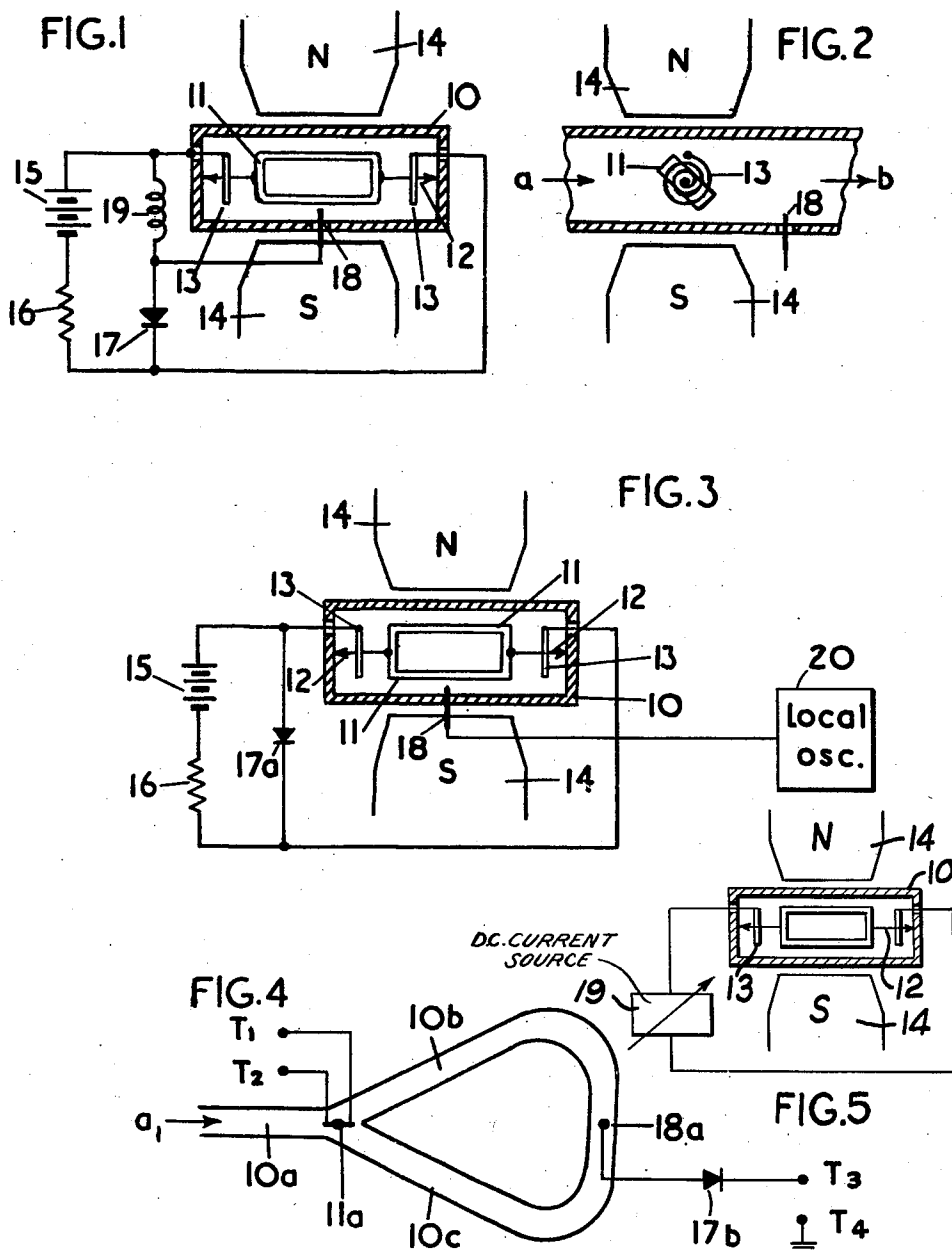


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WAVE GUIDE REGULATOR  
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## WAVE GUIDE REGULATOR

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5 Claims. (Cl. 178-44)

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This invention relates to ultra-high frequency electrical apparatus and is more particularly concerned with arrangements comprising an electromagnetic wave guide.

An object of the invention is to provide an improved device for regulating the electromagnetic energy passing through a wave guide.

A further object of the invention is to provide an arrangement for use as a means of stabilising the electromagnetic power passing through a wave guide at a desired predetermined level.

Another object of the invention is to provide an arrangement by which the output of a rectifying device such as a crystal mixer, whose conversion efficiency is subject to variation, may be stabilised at a desired predetermined level.

Yet a further object of the invention is to provide an arrangement by which amplification of a weak direct current may be effected.

The arrangement according to the invention comprises a coil of conducting material mounted within an electromagnetic wave guide and free to rotate about an axis perpendicular to the axis of the coil, said coil being so shaped and dimensioned that bodily it forms an obstacle resonant to electromagnetic energy passing through the wave guide; biasing means for urging said coil towards a predetermined position and means for producing a magnetic field surrounding said coil whereby by the application of a direct current to the coil winding, the resonant obstacle formed thereby may be rotated on the said axis against the action of said biasing means to control the flow of electromagnetic energy through the wave guide. The control of electromagnetic energy flowing through a wave guide by means of a resonant obstacle is described and claimed in copending United States application Serial No. 763,621, filed July 25, 1947 as the equivalent of corresponding British Specification No. 597,216, filed April 20, 1944, and accepted in Great Britain on January 21, 1948. The coil may be arranged for movement against the action of control means such as hairsprings or alternatively may be supplied with a suitable opposing current derived from a constant D. C. source.

In a preferred form the coil winding is adapted to form a closed resonant ring of the kind described in the aforesaid copending United States application Serial No. 763,621, filed July 25, 1947 as the equivalent of corresponding British Specification No. 597,216, filed April 20, 1944, and accepted in Great Britain on January 21, 1948 whereby it allows substantially unimpeded transmission of energy when disposed with its

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own plane parallel with that of the axial direction of the guide and effects substantially complete cut-off of energy when disposed with its plane normal to the said axial direction.

A number of arrangements embodying the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a semi-diagrammatic cross sectional view and Figure 2 is a similar sectional elevational view of an arrangement for stabilising the electromagnetic power flowing through a wave guide.

Figure 3 is a view similar to Figure 1 of an arrangement for stabilising the rectified output of a crystal mixer at a predetermined level, while

Figure 4 is a diagram showing an arrangement for effecting amplification of a weak direct current, and

Figure 5 shows an arrangement for use as a remote controlled regulator for controlling the power flowing through a waveguide.

Referring first to Figs. 1 and 2, the device comprises a multi-turn rectangular coil winding 11 rotatably mounted on pivots 12 within a rectangular wave guide 10. The guide carries a wave of the  $H_{10}$  mode between a source connected beyond the end *a* and a load at the opposite end *b*. The axis of rotation of the coil is perpendicular to the E-vector of the wave and to the longitudinal axis of the guide.

The dimensions of the coil are such that, bodily, it forms a resonant closed ring of the kind described in the aforesaid copending United States application Serial No. 763,621, filed July 25, 1947 as the equivalent of corresponding British Specification No. 597,216, filed April 20, 1944, and accepted in Great Britain on January 21, 1948 and serves to allow substantially unimpeded transmission of power through the guide when disposed with its plane parallel with the axial direction of the guide while effecting substantially complete cut-off of power transmission when disposed with its plane normal to said axial guide direction.

Electrical connection is made to the coil winding through two very light hairsprings 13. A permanent magnet having opposed poles 14 provides a magnetic field normal to the axis of rotation of the coil 11.

A crystal detector 17 is connected to a probe 18 coupled loosely to the guide 10 by insertion through a suitable aperture on the load side *b* of the coil. The rectified crystal current is passed through the coil 11 by way of choke coil 19, in

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opposition to a steady current derived from a stabilised D. C. source 15 flowing through a high resistance 16. The arrangement is such that increase in rectified crystal current turns the coil in a direction so as to cut down the power transmitted therepast, i. e. so as to reduce the crystal current. Obviously the probe 13 may be replaced by any other known form of electromagnetic pick-up device such as a loop.

Assuming the coil 11 to be perfectly free, it may turn until no current flows through it, i. e. until the crystal current is exactly equal to that from the source 15. The crystal current is a function of its rectifying efficiency and the power supplied to the load; assuming the crystal has a constant characteristic, the power supplied will accordingly be held constant. Alteration of the value of the counter-current supplied by the source 15, e. g. by variation of resistance 16, affords a control of the value of power supplied. In practice, the control exerted by the hairsprings 13 is not zero and an out-of-balance current must flow through the coil; this need not exceed a few micro-amperes, however.

In the arrangement shown in Fig. 3, the construction is substantially identical with that described above with the exception that the crystal rectifier 17a, now connected directly across the coil winding, is that forming part of the crystal mixer device whose rectified D. C. output is required to be kept constant in spite of variations of the characteristics of the crystal. The wave guide 19 conveys electromagnetic energy from the local oscillator 20 to a crystal mixer and the coil winding 11 is arranged to turn within the guide so as to maintain the power supplied by the local oscillator at an intensity such that the rectified current from the crystal is at a desired predetermined level. Adjustment of the power flowing through the wave guide from the local oscillator is effected by adjusting the D. C. current applied to the coil from a D. C. source 15.

Fig. 4 shows a D. C. amplifier arrangement. A length of wave guide 10a is arranged so as to divide into two sections 10b, 10c whose other ends are joined to form a closed loop. At the throat of the division point of the guides is arranged a moving coil winding 11a shaped to form a resonant ring similar to that already described. This ring, by its movement into different positions of inclination with respect to the divergent guide portions, serves to vary the ratio of the E. M. energy values supplied from the end a1 to the respective guide portions. A probe 13a connected to a crystal rectifier, is located at a point in the wave guide loop such that the path length by way of one fork, e. g. 10b, is  $\lambda/2$  or an odd multiple thereof longer than the path length by way of the other fork.

With the moving coil in a position such that equal division of energy is made between the two paths, the rectified output from 13a will be zero owing to the cancellation effect caused by the 180° phase displacement of the two wave components reaching it from opposite directions. Movement of the coil 11a, by a current of the order of microamperes applied by way of terminals T<sub>1</sub> and T<sub>2</sub> thereto, from such position will upset the balance between the two branches and so provide a resultant wave component at the probe 13a which, after rectification in rectifier 17b, may give rise between terminals T<sub>3</sub> and T<sub>4</sub> to a current of the order of milliamperes.

Figure 5 shows an arrangement substantially identical to the arrangement shown in Fig. 1

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in which, however, the rectifier and counter current source is replaced by a source of current 19. The arrangement may be used as a remote controlled power regulator since the position of the coil 11 within the waveguide and thus the power flowing through the waveguide may be controlled by varying the current applied to the coil from source 19.

I claim:

1. An arrangement for regulating the electromagnetic energy flowing through an electromagnetic wave-guide comprising, an electromagnetic wave-guide, a coil of conducting material rotatably mounted within said wave-guide on an axis perpendicular to its own axis, said coil being resonant to electromagnetic energy flowing through said wave-guide, magnetic field producing means producing a magnetic field surrounding said coil, an electromagnetic pick-up device coupled to said wave-guide at a position beyond the coil in the direction of flow of electromagnetic energy, a rectifier rectifying the electromagnetic energy in said pick-up device, electrical connections applying the rectified current output of said rectifier to said coil in a sense tending to decrease the electromagnetic energy passing said coil, a source of electrical current, and electrical connections applying current from said source of electrical current to said coil in opposition to said rectified current output of said rectifier.

2. An arrangement for regulating the flow of electromagnetic energy through an electromagnetic wave-guide according to claim 1 wherein said rectifier is a crystal rectifier.

3. An arrangement for regulating the electromagnetic energy flowing through an electromagnetic wave-guide comprising, an electromagnetic wave-guide, a coil of conducting material rotatably mounted within said wave-guide on an axis perpendicular to its own axis, said coil being a closed ring which is resonant to electromagnetic energy passing through said wave-guide, magnetic field producing means producing a magnetic field surrounding said coil, an electromagnetic pick-up device coupled to said wave-guide at a position beyond the coil in the direction of flow of electromagnetic energy, a rectifier rectifying the electromagnetic energy in said pick-up device, connections applying the rectified current output of said rectifier to said coil in a sense tending to decrease the electromagnetic energy passing said coil, a source of electrical current and connections applying current from said source of electrical current in opposition to said rectified current output of said rectifier.

4. An arrangement for regulating the electromagnetic energy flowing through an electromagnetic wave-guide comprising an electromagnetic wave-guide, a coil of conducting material rotatably mounted within said wave-guide on an axis perpendicular to its own axis said coil being resonant to electromagnetic energy passing through said wave-guide, magnetic field producing means producing a magnetic field surrounding said coil, hairsprings urging said coil towards a predetermined position and making electrical connection to the two ends of said coil, an electromagnetic pick-up device coupled to said wave-guide at a position beyond the coil in the direction of flow of electromagnetic energy, a rectifier rectifying the electromagnetic energy in said pick-up device whose rectified current output is applied through said hairsprings to said coil in a sense tending to decrease the electromagnetic energy passing

said coil, and a source of current feeding said coil in opposition to the rectified current output of said rectifier.

5. An arrangement for regulating the electromagnetic energy flowing through an electromagnetic waveguide comprising in combination with the electromagnetic waveguide of a coil of conducting material rotatably mounted on an axis perpendicular to its own axis, said coil being resonant to electromagnetic energy flowing through said waveguide, magnetic field producing means producing a magnetic field surrounding said coil, an electromagnetic pick-up device coupled to said waveguide at a position beyond the coil in the direction of flow of electromagnetic energy, a rectifier rectifying the electromagnetic energy in said pick-up device, electrical connections applying the rectified current output of said rectifier to said coil in a sense tending to decrease the electromagnetic energy passing said coil, and resilient means biasing the coil in a sense opposite to the first-named sense.

RICHARD G. GARFITT.

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