Oct. 4, 1949. I. KARMIN 2,483,419

ADJUSTABLE REACTANCE LINE

Filed July 24, 1944

3 Sheets-Sheet 1

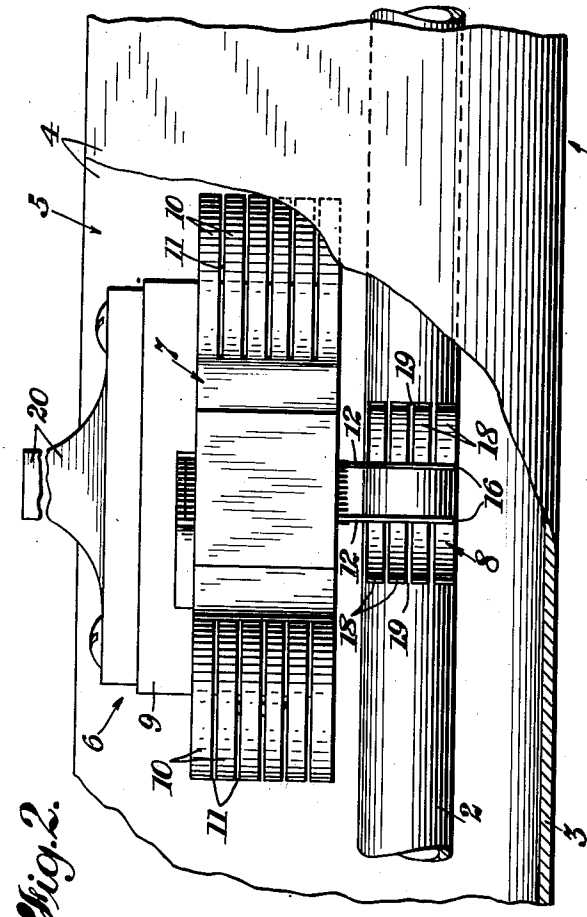

Fig. 2.

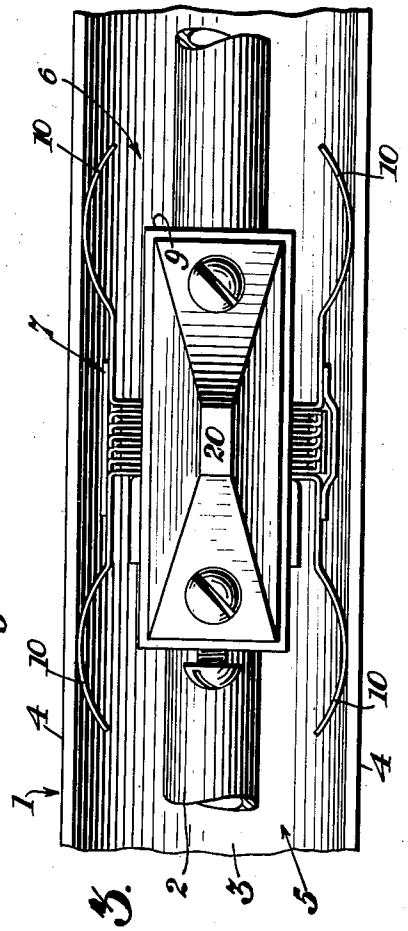

Fig. 3.

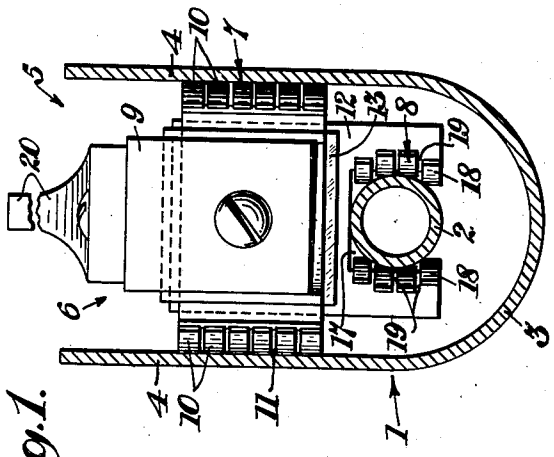

Fig. 1.

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Fig. 4.

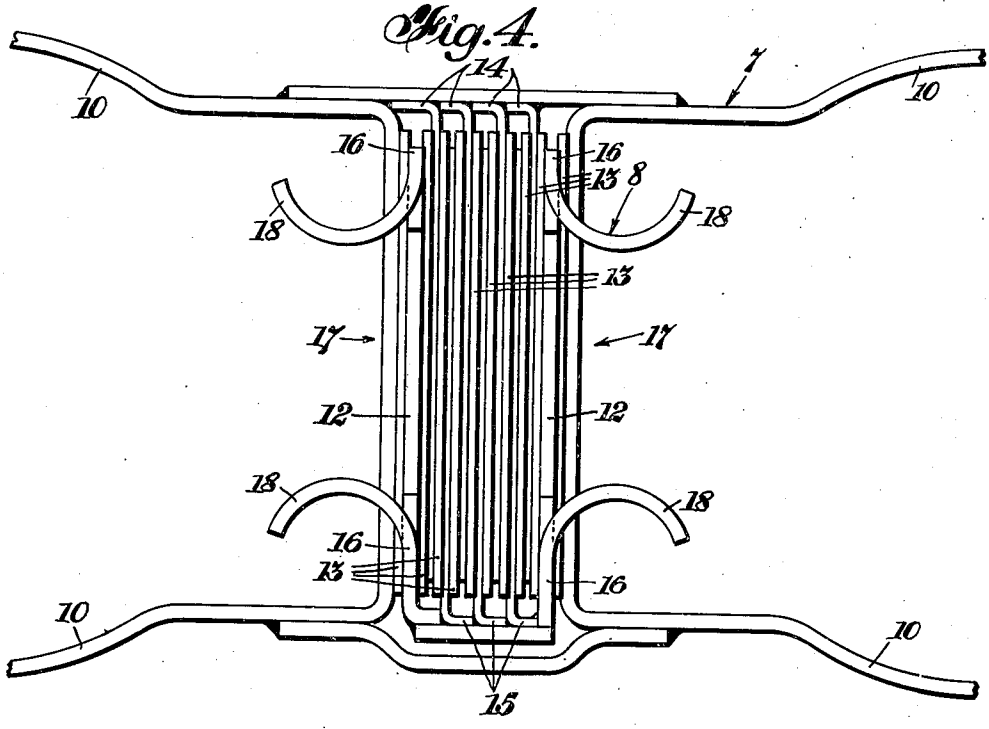
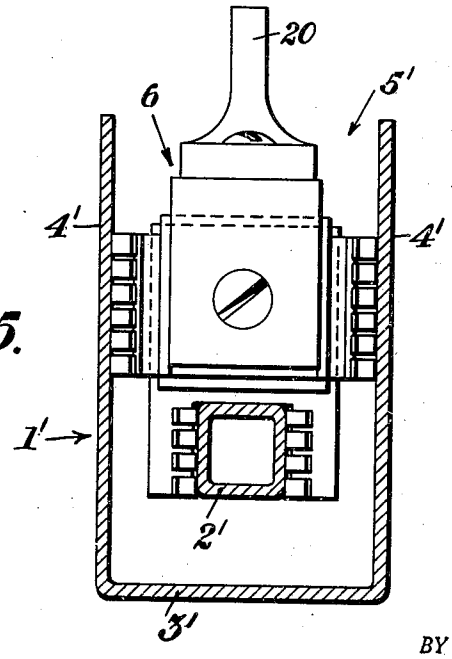


Fig. 5.



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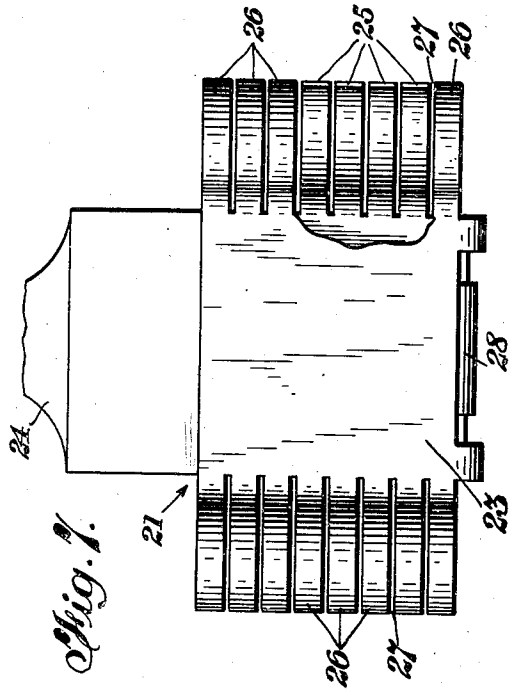

Fig. 1.

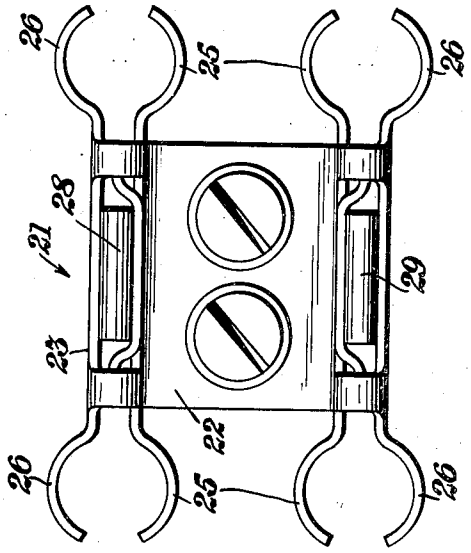

Fig. 8.

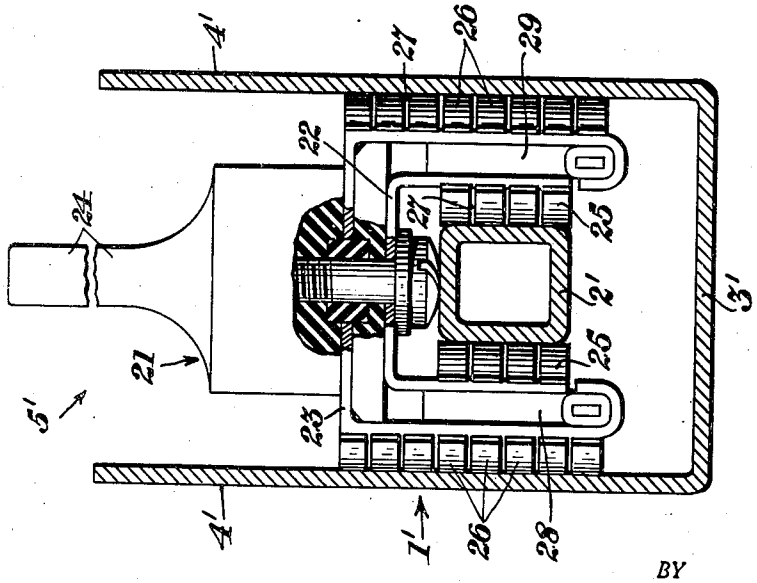

Fig. 6.

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UNITED STATES PATENT OFFICE

2,483,419

ADJUSTABLE REACTANCE LINE

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Application July 24, 1944, Serial No. 546,379

7 Claims. (Cl. 178—44)

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This invention relates to line sections wherein the reactance of the line can be varied, in accordance with the frequencies desired, by a shorting device adjustably mounted within the line section and adjusted from without along the longitudinal length thereof.

Where coaxial line sections are employed in high frequency circuits for both the tuning of the circuits for desired frequencies and for the transmission of high voltage currents, it is of utmost importance to have the impedance characteristics of the line identical throughout, and of still greater importance to prevent the passage of the high voltages from one conductor to the other when tuning the line for a desired resonant frequency.

It is also often necessary, where the longitudinal working length of the coaxial line is confined to its actual length because of the restriction of space, to provide the line section with a longitudinal slot or opening for adjusting the shorting device within the line to vary the effective length of the line section.

This longitudinal slot or opening in the outer conductor changes somewhat the characteristic impedance of the line and is found to be quite unsatisfactory.

One of the objects of my invention is to construct a tunable line section having an outer conductor provided with a longitudinal slot or opening and still have substantially the same impedance characteristic as a similar closed coaxial line.

Another object of my invention is to provide a shorting device which will operate in conjunction with my particular types of coaxial line.

A further object of my invention is to provide a shorting device which will pass the high frequency currents and yet prevent the passage of direct current from one conductor of the coaxial line to the other.

In carrying out my invention, I prefer to construct the outer conductor with a longitudinal opening wide enough to insert and withdraw the shorting device so that it will be unnecessary to slide the shorting device the whole length of the line when making the desired adjustments.

When it is desired to make a radical adjustment in the length of the line it will only be necessary to lift the shorting device out of the coaxial line through the slot or opening and carry it to the approximate distance for the new adjustment and then insert it through the slot or opening into the coaxial line, from which point the shorting device can be moved longitudinally forwardly

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or rearwardly until the desired resonant frequency has been reached.

Further objects will become apparent, reference being had to the accompanying description and claims read together with the drawings in which:

Fig. 1 is an end elevation view of one embodiment of my invention provided with one form of shorting device applied to one form of line section;

Fig. 2 is a side elevational view of Fig. 1, with part of the outer conductor broken away to more readily show the shorting device;

Fig. 3 is a top plan view of the line section and shorting device shown in Figs. 1 and 2;

Fig. 4 is a bottom plan view of the shorting device;

Fig. 5 is an end elevational view of another embodiment of my invention showing the same shorting device shown in Figs. 1, 2 and 3 cooperating with a different form of line section;

Fig. 6 is an end elevational view of a further embodiment of a shorting device in accordance with my invention for use in conjunction with the line sections shown in Figs. 1 to 5 inclusive;

Fig. 7 is a side elevational view of the shorting device shown in Fig. 6; and

Fig. 8 is a bottom plan view of the shorting device shown in Figs. 6 and 7.

Referring now to Figs. 1, 2, 3 and 4 wherein a line section 1 is shown composed of an inner conductor 2, and an outer conductor 3 the lower portion of which is spaced substantially equally from the inner conductor 2, and provided with upwardly extending side walls 4, 4 to define an opening 5 in the outer conductor thereof.

The side walls 4, 4 also extending longitudinally of the line section 1, extend upwardly in a substantially parallel relation to one another from approximately the transverse center line of the line section and are sufficiently extended to maintain substantially the same impedance characteristics as a similar closed coaxial line, that is, a coaxial line which has an inner conductor of the same dimensions as the corresponding conductor of line section 1 and a completely closed substantially circular outer conductor having an inner diameter equal to the spacing of the inner faces of the extended side walls.

Slidably mounted within the line section 1 is a shorting device 6 provided with a pair of resilient conductive members 7 and 8 adapted to respectively engage the inner opposite side walls 4, 4 of the outer conductor 3 and the outer opposite side walls of the inner conductor 2. Although the resilient conductive member 8 is

primarily adapted for contacting the inner conductor electrically, it is also adapted to straddle the conductor and be longitudinally adjusted along the length of the line section. The conductive member 7 serves not only to electrically contact the outer conductor but also to maintain the entire shorting device centralized between the parallel side walls 4, 4 of conductor 3.

Referring now to Fig. 4 wherein the shorting device 6 is shown on an enlarged scale so that a better understanding can be had of its construction and the employment thereof, it will be seen that the conductive members 7 and 8 are assembled as a unitary structure. The conductive member 7 being composed of a pair of outwardly bowed members 10, 10 have their free ends positioned oppositely one another longitudinally of the supporting element 9 (Figs. 1, 2 and 3) and their other ends connected together transversely thereof in spaced-apart relation thereto. The free end portions of the parallel side flanges of each element 10 is provided with a plurality of longitudinal slits 11, to render the conductor contacting end portions more flexible. The conductive members 8, composed of a pair of flat conductive elements 12, 12 positioned transversely of the supporting element 9, are interposed in spaced-apart relation between the members 10, 10. Between the interconnected ends of the members 10, 10 and the members 12, 12 is a sheet of insulating material 13, 13 separating these members in capacitive relation. Interposed between the members 12, 12 are a plurality of capacitor plates 14 and 15 also separated by sheets of insulating material. The capacitor plates 14 are connected together with the members 10, 10 whereas the capacitor plates 15 are connected together with the members 12, 12. From the foregoing description it can be readily seen that the members 10, 10 are in capacitive relation to the conductive members 12, 12 and when employed in the line section will pass high frequencies currents and prevent the passage of direct currents from one conductor to the other.

The conductive members 12, 12 are provided with depending extensions 16, 16 bifurcated at their lower extremities to provide the extensions with openings 17 by which the shorting device 6 can be mounted upon and straddle the inner conductor 2 of the coaxial line 1. Each leg of the bifurcation is further provided with conductive contacting portions 18 bent longitudinally to the supporting element 9 and bowed inwardly to contact the outer opposite side walls of the inner conductor 2 and further provided with longitudinal slits 19 to render the contacting portions 17 more flexible.

From the foregoing description of the coaxial line 1 and the shorting device 6, it can readily be seen that the shorting device can easily be inserted into the coaxial line section through the longitudinal slot or opening for the purposes of tuning the line to a desired frequency. Upon inserting the shorting device through the opening, the upper edge of opening 17 of the bifurcated extensions will rest upon, and the legs thereof will straddle, the inner conductor 2 while the bowed conductor-contacting portions will engage the outer opposite side walls to position the shorting device centrally of the line section, whereas the bowed ends of the conductive members 10, 10 will prevent misalignment of the shorting device 6 when adjusted longitudinally along the length of the line section. It can also be seen that the shorting member can be withdrawn at any time

and readjusted at a different point along the line without sliding it along the conductors, thus reducing the wear and tear of both the shorting device 6 and the conductors 2 and 3 of the line section.

Mounted upon the upper portion of the supporting element 9 is an insulated handle 20 with which adjustment of the shorting device can be made.

Referring now to Fig. 5 the line section 1' is substantially silimar to line 1 previously described. However, the inner conductor 2' is substantially rectangular in form and, the outer conductor 3' is substantially channel shaped and spaced substantially equally from the inner conductor at the lower portion thereof. The parallel side walls 4', 4' are sufficiently extended from the base of the channel to maintain substantially the same impedance characteristics as a similar closed coaxial line. The side walls 4', 4' define an opening 5' in the outer conductor through which the same shorting device 6 shown in Figs. 1 to 4 can be inserted and slidably mounted upon the inner conductor 2' in the same manner as described in connection with Figs. 1-4.

Referring now to Figs. 6, 7 and 8 a slightly modified form of shorting device 21 is shown in conjunction with the line section 1'. It is clear that other forms of line section may be used as desired. This shorting device 21 is provided with a pair of U-shaped conductive members 22 and 23 nested one within the other in spaced-apart relation and secured to a handle 24 for longitudinal adjustment of the device within the coaxial line.

The base of the inner U-shaped member 22 positioned transversely of the coaxial line is provided with parallel side flanges the ends of which are extended longitudinally of the transverse bases to provide inwardly bowed conductor-contacting portions 25 adapted to engage the outer opposite side walls of the inner conductor 2'. The outer U-shaped member 23 is provided at the ends of its parallel side flanges with longitudinal extensions 26 bowed outwardly to engage the inner opposite side walls of the outer conductor 3'. These bowed ends 25 and 26 may be provided with a plurality of longitudinal slits 27 to render them more flexible. Interposed between and connected to the side flanges of the U-shaped members 22 and 23 are a pair of condensers 28 and 29 coupling the conductive members in capacitive relation for the passage of high frequency currents when adjusted within the line section.

It can readily be seen that the shorting device shown in Figs. 6, 7 and 8, although somewhat different in construction will have the same useful function as the shorting device shown in Figs. 1, 2, 3, 4 and 5 and the same operational functions for shorting this line section can be performed in exactly the same manner as described hereinabove for the first shorting device.

While I have shown and described two forms of line sections and two forms of shorting elements to be employed therewith, I realize that many more variations in construction in both the line section and the shorting device and their applications thereof are possible without departing from the spirit and scope of my invention. It is to be understood, however, that the forms herein shown and described are only illustrations of my invention and should not be construed as a limitation of the scope of my invention as set forth in the foregoing objects and the appended claims.

I claim:

1. A reactance line section comprising inner and outer conductors, said outer conductor including a semi-circular portion spaced substantially equally from said inner conductor and side walls mounted on the edges of said semi-circular portion and normal thereto and spaced apart a distance equal to the diameter of said semi-circular portion for providing a reactance line section with an opening along the length and a characteristic impedance substantially the same as a completely closed coaxial line section having the spacing existing between said inner conductor and semi-circular portion.

2. A variable reactance device according to claim 1 in which said outer conductor includes a circular portion of the same diameter as said semi-circular portion and coaxially about a portion of said inner conductor and connected to said semi-circular portion.

3. A variable reactance device according to claim 1 further including shorting means insertable between said side walls to couple together said inner and outer conductors, said shorting means being adjustable longitudinally of said line section through the opening formed between said side walls.

4. A shorting device for electrically coupling together the inner and outer conductors of a line section, wherein the outer conductor is provided with a longitudinal opening defined by laterally extending side walls, comprising a shorting element including a first and second resilient conductive member capacitatively coupled together and securely mounted thereon, said shorting device capable of being inserted through and withdrawn from said opening to adjustably mount said shorting device upon said inner conductor within said line, said first conductive member engaging the inner opposite side walls of said outer conductor and said second conductive member engaging the outer opposite side walls of said inner conductor, and means accessible through said opening for adjusting said shorting device longitudinally along the length of said line section to vary the reactances thereof.

5. A shorting device according to claim 4, wherein said first conductive member is further provided with resilient parallel side flanges engaging the inner opposite side walls of said outer conductor and said second conductive member is further provided with downwardly extending bifurcated portions at its extended end for movably mounting said shorting element upon said inner conductor, the legs of said bifurcated end portion being provided with resilient conductor-engaging portions bent longitudinally to said line and adapted to engage the outer opposite side walls of said inner conductor.

6. A shorting device for electrically coupling together the inner and outer conductors of a line section wherein said outer conductor is provided with a longitudinal opening defined by laterally extending side walls, comprising a shorting element having a first pair and a second pair of conductive members, said first pair of conductive members being substantially U-shaped in cross-section and oppositely disposed in spaced-apart relation from one another, the resilient parallel sides of said first pair of members adapted to engage the inner lateral side walls of said outer conductor longitudinally thereof, said second pair of conductive members being spaced capacitatively apart from each other and interposed in capacitive relation to said U-shaped conductive members, said second pair of conductive members being provided with downwardly extending bifurcated portions at their extended ends to provide means for movably mounting said shorting device upon said inner conductor, the legs of said bifurcated end portions being provided with resilient conductor-engaging portions bent oppositely one another and longitudinally to said line and adapted to engage the outer lateral side walls of said inner conductor, the capacitatively coupled conductive members being securely mounted on said shorting element for insertion through and withdrawal from said opening and for longitudinal adjustment along said line section to vary the reactance thereof.

7. A shorting device for electrically coupling together the inner and outer conductors of a line section wherein said outer conductor is provided with a longitudinal opening defined by laterally extending side walls, comprising a shorting element having a pair of substantially U-shaped conductive members nested in spaced-apart relation, one within the other, and positioned within said line above and surrounding the greater portion of said inner conductor, the inner of said pair of U-shaped conductive members being provided with inwardly curved extensions on the ends of the parallel side thereof and engaging the outer opposite sides of said inner conductor longitudinally thereof, the outer of said pair of U-shaped conductive members being provided with outwardly curved extensions on the ends of the parallel sides thereof and engaging the inner opposite sides of said outer conductor, separate capacitive means interconnected between the parallel sides of said pair of U-shaped conductive members whereby said inner and outer conductors of said line are capacitatively coupled, and means accessible through said opening for longitudinal adjustment of said shorting device along the length of said line to vary the reactance thereof.

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