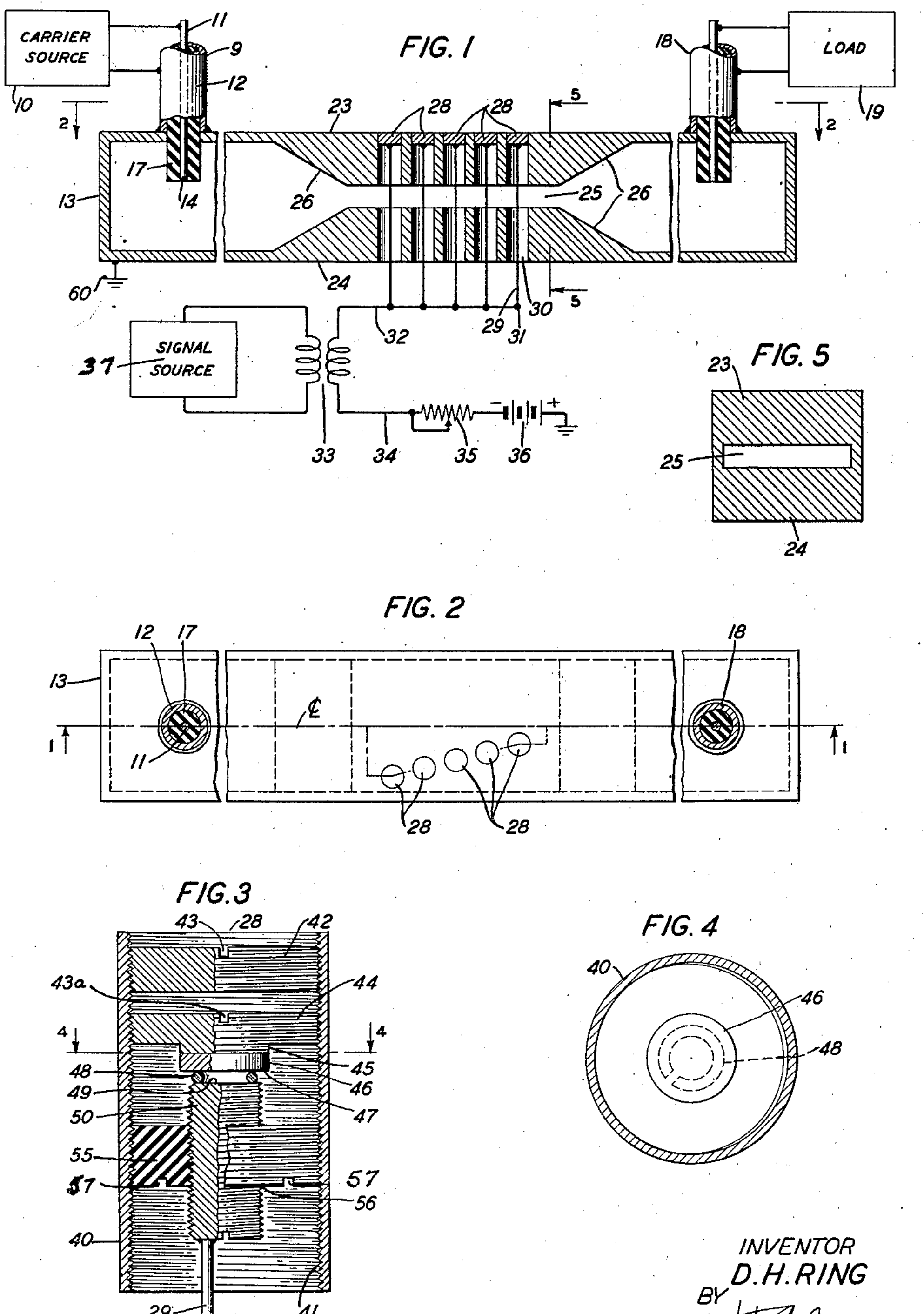
Dec. 28, 1948. D. H. RING 2,457,601

WAVE TRANSLATING APPARATUS

Filed July 27, 1945



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Patented Dec. 28, 1948

2,457,601

UNITED STATES PATENT OFFICE

2,457,601

WAVE TRANSLATING APPARATUS

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Application July 27, 1945, Serial No. 607,429

14 Claims. (Cl. 179—171.5)

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This invention relates to microwave translating apparatus, and particularly to such apparatus provided with a 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 a portion of its interior formed with a constricted section of uniform dimensions whose opposite ends terminate in flared sections. A plurality of solid rectifier elements is mounted in stepped relation diagonally of the constricted section, and a plurality of leads is connected to the rectifier elements and extends across the wave guide to expose equal 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 such 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;

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

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 sidewall 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, opposite surfaces 23 and 24 of wave guide 13 are constricted to provide therebetween a rectangular opening 25 of uniform dimensions, Fig. 5, and whose opposite ends terminate in flared openings 26, 26. Mounted diagonally of the surface 23 in suitable steps is a plurality of rectifier elements 28, 28 whose specific function and structure will be hereinafter explained. Connected to each rectifier element 28 is one end of an electrical lead 29 which extends across the opening 25 of wave guide 13, projecting through R. F. by-pass capacitor 30 of well-known structure in surface 24 and terminating at point 31 lying outside of wave guide 13. The leads 29, 29 expose substantially equal lengths in the opening 25. 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 having its positive terminals 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 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 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 is disclosed in the copending application of R. S. Ohl, Serial No. 530,419, filed April 10, 1944, now Patent No. 2,437,269. The disk 44 also embodies a screwdriver slot 43*a*.

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 the rectifier element 28 serve to adjust their relative positions interiorly of the member 40. For further details regarding the rectifier element 28, reference is made to the copending application of R. S. Ohl, 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 comprising ground conected 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 superimosed via transformer 33 on the biasing current flowing in the circuit just traced. The signal energy varies the effective resistivity of the combined elements 28, 28 and thereby the effective attenuation thereof. This varies the amount of carrier current 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 diagonal disposition of the rectifier elements 28, 28 in suitable steps in the wave guide sections 23 and 24 and the equal lengths of the leads 29 in opening 25 in Fig. 2, the individual rectifier elements 28, 28 will absorb substantially the same amount of power. This tends to minimize reflections and thereby maintain the impedance match between the carrier source 10, wave guide 13 and load 19 hereinbefore mentioned. The modulator comprising surfaces 23 and 24, opening 25 therebetween, flared openings, 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 low impedance sections 23 and 24 tend 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.

The lengths of the leads 29, 29 exposed in the opening 25 should not exceed one-quarter wavelength to provide the system of Fig. 1 with a broad-band characteristic form 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. A 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 different distances from an antinodal region of maximum field intensity at respective successive points along said section of guide, and electrical circuit means for varying the impedance of said elements concurrently.

2. A microwave translating apparatus according to claim 1 in which said elements and coupling means are disposed along a straight line which is oblique to the longitudinal axis of said guide and which is on one side of such axis.

3. 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 successive points being progressively closer to a region which with regard to the variation of field intensity transversely of said guide is a region of maximum field intensity whereby such coupling of said absorbers progressively increases from one to another thereof.

4. A combination according to claim 3 in which said power absorbers are coupled to absorb substantially equal amonnts of power from said microwaves.

5. 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 successive points being progressively closer to a region which with regard to the variation of field intensity transversely of said guide is a region of maximum field intensity whereby the coupling

of said absorbers progressively increases from one to another thereof, and the successive points progressively approaching the center line of said section of guide.

6. In combination, a section of guide for the transmission of microwaves, a plurality of microwave power absorbers individually coupled to the transmitted microwaves at respective successive points along said section of guide, said absorbers comprising variable impedance elements, said successive points being progressively closer to a region which with regard to the variation of field intensity transversely of said guide is a region of maximum field intensity whereby the coupling of said absorbers progressively increases from one to another thereof, said points progressively receding from a side wall of said section of guide, and electrical circuit means for varying the impedance of said elements concurrently.

7. In combination, in microwave translating apparatus, a section of guide for the transmission of microwaves, a plurality of variable impedance elements mounted in said section of guide, said elements being so mounted in said section of guide that the respective elements lie different distances from the longitudinal axis thereof, a plurality of electrical leads for coupling said elements to the transmitted microwaves, each lead 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 substantially the same amount in the interior of said guide, said mounting of said elements and leads associated therewith being at different distances from the longitudinal axis of said section of guide for varyingly coupling said elements 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 concurrently.

8. A combination according to claim 7 in which said elements are mounted diagonally of the longitudinal axis of said section of guide.

9. A combination according to claim 7 in which said section of guide has a substantially uniform cross-section.

10. A combination according to claim 7 in which said elements are mounted longitudinally of said section of guide an over-all distance of at least one-half wavelength.

11. A combination according to claim 7 in which the amount of the exposure of said leads in the interior of said section of guide has a maximum value of the order of one-quarter wavelength.

12. A combination according to claim 7 in which said elements are mounted longtiudinally of said section of guide an over-all amount whose maximum value does not exceed one wavelength.

13. In combination, a section of wave guide for the transmission of microwaves, and a plurality of variable impedance elements individually coupled to the transmitted microwaves at respective successive points along said section of guide, the successive points being progressively closer to a region which with regard to the variation of field intensity transversely of said guide is a region of maximum field intensity.

14. In combination, a section of wave guide for the transmission of microwaves, a plurality of variable impedance elements individually coupled to the transmitted microwaves at respective successive points along said section of guide, the successive points being progressively closer to a region which with regard to the variation of field intensity transversely of said guide is a region of maximum field intensity whereby such coupling of said elements progressively increases from one to another thereof, and an electrical circuit external of said guide and interconnecting said plurality of elements.

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