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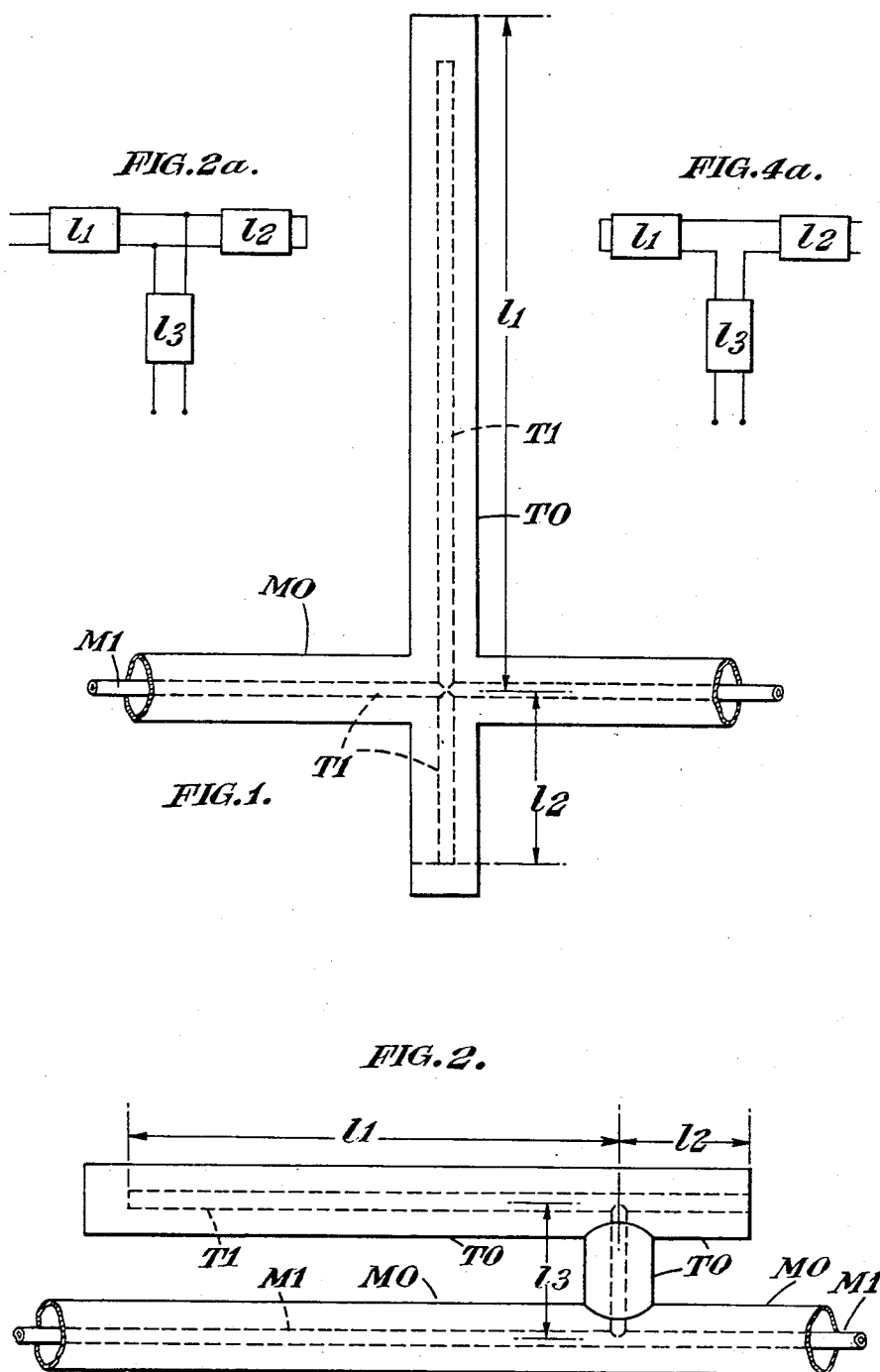
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T-CONNECTED STUB FILTERS FOR USE ON VERY HIGH FREQUENCIES

Filed Feb. 11, 1952

2 Sheets-Sheet 1



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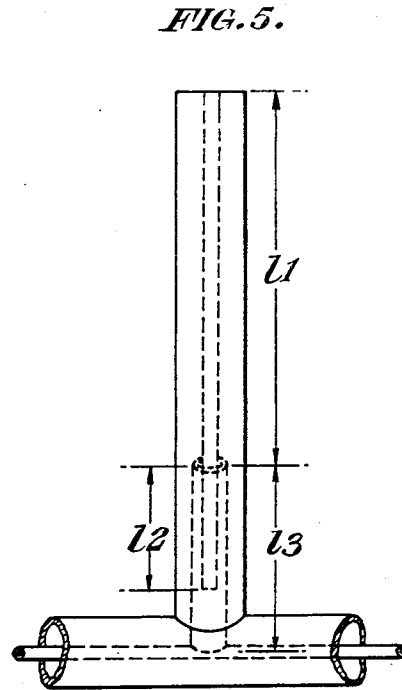
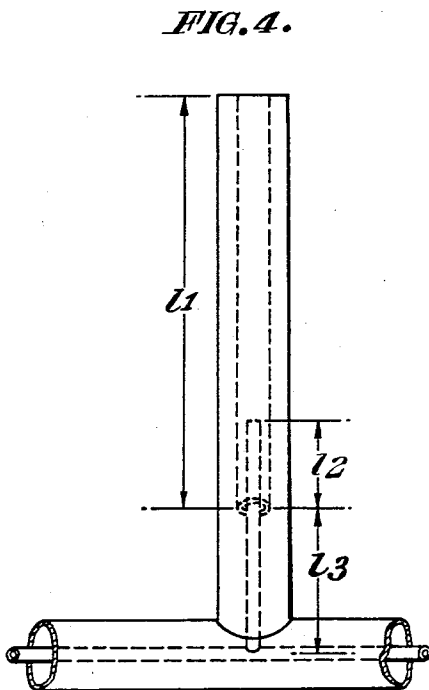
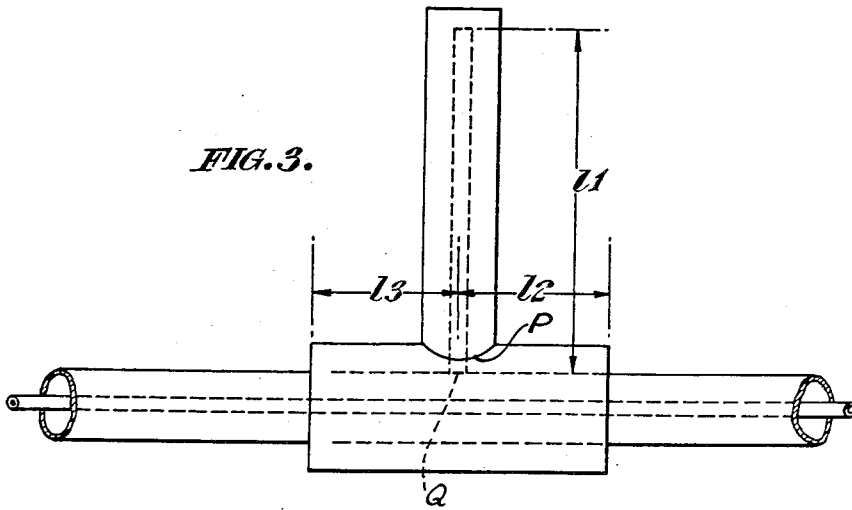
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T-CONNECTED STUB FILTERS FOR USE ON VERY HIGH FREQUENCIES

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8 Claims. (Cl. 333—73)

This invention relates to filters and other frequency selective arrangements for use on very high frequencies and more particularly to filters of the so-called line or distributed constants type i. e. the type in which, instead of lumped impedances lengths of high frequency line are used.

The invention is illustrated in and explained in connection with the accompanying diagrammatic drawings in which Fig. 1 shows a typical known arrangement; Figs. 2, 3, 4 and 5 show embodiments of this invention; and Figs. 2a and 4a are equivalent block diagrams for purposes of explanation.

It is general practice in present day filters and the like of the line type to obtain the required frequency selective characteristics by means of one or more series or parallel connected stubs. Fig. 1 shows a typical example of this practice for a case in which it is required to stop one frequency f_1 and pass an adjacent frequency f_2 . Referring to Fig. 1 a main transmission line comprising an inner tubular conductor M1 concentrically within an outer tubular conductor M0 has a parallel connected tapped stub consisting of an inner conductor T1 concentrically within an outer conductor T0. The stub has a longer length l_1 and a shorter length l_2 of which either may be short circuited at the far end or open circuited at the far end. If the longer length is open circuited it is made an odd number of quarter wave lengths long at the stop frequency: if it is short circuited it is made an integral number of half wave lengths long at that frequency. The short length l_2 provides, at the pass frequency, a reactance as nearly as possible equal and opposite to that of the long length.

This arrangement has the serious practical defect that, owing to the limiting value of the possible surge impedance of the transmission line of which the stub is made, the impedance presented by the stub for the pass frequency f_2 is necessarily much below the theoretically required value and accordingly considerable loss occurs even if the longer length l_1 is made very long. The type of defect is present in other known tapped stub arrangements. The present invention seeks to reduce this defect and to provide improved and efficient filters and the like of the type referred to wherein losses are reduced to acceptable amounts without having to use unduly long and clumsy stubs.

According to this invention a filter or the like of the line type comprises one or more T connected stubs each of which has a connecting arm which is other than a quarter wave length or a multiple thereof long and which meets the other two arms (the "cross piece" of the T) at their junction, the said arms being either open or short circuited at their far ends.

Fig. 2 shows one embodiment of the invention serving the same purpose as the known arrangement of Fig. 1. Here the main transmission line comprises the conductors M1 and M0. The stub, however, is now a T stub with its inner and outer conductors T1 and T0 in the form of a T with three arms of lengths l_1 , l_2 and l_3 as

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shown. The length l_3 is any arbitrary length other than a quarter wave length at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit. The significance of making l_3 other than a quarter wave length is that it is not required to invert the impedance. It would be practicable if impedance inversion was required to put a quarter wave length at l_3 and then add the stub including an additional element for l_3 designed on the principles outlined in the application. If, in fact, a quarter wave length line was used at l_3 the whole benefit of the invention would be lost because the dimensions of the stub would be inconveniently large. What is required at l_3 is a means of controlling the impedance level and to do this a length is required which is other than a quarter wave length; as low as 6° , or it may be very much higher, but the essential feature is that l_3 shall not be a quarter wave length. The lengths l_1 , l_2 may be either open circuited or short circuited at their far ends. In this example if l_1 is open circuited its length is such that $l_1 + l_3$ is substantially an odd number of quarter wave lengths long at the required stop frequency—more precisely the length will be slightly modified from the exact odd number of quarter wave lengths owing to the presence of the length l_2 . Then the length l_2 will be short circuited and $l_1 + l_2$ is made substantially an odd number of quarter wave lengths long at the pass frequency—modified slightly from the exact odd number of quarter wave lengths by the presence of the length l_3 . If l_1 is short circuited $l_1 + l_3$ is made substantially an even number of quarter wave lengths long at the stop frequency and if l_2 is also short circuited $l_1 + l_2$ is made substantially an even number of quarter wave lengths long at the pass frequency.

With these arrangements the ratio of the lengths of l_2 to l_1 is much greater, other things being equal than with the known arrangement of Fig. 1 and in practice, for the same length of stub, the losses are reduced by about four times or more in an arrangement in accordance with this invention as compared to a known arrangement as in Fig. 1. In addition high currents are kept away from the junction point with the main transmission line and a closer correspondence between practice and theoretical design can be achieved than with known arrangements.

Fig. 3 shows a T-stub arrangement in accordance with the invention inserted in series in the main transmission line instead of, as in Fig. 2, in parallel connection. In Fig. 3 the same references are used as in Fig. 2 so that the said Fig. 3 will be, it is thought, self-explanatory. Fig. 3 shows the series case in which the main transmission line is broken at its outer portion at point P so that the T stub can be connected. The outer portion is then continued as the larger diameter for l_3 , the inner portion of l_3 being a continuation of the outer portion of the main transmission line that is joined to the T stub at the opposite end of the stub. The inner portion of l_2 is comprised of the outer portion of the main transmission line and the inner portion of l_1 is connected to the inner portion of l_2 and the inner portion of l_3 at the point indicated at Q.

The "reciprocal" T-stub can be used in place of the "straight" T in carrying out the present invention for it is the obvious alternative. Figs. 4 and 5 show reciprocal T arrangements connected in parallel to the main line. As shown in Figs. 4 and 5 the arrangements do not look like T's but in fact they are as will be apparent from Figs. 2a and 4a of which Fig. 2a is the equivalent block diagram of the stub of Figs. 2 and 3 and Fig. 4a the equivalent block diagram of the stub of Figs. 4 and 5. Like references are used throughout Figs. 2, 2a, 3, 4,

4a, and 5 to make identification easy. For the reciprocal T stub the lengths of the various parts are made the same as the corresponding lengths of the straight T-stub but the far end of the corresponding part of the reciprocal T-stub is short circuited if that of the straight T-stub is open circuited and vice versa. A reciprocal T-stub may also be employed in series with the main line but in this case the provision of an isolating stub may be required.

The known tapped stub arrangements such as that exemplified in Fig. 1 or the reciprocal thereof (which is two stubs in series) present defects as already described. The present invention, by adding the interposed length l_3 of transmission line to transform the known type of arrangement to a T-stub arrangement, avoids these defects modifying the frequency response and enabling the losses

The table below sets out the various possible arrangements and dimensions of the arms l_1 , l_2 , l_3 of straight and reciprocal T-stub embodiments of the invention. In each case the data for the straight and corresponding reciprocal stubs is given in the same horizontal line. In the table λ is the wave length at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and n is any odd integer. The reference to "short length" in the table below means that the length required is short in relation to one quarter wave length at any frequency within the range stated in the preceding sentence:

"Straight"		"Reciprocal"	
l_1	l_2	l_1	l_2
open circuited about $\frac{n\lambda}{4}$	short circuited short length.	short circuited about $\frac{n\lambda}{4}$	open circuited short length.
short circuited about $\frac{(n+1)\lambda}{4}$	short circuited short length.	open circuited about $\frac{(n+1)\lambda}{4}$	open circuited short length.
open circuited about $\frac{n\lambda}{4}$	open circuited $< \frac{\lambda}{4}$	short circuited about $\frac{n\lambda}{4}$	short circuited $< \frac{\lambda}{4}$
short circuited about $\frac{(n+1)\lambda}{4}$	open circuited $< \frac{\lambda}{4}$	open circuited about $\frac{(n+1)\lambda}{4}$	short circuited $< \frac{\lambda}{4}$

In all cases l_3 may be of any length other than $\lambda/4$ or a multiple thereof. In all the above cases, by choosing a suitable value for l_3 the frequency f_1 at which substantially zero impedance is presented, may be chosen at will either below or above the frequency f_2 at which substantially infinite impedance is presented. For any two specified frequencies f_1 and f_2 in any of the cases envisaged in the above table the lengths l_1 , l_2 and l_3 can be freely chosen in such a way that the bandwidth at f_1 can be varied gradually from wide to narrow and the bandwidth at f_2 can be varied gradually from narrow to wide—in other words l_1 , l_2 and l_3 can be selected at values which will give a wide band at f_1 and a narrow band at f_2 or vice versa, or any intermediate condition of bandwidth, widening of the band at f_1 being accompanied by narrowing of the band at f_2 and vice versa.

I claim:

1. A filter or the like of the line type comprising at least one "straight" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being parallel connected to the other two arms at their junction, one of said other two arms being open circuited at its far end and being substantially a whole odd number, including unity, of quarter wave lengths long at a frequency within said range and the other of said

other two arms being short circuited at its far end and being short in relation to a quarter wave length at any frequency within said range.

2. A filter or the like of the line type comprising at least one "reciprocal" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being series connected to the other two arms at their junction, one of said other two arms being short circuited at its far end and being substantially a whole odd number, including unity, of quarter wave lengths long at a frequency within said range and the other of said two arms being open circuited at its far end and being short in relation to a quarter wave length at any frequency within said range.

3. A filter or the like of the line type comprising at least one "straight" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being parallel connected to the other two arms at their junction, one of said other two arms being short circuited at its far end and being substantially a whole number, including unity, of half wave lengths long at a frequency within said range and the other of said two arms being short circuited at its far end and being short in relation to a quarter wave length at any frequency within said range.

4. A filter or the like of the line type comprising at least one "reciprocal" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being series connected to the other two arms at their junction, one of said other two arms being open circuited at its far end and being substantially a whole number, including unity, of half wave lengths long at a frequency within said range and the other of said other two arms being open circuited at its far end and being short in relation to a quarter wave length at any frequency within said range.

5. A filter or the like of the line type comprising at least one "straight" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being parallel connected to the other two arms at their junction, one of said other arms being open circuited at its far end and being substantially a whole odd number, including unity, of quarter wave lengths long at a frequency within said range and the other of said other two arms being open circuited at its far end and being slightly shorter than a quarter wave length long at any frequency within said range.

6. A filter or the like of the line type comprising at least one "reciprocal" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being series connected to the other two arms at their junction, one of said other two arms being short circuited at its far end and being substantially a whole odd number, including unity, of quarter wave lengths long at a frequency within said range and the

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other of said other two arms being short circuited at its far end and being slightly shorter than a quarter wave length long at any frequency within said range.

7. A filter or the like of the line type comprising at least one "straight" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any frequency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being parallel connected to the other two arms at their junction, one of said other arms being short circuited at its far end and being substantially a whole number, including unity, of half wave lengths long at a frequency within said range and the other of said other two arms being open circuited at its far end and being slightly shorter than a quarter wave length long at any frequency within said range.

8. A filter or the like of the line type comprising at least one "reciprocal" T-connected stub having a connecting arm which is other than a whole number, including unity, of quarter wave lengths long at any fre-

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quency within the frequency range having the stop frequency of the filter as one limit and the pass frequency of the filter as the other limit and two other arms, said connecting arm being series connected to the other two arms at their junction, one of said other two arms being open circuited at its far end and being substantially a whole number, including unity, of half wave lengths long at a frequency within said range and the other of said other two arms being short circuited at its far end and being slightly shorter than a quarter wave length long at any frequency within said range.

References Cited in the file of this patent

UNITED STATES PATENTS

2,128,400	Carter	Aug. 30, 1938
2,214,041	Brown	Sept. 10, 1940
2,270,416	Cork et al.	Jan. 20, 1942
2,495,589	Masters	Jan. 24, 1950
2,532,993	Carter	Dec. 5, 1950
2,540,734	Huggins et al.	Feb. 6, 1951
2,570,579	Masters	Oct. 9, 1951