Oct. 30, 1945. J. T. GOODE 2,388,049

ATTENUATOR

Filed Aug. 25, 1943

Fig. 1

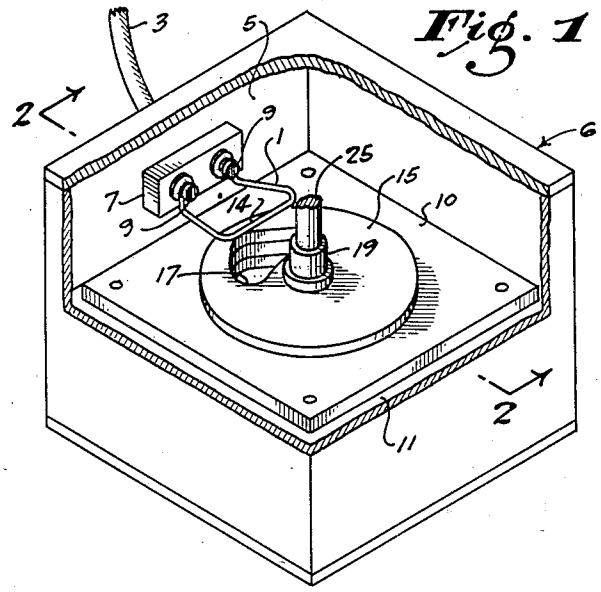


Fig. 4

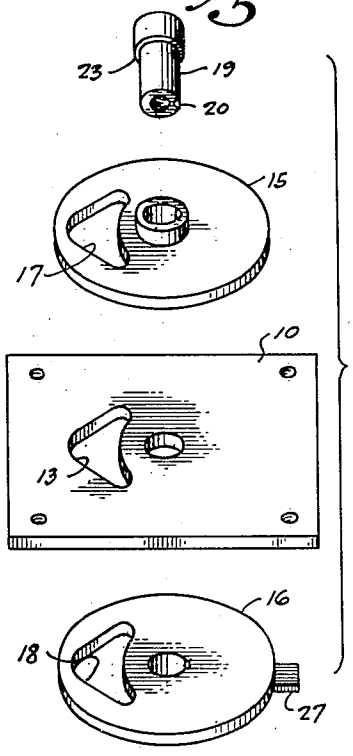


Fig. 3

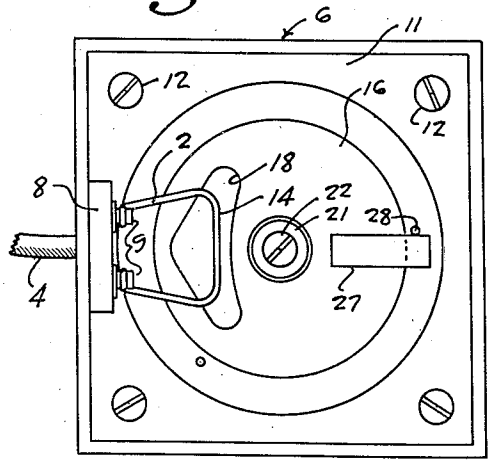
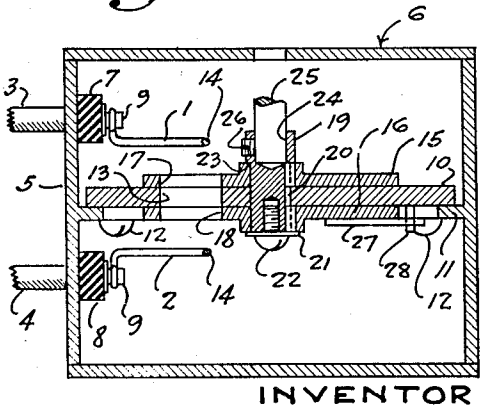


Fig. 2



INVENTOR

Joseph T. Goode

BY John Flam

ATTORNEY

Patented Oct. 30, 1945

2,388,049

UNITED STATES PATENT OFFICE

2,388,049

ATTENUATOR

Joseph T. Goode, Los Angeles, Calif., assignor to Herbert A. Bell, Los Angeles, Calif.

Application August 25, 1943, Serial No. 499,939

3 Claims. (Cl. 178—44)

This invention relates to the control of electrical energy, manifested in the transmission of ultra high frequency current. More particularly, the invention relates to the control of the transfer of energy from one circuit to another. Such control is often necessary during testing.

The advantages of radio signaling over relatively short distances by the aid of carrier frequencies of the order of hundreds of megacycles are now quite well recognized. It is, however, more difficult to vary the characteristics of circuits employing such frequencies. For example, it is often necessary to vary the degree of energy transfer between coupled circuits for the purpose of testing or standardizing systems using these ultra high frequencies. Use of ordinary switching devices or movable contact points leads to vagaries that are not tolerable.

It has been especially difficult to vary the coupling between two circuits carrying such ultra high frequency in a continuous manner. Such continuous variations are required, for example, in the attenuation of energy in a circuit. The usual methods of varying the coupling by varying the relative positions of the coupled coils or loops are quite impractical; nor is it possible to reduce the coupling to a very low value by the usual methods.

It is one of the objects of this invention to make it possible easily to adjust the coupling between two circuits operating at ultra high frequencies, such as 100 megacycles and up.

It is another object of this invention to effect such continuously variable coupling without switches or contacts, and without the necessity of moving any component of the circuits involved.

This invention possesses many other advantages, and has other objects which may be made more easily apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawing accompanying and forming part of the present specification. The form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

Referring to the drawing:

Figure 1 is an isometric view of an attenuator, incorporating the invention, a part of the casing being broken away;

Fig. 2 is a sectional view taken along plane 2—2 of Fig. 1;

Fig. 3 is a view taken from the bottom of the attenuator, with the bottom wall of the casing removed; and

Fig. 4 is an exploded pictorial view of the essential parts of the attenuator structure.

The attenuator is used to vary the degree of coupling between a pair of conductors, shown in this instance as loops 1 and 2. These loops are shown as formed of substantially a single turn and appropriately supported in a manner to be hereinafter set forth. These loops are intended to be incorporated in electric circuits by the aid of twin conductor leads 3 and 4. The planes of the loops are parallel, so that inductive coupling may be effected between them.

The loops, in the present instance, are intended to be incorporated in circuits that carry ultra high frequency currents of the order of 100 megacycles and higher. Accordingly, these loop conductors can be made of quite small size; in fact, parallel conductors could be used. It is also essential, when such high frequencies are used, carefully to shield the leads connected with the coupled conductors with a metallic tubular conductor and to ground the shields.

The loops 1 and 2 are fixedly supported on a wall 5 of a casing 6 that completely encloses both of the loops. This casing is made of a good conductor, such as aluminum. Insulation terminal blocks 7 and 8 are provided respectively for the loops 1 and 2, and attached to a wall of casing 6. The terminals of the loops are appropriately attached to binding posts 9 supported on the blocks 7 and 8 and joined to conductors in the leads 3 and 4.

The coupling between loops 1 and 2 is made variable; and the lower limit of energy transfer approaches zero. With frequencies considerably less than the ultra high frequencies, such reduction in energy transfer may readily be provided by conventional means. Any attempt to attenuate the energy transfer at ultra high frequencies between loops 1 and 2 by conventional methods fails to bring the transfer substantially to zero.

The transfer of energy can be substantially entirely prevented by the interposition of a conducting separator plate between the loops 1 and 2. This interposed plate thus serves completely to enclose each of the loops in a separate compartment formed of conducting walls. It has been found that energy transfer can be controlled at such ultra high frequencies by opening a part of the metallic separator between the loops. Apparently at ultra high frequencies (such as 100 megacycles and higher), the magnetic lines of force that would link the two conductors 1 and

2 behave more nearly as light rays; and it is possible to regulate the quantity of linkage lines by adjusting the extent of opening in the separator plate.

These phenomena are utilized in controlling the energy transfer between loops 1 and 2. For this purpose, there is provided a plate or separator 10, shown to best advantage in Fig. 4. This metallic member is appropriately attached, as by screws 12, to a flange 11 extending around the interior of the casing 6. Separator plate 10 has an aperture 13. This aperture 13 has a configuration such as to form a clear space from one loop to the other, and especially around the intermediate legs 14 of the loops.

Movable conducting members are provided for covering or uncovering the aperture 13. The extent of the uncovered portions of aperture 13 determines the degree of coupling. If the aperture 13 be entirely covered, the energy transfer can be reduced to a value approaching zero.

The covering members are in the form of metallic discs 15 and 16 disposed respectively above and below the separator plate 10. Each of these discs is provided with an aperture 17 or 18, arranged to be in simultaneous registry with aperture 13. This simultaneously registered position is indicated in Figs. 1, 2, and 3.

To move the discs 15 and 16 angularly, and thereby to control the degree of registry between the apertures 13, 17, and 18, a shaft structure is utilized. This shaft structure includes a shaft extension 19 that passes through the plate 10 and that is journalled therein. This shaft extension carries a keyway 20 by the aid of which it may be keyed to the hubs of the discs 15 and 16. A washer 21 overlies the hub of the lower disc 16 and is held to the extension by the aid of a screw 22. Furthermore, the hub of the upper disc 15 abuts a shoulder 23 (Fig. 4) formed on the extension 19. In this way the discs 15 and 16 may be confined against axial movement with respect to the extension 19.

The extension 19 has a socket 24 in its upper end into which may be inserted an operating shaft 25. This operating shaft may be held in place by the headless set screw 26 (Fig. 2).

The shaft 25 may be arranged to pass out of the casing 6 for exterior manipulation.

By the aid of the overlapping members 10, 15, and 16, the degree of coupling between loops 1 and 2 may be varied within a wide range, the lower limit approaching zero.

Accurate registry of the apertures 13, 17, and 18 can be attained readily by the provision of a stop mechanism, arranged to be effective when the discs 15 and 16 are in the proper angular position. For this purpose, the lower disc 16 carries a stop member 27 (Figs. 2 and 3). This stop member is arranged to co-operate with a stop pin 28 carried by the separator 10.

The inventor claims:

1. In a variable coupler for circuits utilizing ultra high frequency currents, a pair of spaced conductors, a metallic casing for both conductors and forming a substantially complete enclosure for the conductors, terminals for the conductors passing through a wall thereof, a metallic plate disposed between the conductors, and having an aperture opposite the conductors, and a metallic member having an aperture capable of being in registry with the aperture in the plate, and movable to alter the extent of the opening through the plate and the member.

2. In a variable electromagnetic coupler for circuits utilizing ultra high frequency currents, a pair of spaced conductors, means forming a substantially complete metallic enclosure for the conductors, a metallic plate between the conductors and having an aperture opposite at least a portion of the conductors, and an adjustable metallic member adjacent the plate and having an aperture that can be placed into either complete or partial register with the aperture in the plate, or out of register therewith.

3. In a variable electromagnetic coupler for circuits utilizing ultra high frequency currents, a pair of spaced conductors, said conductors forming less than one turn, a substantially complete metallic enclosure for the conductors, each of said conductors having ends extending through the casing, a metallic plate between the conductors and having an aperture opposite the conductors, the length of the aperture being in the direction of the length of the conductors, and an adjustable metallic member adjacent the plate and having an aperture capable, by adjustment of the member, of partially or entirely covering and uncovering the aperture in the plate.

JOSEPH T. GOODE.