEVICE

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WAVE TRANSLATING DEVICE

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10 Claims. (Cl. 179-171.5)

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This invention relates to microwave translating apparatus, and particularly to such apparatus provided with capability for handling a relatively large amount of signaling power.

In the development of signaling systems for microwaves having a wavelength of the order of one meter or less, one critical need is a satisfactory modulating device for handling the amount of signaling power involved. To be attractive from a circuit standpoint, such device should embody a capability for handling a preselected maximum amount of signaling power. This requires the modulating device to pass a maximum amount of signaling current for long and continuous periods of time without showing any deleterious effects.

The present invention contemplates microwave translating apparatus embodying a modulating device of substantially increased current carrying capability.

The object of the invention is to provide microwave translating apparatus including modulating elements capable of handling a large amount of signaling power for long and continuous periods of time without impairment of their efficiency.

In a specific embodiment of the present invention disclosed in connection with a conventional microwave signaling system described hereinafter, a wave guide has the inner surface at one side formed with a tapered portion. A plurality of solid rectifier elements is mounted in stepped relation along the longitudinal axis of such portion, and a plurality of leads is connected to the rectifier elements and extends across the wave guide to expose varying lengths interiorly thereof and to terminate outside thereof. A source of biasing voltage is connected via these leads to the rectifier elements. A signal source is connected in circuit with the leads and biasing source. It has been found in practice that the foregoing microwave translating apparatus embodies a substantially increased capability for handling signal energy.

The invention will be readily understood from the following description taken together with the accompanying drawing in which:

Fig. 1 is a schematic circuit diagram of a microwave translating apparatus including a specific embodiment of the invention and showing an elevational view of a circuit element in cross-section;

Fig. 2 is a plan view of Fig. 1;

Fig. 3 is an enlarged cross-sectional view of a circuit element of Fig. 1; and

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Fig. 4 is a sectional view taken along the line 4-4 in Fig. 3.

Herein, the term "microwave" denotes a wave having a length less than one meter, and as short as one centimeter or one millimeter.

Referring to Figs. 1 and 2, a source 10 of carrier microwaves is connected to inner conductor 11 and outer conductor 12, both of which constitute a coaxial conductor line 9. At the left-hand end of wave guide 13, the outer conductor 12 is electrically connected thereto, and a portion 14 of the inner conductor 11 covered with dielectric 17 extends into the interior of wave guide 13 through a suitable opening in an upper side wall thereof. The dielectric-covered portion 14 effects transmission between the coaxial line 9 and wave guide 13 in the well-known manner. At the right-hand end of wave guide 13, a similar coaxial line 18 effects transmission between wave guide 13 and load 19. A microwave transmission system of the foregoing type having a suitable impedance match between the carrier source 10, wave guide 13 and load 19 is disclosed in the copending application of W. W. Mumford, Serial No. 585,096, filed March 27, 1945.

In accordance with the present invention illustrated in Figs. 1 and 2, the inside surface of the upper side of wave guide 13 is formed with a constricted or substantially V-shaped section 25. This comprises linearly tapered portions 26 and 27 having points of minimum thickness lying nearest the carrier source 10 and load 19, respectively, and an intermediate point of maximum thickness.

Mounted in the tapered portion 27 in stepped relation along the longitudinal axis of the wave guide 13, Figs. 1 and 2, is a plurality of rectifier elements 28, 28 whose particular structure and function will be hereinafter explained. Connected to each rectifier element 28 is one end of an electrical lead 29 which extends across the wave guide 13, projecting through R. F. by-pass capacitors 30 of well-known structure in a lower side of wave guide 13 and terminating at point 31 lying outside thereof. The rectifier elements 28, 28 are shown in the number of five for the purpose of this illustration and such number may vary for individual microwave systems.

Each point 31 is connected via lead 32, secondary winding of transformer 33, lead 34, and variable resistor 35 to the negative terminal of a source 36 of biasing voltage whose positive terminal is grounded. A source 37 of signal waves is connected to the primary winding of transformer 33.

Rectifier element 28 is shown in Figs. 3 and 4 and comprises a tubular member 40 of conductive material formed with a thread 41 on its interior surface, each member 40 being mounted in electrical contact with the wave guide 13. At the uppermost end of tubular member 40 is a brass disk 42 provided with a peripheral thread and including a screwdriver slot 43 in its upper surface. Below the disk 42 and protected thereby from damage and/or dust is a second disk 44 of conductive material formed with a peripheral thread to engage thread 41 of member 40 and a boss 45 on its lower surface. A disk 46 of a suitable semiconducting material is suitably secured to the lowermost surface of the boss 45. Such material may include silicon or germanium or combinations of these elements with such other elements as tend to yield improved electrical properties. One method of preparing the disk 46 including a polished surface 47 is disclosed in my copending application Serial No. 530,419, filed April 10, 1944, Patent No. 2,437,269. The disk 44 also embodies a screwdriver slot 43a.

A split ring 48 of tungsten wire is positioned on the polished surface 47 of the disk 46, and pressed thereon by a flat surface 49 on the upper end of a conductive cylinder 50 having a peripheral thread 51 and a screwdriver slot 52 in its lower end. A disk 55 of dielectric material embodies a central opening 56 provided with a thread for accommodating the threaded peripheral surface of the cylinder 50, and a peripheral thread for engaging the thread 41 of the member 40. A pair of screwdriver slots 57, 57 is formed in the lower surface of the dielectric disk 55. Lead 29 is suitably attached to the lower end of the cylinder 50. The screwdriver slots in the respective components of rectifier element 28 serve to adjust their relative positions interiorly of the member 40. For further details on the rectifier element 28 reference is made to my copending application Serial No. 607,427, filed July 27, 1945.

In the operation of the invention, the variable resistor 35 in Fig. 1 is adjusted and the source 36 is poled to apply a preselected magnitude of negative biasing voltage to the split ring 48. The biasing current flows in a circuit including ground connected to the positive terminal of biasing source 36, source 36, resistor 35, lead 34, secondary winding of transformer 33, lead 32, terminals 31, leads 29, rectifier elements 28, 28 and wave guide 13 to ground 60 connected to the lower left-hand end thereof. The energy from signal source 37 is superimposed via transformer 33 on the biasing current flowing in the circuit just traced. The signal energy varies the effective resistivity of the combined rectifier elements 28, 28 and thereby the effective attenuation thereof. This varies the amount of carrier energy absorbed by the rectifier elements 28, 28 and as a consequence the amount of carrier energy supplied to the load 19. Thus, the signal energy serves to modulate the carrier energy.

Due to the varying lengths of the leads 29, 29 exposed to the carrier waves in the interior of the wave guide 13, their combined effect tends to simulate the effect of a tapered attenuator comprising a tapered strip of cardboard covered with a film of carbon, and to minimize reflection and thereby maintain the impedance match between the carrier source 10, wave guide 13, and load 19, hereinbefore mentioned. The modulator comprising the constricted section 25, rectifier elements 28, 28 and leads 29, 29 would be normally located in proximity of the carrier end of wave

guide 13, and because of the foregoing impedance match may be inserted at any suitable point therealong.

The V-shape section 25 in the interior of the wave guide 13 shown in Fig. 1 tends to lower the effective carrier frequency voltage applied to the rectifier elements 28, 28 which operate most efficiently at low voltages say, for example, of the order of one volt. This is an important consideration in microwave systems transmitting signal modulated energy at power values up to 30 watts. The rectifier elements 28, 28 have been found to pass 7.5 amperes at approximately one volt and to operate continuously at approximately 150 degrees centigrade with no apparent impairment thereof. Thus, the rectifier elements 28, 28 provide the microwave translating system with a substantially increased power handling capability. As circumstances warrant, the rectifier elements 28, 28 may be water or forced-air cooled.

The lengths of the leads 29, 29 exposed in the interior of the wave guide 13 should not exceed one-quarter wavelength to provide the system of Fig. 1 with a broad band characteristic from a frequency standpoint say, for example, several hundred megacycles at a wavelength of the order of one centimeter. The over-all spacing of the rectifier elements 28, 28 should probably not exceed one wavelength, nor be less than one-half wavelength.

Although the modulation is effected in Fig. 1 with a negative bias applied to the rectifier element 28, it will be understood that modulation can also be effected with a positive bias applied to the rectifier element 28, in which case the terminals of the biasing source 36 are interchanged.

What is claimed is:

1. In combination, in microwave translating apparatus, a tapered section of guide for the transmission of microwaves, a plurality of variable impedance elements mounted in stepped relation longitudinally of said section of guide, a plurality of electrical leads for coupling said elements to the transmitted microwaves, each of said leads having one end connected to one of said elements and extending across the interior of said section of guide to project its opposite end outside thereof, said leads being exposed varying amounts in the interior of said section of guide whereby said elements are coupled varying amounts to the transmitted microwaves, and electrical circuit means connected to the ends of said leads outside said section of guide for varying the impedance of said elements.

2. A combination according to claim 1 in which said elements and associated leads are mounted along the longitudinal axis of said section of guide.

3. Microwave translating apparatus comprising, in combination, a section of guide for the transmission of microwaves, a plurality of variable impedance elements, means for individually coupling said elements to the transmitted microwaves in progressively increasing degree at respectively corresponding successive points along said section of guide, and electric circuit means for varying the impedance of said elements concurrently.

4. In combination, a section of guide for the transmission of microwaves, and a plurality of microwave power absorbers individually coupled to the transmitted microwaves at respective successive points along said section of guide, the coupling of said power absorbers progressively increasing from one to another thereof.

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5. A combination according to claim 4 in which said section of guide is tapered.

6. A combination according to claim 4 in which said power absorbers comprise variable impedance elements, and which includes electrical circuit means for concurrently varying the impedance of said elements.

7. A combination according to claim 4 in which said absorbers are coupled at successive points along the longitudinal axis of said section of guide.

8. A combination according to claim 1 in which said elements are stepped longitudinally of said section of guide an overall distance of at least one-half wavelength.

9. A combination according to claim 1 in which the amounts of varying exposure of said

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leads in the interior of said section of guide have a maximum value of the order of one-quarter wavelength.

10. A combination according to claim 1 in which said elements are stepped longitudinally of said section of guide an overall amount whose maximum value does not exceed one wavelength.

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REFERENCES CITED

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

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Number	Name	Date
2,085,406	Zworykin	June 29, 1937
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