

Jan. 23, 1945.

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2,367,693

IMPEDANCE ADJUSTER

Filed Feb. 27, 1943

2 Sheets-Sheet 1

Fig. 1.

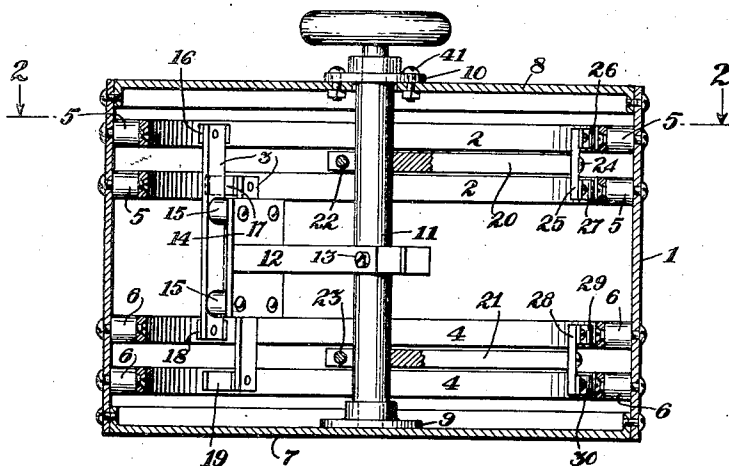
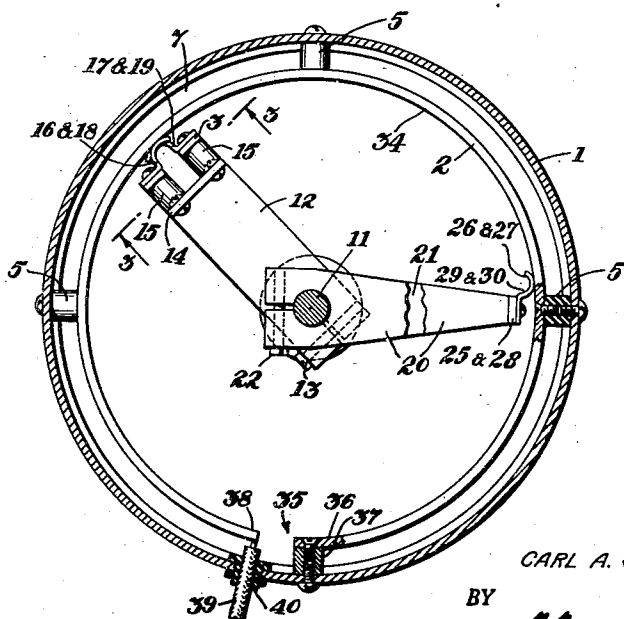


Fig. 2.



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Fig. 3.

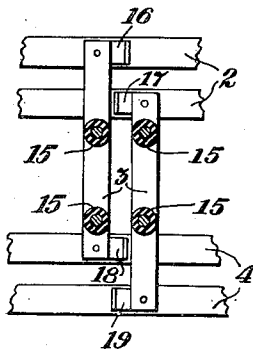
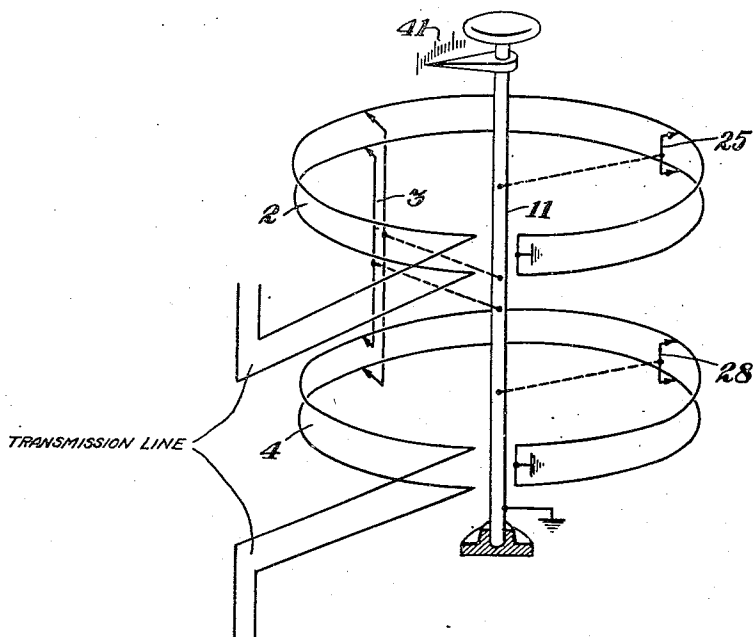


Fig. 4.



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IMPEDANCE ADJUSTER

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Application February 27, 1943, Serial No. 477,334

5 Claims. (Cl. 178-44)

This invention relates to phase adjusters and in particular to a phase adjuster suitable for changing the electrical length of a line wherein the phase relationship between the input or output current or voltages is to be controlled. The invention is in the nature of an improvement on the invention disclosed in an application of Sidney B. Pickles, Serial No. 442,657, filed May 12, 1942, and assigned to the same assignee.

An object of my invention is to construct a phasing device by which the electrical length of a line may be continuously varied.

Another object of my invention is to construct a phasing device which occupies less space than known equivalent devices.

These and other objects of my invention will be best understood and appreciated from the following description of a particular embodiment thereof, for purposes of illustration, and shown in the accompanying drawings, in which:

Fig. 1 is a sectional view of the phase adjuster of my invention in accordance with a preferred embodiment thereof.

Fig. 2 is a view of the phase adjuster taken across the section line 2-2 of Fig. 1.

Fig. 3 is a sectional view of the phase adjuster taken across the section 3-3 of Fig. 2, and

Fig. 4 is a schematic diagram illustrating the operation of the phase adjuster of my invention and showing how it may be connected to a transmission line.

In the aforesaid application of Sidney B. Pickles the phasing unit disclosed comprises four arcuate segments, two each mounted on the opposite sides of a center axis. The two segments on one side of the axis simulate one short length of a transmission line and the two segments on the other side of the axis simulate another length of line. The disposition of the segments is such that a substantially cylindrical structure is formed, the segments lying on semi-circumferences of the cylinder. The segments are adjustably connected together by a pair of conductors passing across a diameter of the cylinder and capable of rotation about the axis thereof, these conductors also simulating a fixed length of transmission line having substantially the same electrical constants as do the segments and the line of which the phase changer may form a part. As the conductors rotate about their axis of rotation and make sliding contact with the segments, the electrical length of the line is increased or decreased depending on the direction of rotation.

The Pickles' application also discloses a means

for preventing the unused portions of the conductors of the phase adjuster from reacting on the transmission line, thus avoiding discontinuities which would result in standing waves. This is done by shorting the unused portions at a distance equal to one quarter wave length from the point on the conductors where the sliding or adjustable contacts are made.

In accordance with my present invention, I made use of several of the principles disclosed in the Pickles application including the idea of shorting the unused conductors, as above mentioned. However, the structure of my phase adjuster is such that I am able to utilize a considerably greater portion of the conductor for increasing the length of the line, reserving only a relatively small portion for the one quarter wave length section. Accordingly, the phase adjuster of my invention when designed for a given maximum phase change at a given frequency, occupies a much smaller space than does the wave changer disclosed by Pickles.

Referring now to Fig. 1, the numeral 1 represents a cylindrical casing or housing for the complete phase changer unit. Within the housing are three lengths or sections of line 2, 3 and 4. The sections 2 and 4 are substantially circular and are mounted within the housing on a plurality of stand-off insulators 5 and 6 respectively. Sections 2 and 4 are also sufficiently displaced in the direction of their common axis to prevent appreciable interaction therebetween. These sections of line 2 and 4 are adjustably connected together by the third section of line 3 in a manner about to be described.

Riveted or otherwise fastened to the cylindrical housing 1 are two end members 7 and 8. Upon these end members are mounted two bearings 9 and 10 into which is journaled the rotatable shaft 11. The bearing 9 may be riveted or otherwise fastened to the end plate 7, but it is preferable that the bearing block 10 be fastened to the end plate 8 in such a way that it may be removed such as, for example, by screws 41. This is desirable in order that the shaft and the members which are mounted thereon may be easily assembled.

On the shaft 11 is mounted an arm 12. This arm may be clamped in position on the shaft by the screw 13. Mounted on the arm 12 remote from the shaft is a shield member 14 of conductive material and upon this member the section of line 3 is insulatingly mounted through the agency of stand-off insulators 15. The two conductors which form the section of line 3 are staggered,

as more clearly shown in Fig. 3, so that the ends thereof are adjacent the conductors composing the sections of line 2 and 4. On the ends of the line 3 are riveted, welded or otherwise fastened, spring contacts 16, 17, 18 and 19. Contact 16 at one end of one of the conductors of line 3 makes a sliding contact with one of the conductors of line 2 while the contact 18 at the other end of said conductor of line 3 makes a sliding contact with one of the conductors of line 4. Similarly, contacts 17 and 19 at the extremities of the other conductor of line 3 make sliding contacts with the remaining conductors of lines 2 and 4.

It will be noted that all of the contacts 16, 17, 18 and 19 lie on a single line and make contact with the line sections 2 and 4 at points which also lie on this line. The spacing of the two conductors of line sections 2, 3 and 4 are made equal in order that the electrical characteristics of all line sections will be the same.

As aforesaid, the phase adjuster of my invention is preferably adapted to be used as a section of transmission line. A transmission line usually has a grounded shield surrounding it, which together with the size and spacing of the line conductors, determines the surge impedance of the line. It is very desirable that the sections of line composing the phase adjuster also have substantially the same surge impedance as the line to which they are connected and this is accomplished in accordance with my invention by suitably spacing the conductors of the sections 2 and 4 a predetermined distance from the housing or casing 1. For example, that portion of the casing 1 which is adjacent to section 2 determines in part the surge impedance of the section. Similarly, the member 14 upon which the section of line 3 is insulatingly mounted aids in determining the surge impedance of the section 3. By this construction there is practically no discontinuity of surge impedance between the line in which the phase adjuster may be inserted and the sections 2, 3 and 4 of the phase adjuster itself.

As shown in Figs. 1 and 2 there are also mounted on the shaft 11 two conducting arms 20 and 21. These arms may be adjustably fastened to the shaft 11 in the same manner as was the arm 12, that is, by the use of clamping screws 22, 23. On the end of arm 20 remote from the shaft, a shorting bar 25, is fastened, for example, by screw 24. On the extremities of this bar are mounted two contacts 26 and 27 which are in slidable engagement with the conductors of line section 2. Similarly, there is mounted on the end of arm 21 a shorting bar 28. On the ends of this shorting bar are mounted contacts 29 and 30 which are in slidable contact with the conductors of the line section 4. It will be seen from Fig. 2 that the arms 20 and 21, make an angle with the arm 12 and furthermore that this angle may be varied by loosening the clamping screws 22 and 23, moving both arms 20 and 21 with respect to arm 12 and again tightening the clamping screws. In this manner it is possible to vary the distance, as measured along the conductors of sections 2 and 4, between the contacts 26, 27, 29 and 30 of the arms 20 and 21 and the contacts 16, 17, 18 and 19 on the extremities of the conductors of line 3. This distance between the contacts for any given frequency of operation is made equal to one quarter wave length. By this arrangement the overhanging section or unused portion 34 of line 2 for example presents an extremely high impedance to the line section 2

at the point of contact between this line and the contacts 16 and 17. Similarly the unused quarter wave length portion of line 4 presents an extremely high impedance at the point of contact between contacts 18 and 19 of the line section 4.

In accordance with my invention the sections 2 and 4 are substantially complete circles and are broken only at one point 35, as shown in Fig. 2. Ends 36 of the circular line sections 2 and 4 are grounded to the casing 1 by the conducting members 37. The other ends 38 of the circular sections are insulated from the casing 1 by stand-off insulators 5. The ends 39 of the various line sections are conductively connected to a transmission line 39 through a suitable insulating bushing 40.

Referring now to Fig. 4, I have schematically illustrated the manner in which the various line sections 2, 3 and 4 are adjustably connected together and also the manner in which these sections may be connected to a transmission line whose electrical length it is desired to vary. This line may be broken at any suitable point and one section, 2 for example, of the phase adjuster may be connected to one end of the line and the other section 4 of the phase adjuster may be connected to the other end of the transmission line at the point where the latter is broken. The two sections 2 and 4 are bridged by the third section of line 3 and this bridging connection is adjustable as above described by the rotation of shaft 11. Since the arms 12, 20, and 21 are all clamped to the shaft 11 the shorting bars 25 and 28 are moved simultaneously with the line section 3 and the one quarter wave length distance above referred to is maintained constant for a given frequency.

As illustrated in Fig. 4 one end of the line sections 2 and 4 and the shorting bars 25 and 28 are shown as being grounded. This is not necessary but in general is desirable.

If the operating frequency is such that the length of the arms 12, 20, and 21 approximates one quarter wave length, it is desirable that the arms be made of insulating rather than conducting material, since there may be standing waves produced thereon under these conditions.

If desirable a pointer and scale, schematically shown at 41 on Fig. 4, may be employed in order to calibrate the phase adjuster.

While I have shown and described only one embodiment of my invention, it will be understood that it is given by way of example only, and not as limiting the scope of the invention, as set forth in the objects and the appended claims.

What is claimed is:

1. A phasing unit comprising two similar sections of a two conductor transmission line, said sections forming substantially complete circles, a rotatable element, two conducting members movable with said element, one of said members having sliding engagement with one conductor of one of said sections, and with one conductor of the other of said sections, the other of said members having sliding engagement with the other conductor of said first section and with the other conductor of said other section, two shorting members, one shorting member having sliding engagement with the two conductors of said first section, the other shorting member having sliding engagement with the two conductors of said other section, the points of sliding engagement as measured along any conductor being separated by a distance substantially equal to one-fourth

wave length of the current flowing in said conductors.

2. A phase changer comprising three sections of a two-conductor transmission line, two of said sections being similar and forming substantially complete circles, the third section being substantially straight and in sliding engagement with said two similar sections, a rotatable member, said third section being mounted on said rotatable member for rotation therewith, two shorting members mounted on said rotatable member for rotation therewith one shorting member being positioned for sliding engagement with one of said similar sections, the other shorting member being positioned for sliding engagement with the other of said similar sections, the points of sliding engagement as measured along the similar

sections being separated by a distance equal to one-fourth the wave-length of the current carried by said sections.

3. A phase changer in accordance with claim 2 wherein the three sections of transmission line each comprise two similar conductors.

4. A phase changer in accordance with claim 2 wherein the three sections of transmission line each comprise in combination, two similar conductors and a shield adjacent thereto, said combination having a predetermined surge impedance.

5. A phase changer in accordance with claim 2 wherein the separation between the points of sliding engagement may be changed for currents of different frequencies.

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