Jan. 2, 1945. G. L. USSELMAN 2,366,660

TRANSMISSION LINE MONITOR

Filed March 19, 1942

Fig. 1.

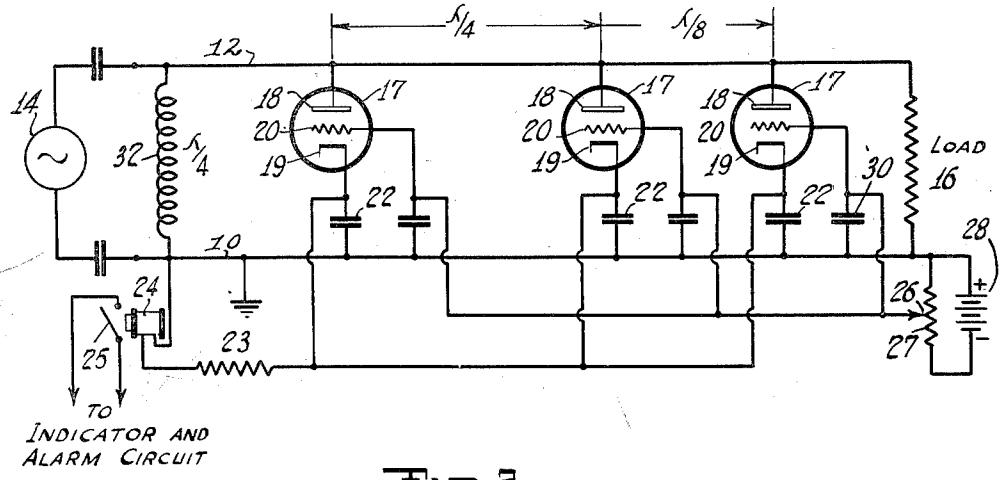
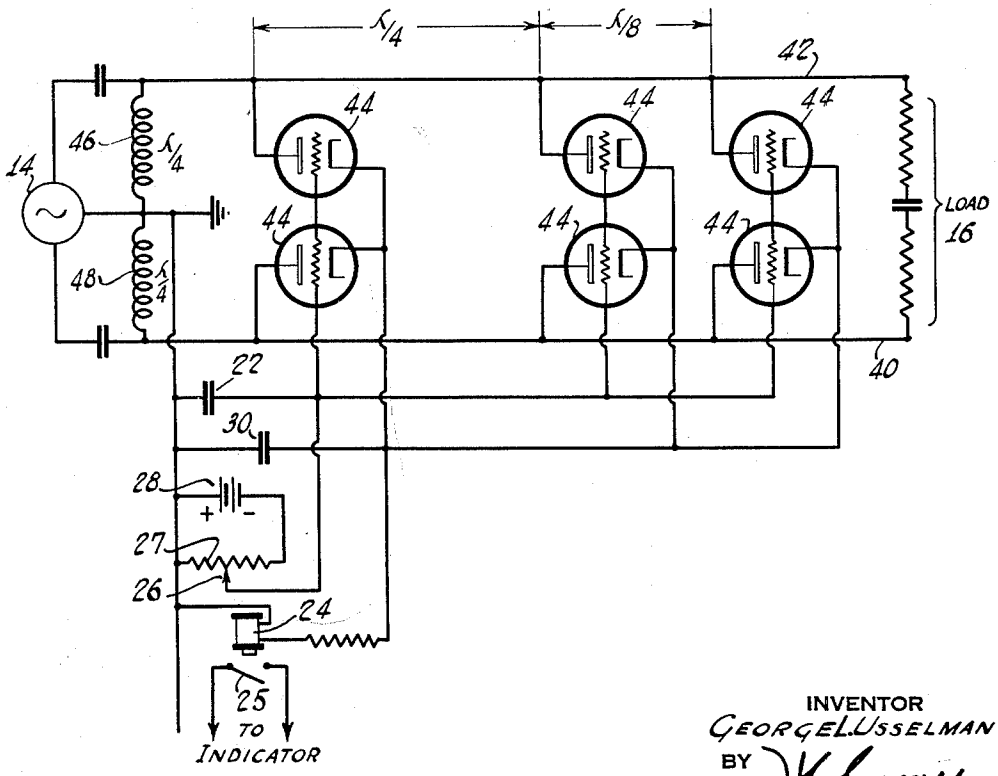


Fig. 2.



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TRANSMISSION LINE MONITOR

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9 Claims. (Cl. 178—44)

This invention relates to radio frequency transmission lines and, more particularly, to protective devices or monitors for use with such transmission lines.

Concentric transmission lines, such as are used with radio frequency transmitters, increase rapidly in cost as sizes increase. Therefore, a transmission line of as small a size as possible is ordinarily used. The size of such line which is selected for a given transmitter output is ordinarily governed by the maximum standing wave voltage which may occur during short-circuit or open circuit of the line. Under certain circumstances, such as when the line becomes temporarily improperly terminated from some unforseen or uncontrollable cause, a standing wave may occur which has an amplitude greater than that existing across the line during normal operation. Such action may occur, for example, if the load connected to said line changes its impedance due to ice accumulation or accidents such as wires breaking, and so forth. In such cases a standing wave voltage may result which exceeds the tolerable maximum. Break down of, or other damage, to the line may then result. To guard against this possibility it has been necessary to use transmission lines of greater size than that dictated by the aforementioned factors governing selection of a suitable line. The resultant increase in cost may be considerable. In the foregoing discussion the case of concentric transmission lines has been particularly considered. However, the present invention may also be applied to open wire transmission lines to indicate the occurrence of improper matching of the load to the line or to prevent break down thereof.

An object of the present invention is to provide an improved protective device for radio frequency transmission lines which will protect such lines from damage upon the occurrence of undesirable standing waves thereon.

Another object of the present invention is to provide an improved protective device, as aforesaid, which will enable the use of transmission lines of least expense.

A further object of the present invention is to provide a protective device for transmission lines which upon the occurrence of standing waves on said line will prevent their amplitude from exceeding a predetermined value.

Still another object of the present invention is to provide an improved reflection indicating means for radio frequency transmission lines which causes no loss of power when normal conditions exist on the lines.

It is also an object of the present invention to provide a protective device for a radio frequency transmission line, as above set forth, which is highly efficient and reliable in use, simple in construction and inexpensive in cost.

In accordance with the principles of the present invention a plurality of biased rectifiers are connected across the transmission line at different distances from each other (for example, three rectifiers may be used spaced from each other at distances equal to one-fourth and one-eighth of the standing wave) and their outputs connected to an alarm relay or to switching means for disabling the transmitter connected to the line. These rectifiers respond to increases in line voltage above a predetermined maximum value at the points where they are respectively located. The value is determined by the bias applied to the control grids of the rectifiers. Several rectifiers should be used since in certain cases a single rectifier, or even two rectifiers, will not always detect an increase in the standing wave on the line. The current in the common output circuit of the rectifiers increases sharply as the standing wave voltage increases over the potential for which the grid bias constitutes cut-off value. This sharp increase is caused to operate a relay in the output circuit to give the desired indication. The arrangement may be such that the alarm relay operates to shut off the transmitter, thereby eliminating possibility of damage to the transmission line by the standing wave. Furthermore, the load or output circuit of the rectifiers may be so proportioned that when the rectifiers draw current from the line the current drawn is sufficient to prevent the potential across the line from exceeding a predetermined value.

The present invention will be more fully understood by reference to the following detailed description which is accompanied by a drawing wherein Figure 1 illustrates an embodiment of the present invention, and Figure 2 illustrates a modification thereof.

Referring more particularly to the drawing wherein similar reference characters designate corresponding parts throughout there is shown in Figure 1 a transmission line including conductors 10 and 12. The transmission line, while it appears as a two-wire open line having conductor 10 grounded, may of course equally well be a concentric transmission line with the conductor 10 constituting the outer shell and conductor 12 the inner conductor. At one end of the transmission line is connected a source of high frequency waves 14 and at the other end, a load 16.

As is common practice in the art, the impedance of load 16 is adjusted to equal the impedance of the transmission lien whereby standing waves along the line are substantially eliminated. A plurality of grid controlled rectifier tubes 17 are connected at specified points along the transmission line. The distance between one pair of adjacent rectifier tubes is preferably one-quarter of the operating wavelength, while the other rectifier tube is spaced one-eighth of a wavelength away from one of the other rectifier tubes. Thus a change in voltage must always occur across at least one of the rectifiers upon the occurrence of standing waves on the line. In the arrangement shown each of the rectifier tubes 17 has its anode 18 connected to conductor 12 of the transmission line and its cathode 19 connected through condenser 22 to the other side of the transmission line. Each of the cathodes 19 are connected together and to a load circuit including resistor 23 and winding 24 of a relay 25. Each of the grids 20 of rectifier tubes 17 are connected together and to a movable tap 26 on potentiometer 27. Potentiometer 27 is connected across a biasing battery 28. By means of this arrangement any predetermined bias may be placed on the grids 20 with respect to cathodes 19. Each of the grids 20 of tubes 17 are by-passed to a ground conductor 10 of the transmission line by means of bypass condensers 30. A coil 32 having an electrical length equal to a quarter wavelength is connected across the transmission line at its end adjacent source 14 in order to complete the direct current circuit for the rectifier tubes. The movable tap 26 on potentiometer 27 is set to supply a negative grid bias voltage such that substantially no plate current is drawn when no reflections are present on the radio frequency transmission line. Now, when reflections do occur on the transmission lines for any reason and if they are large enough, the anode voltage on one or more of the rectifier tubes increases sufficiently to overcome the fixed grid bias. Rectified current flows through the tube by way of the resistor 23, the actuating winding 24 of relay 25 and half wave coil 32, thus closing the contacts of the relay. Closure of the relay contacts energizes a circuit to operate a warning lamp or alarm bell or other indicating devices. The resistance 23 is provided in order to limit the space current through tubes 18 should the reflection voltages be exceedingly high. If the current carrying capacity of tubes 18 is sufficient the resistor 23 may be made of such value as to prevent the peak voltages across the line from exceeding a predetermined minimum value. It may be seen that increasing the bias on the grid of tube 17 will allow some reflection to take place on the line before the alarm operates. This reflection may be made any desirable amount by the bias adjustment.

In Figure 2 is shown a modification of the embodiment shown in Figure 1 wherein the transmission line is balanced with respect to ground, that is, conductors 40 and 42 of the transmission line are each at a potential different from the ground potential. The source 14 and the load 16 are as before described. Pairs of grid controlled rectifier tubes 44 are provided, each tube having its plate connected to one of the two transmission line conductors and its grid connected to the movable tap 26 of potentiometer 27 as described with reference to Figure 1. Since neither of the conductors of the transmission line are at ground potential, a pair of quarter wave coils 46, 48, connected in series across the line and with their center connections grounded, are provided instead of the single quarter wave coil 32 of Figure 1. The coils form a return path for the rectified current flowing through rectifiers 44 from either side of the line to ground. The operation of the embodiment of Figure 2 is substantially the same as described in detail with respect to Figure 1.

From the foregoing description it will be apparent to those skilled in the art that I have provided a simple and effective way of protecting radio frequency transmission lines from becoming damaged as a result of excessive voltages resulting from the occurrence of standing waves on the line.

While I have shown and particularly described several embodiments of my invention, it is to be distinctly understood that my invention is not limited thereto but that modifications within the scope of my invention may be made.

I claim:

1. A radio frequency system including a transmission line having a pair of conductors, a plurality of rectifiers having input circuits connected at spaced points to a conductor of said line, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for biasing said rectifiers inoperative in the presence of normal potentials on said line, said rectifiers being so spaced along said line that upon the occurrence of standing waves on said line at least one of them is at a potential loop.

2. A radio frequency system including a transmission line having a pair of conductors, a plurality of rectifiers having input circuits connected at spaced points to a conductor of said line, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for biasing said rectifiers inoperative in the presence of normal potentials on said line, a pair of said rectifiers being spaced apart a distance equal to an eighth of the operating wavelength.

3. A radio frequency system including a transmission line having a pair of conductors, a plurality of rectifiers having input circuits connected at spaced points to a conductor of said line, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for biasing said rectifiers inoperative in the presence of normal potentials on said line, said rectifiers being so spaced along said line that upon the occurrence of standing waves on said line at least one of them is at a position other than a potential node.

4. A radio frequency system including a transmission line having a pair of conductors, a plurality of rectifiers having input circuits connected at spaced points across said line, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for biasing said rectifiers inoperative in the presence of normal potentials on said line, said rectifiers being so spaced along said line that upon the occurrence of standing waves on said line at least one of them is at a potential loop.

5. A radio frequency system including a transmission line having a pair of conductors, a plurality of rectifiers having input circuits connected at spaced points across said line, said rectifiers

having a common output circuit including a control device operative in response to a current flow through said circuit and means for biasing said rectifiers inoperative in the presence of normal potentials on said line, said rectifiers being so spaced along said line that upon the occurrence of standing waves on said line at least one of them is at a position other than a potential node.

6. A radio frequency system including a transmission line having a pair of conductors, a plurality of grid controlled rectifiers having input circuits connected at spaced points to a conductor of said line, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for applying such bias to the grids of said rectifiers that said rectifiers are inoperative in the presence of normal potentials on said line, said rectifiers being so spaced along said line that upon the occurrence of standing waves on said line at least one of them is at a potential loop.

7. A radio frequency system including a transmission line having a pair of conductors, a plurality of grid controlled rectifiers having input circuits connected at spaced points from a conductor of said line to ground, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for applying such bias to the grids of said rectifiers that said rectifiers are inoperative in the presence of normal potentials on said line, a pair of said rectifiers being spaced apart a distance equal to a quarter of the operative wavelength and another rectifier being spaced from one of said pair a distance equal to an eighth of the operating wavelength.

8. A radio frequency system including a transmission line having a pair of conductors, a plurality of grid controlled rectifiers having input circuits connected at spaced points to a conductor of said line, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for applying such bias to the grids of said rectifiers that said rectifiers are inoperative in the presence of normal potentials on said line, said rectifiers being so spaced along said line that upon the occurrence of standing waves on said line at least one of them is at a position other a potential node.

9. A radio frequency system including a transmission line having a pair of conductors, a plurality of grid controlled rectifiers having input circuits connected at spaced points to a conductor of said line, said rectifiers having a common output circuit including a control device operative in response to a current flow through said circuit and means for applying such bias to the grids of said rectifiers that said rectifiers are inoperative in the presence of normal potentials on said line, a pair of said rectifiers being spaced apart a distance equal to a quarter of the operative wavelength and another rectifier being spaced from one of said pair a distance equal to an eighth of the operating wavelength.

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