Jan. 17, 1961

E. G. BOOK

COAXIAL STUB TUNER

2,968,776

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2 Sheets-Sheet 1

Fig. 1.

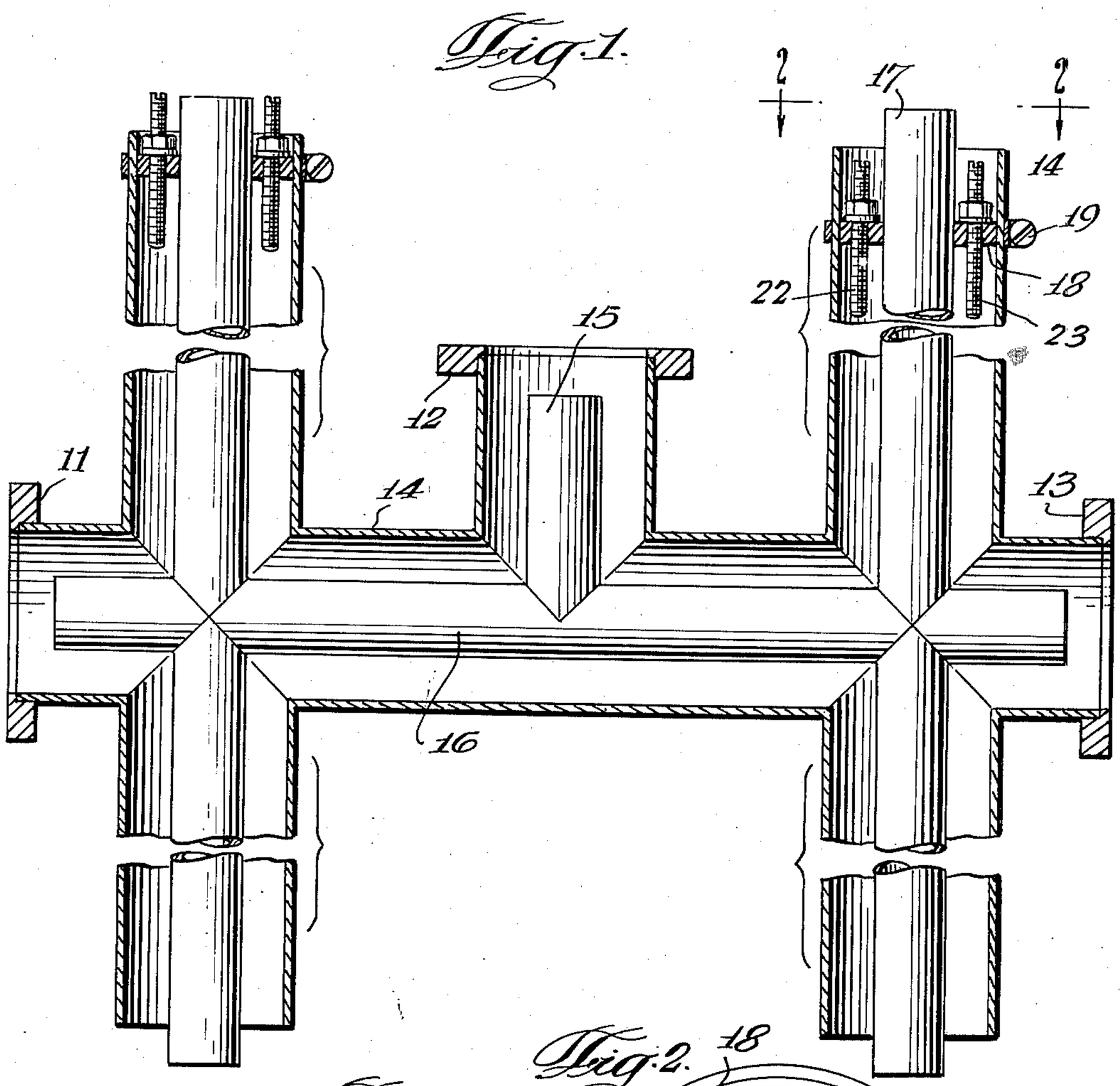

Fig. 2.

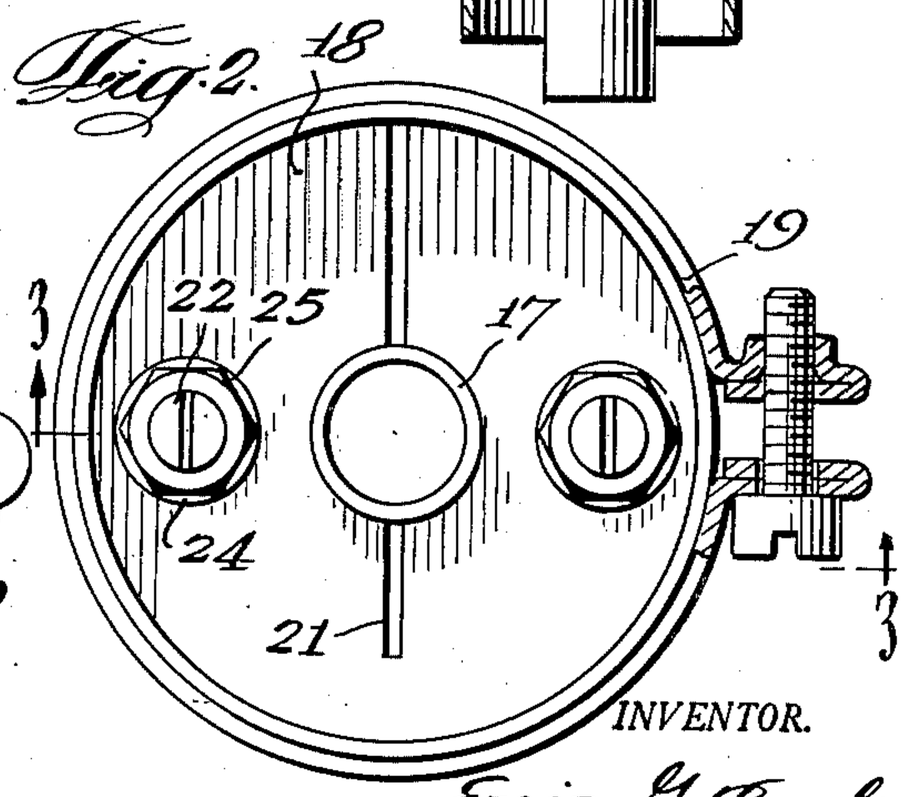

Fig. 3.

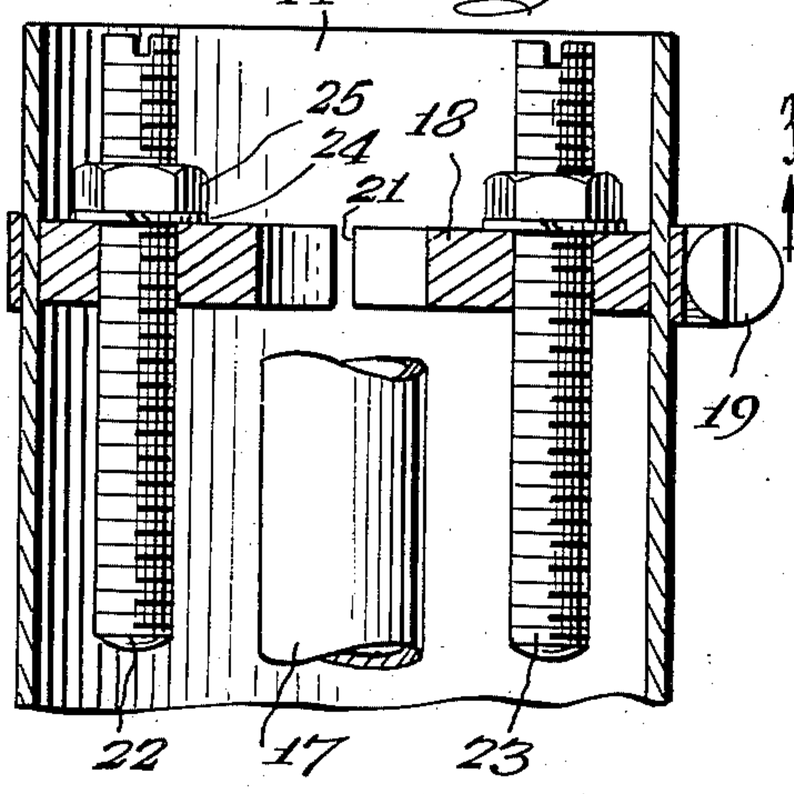

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Fig. 4.

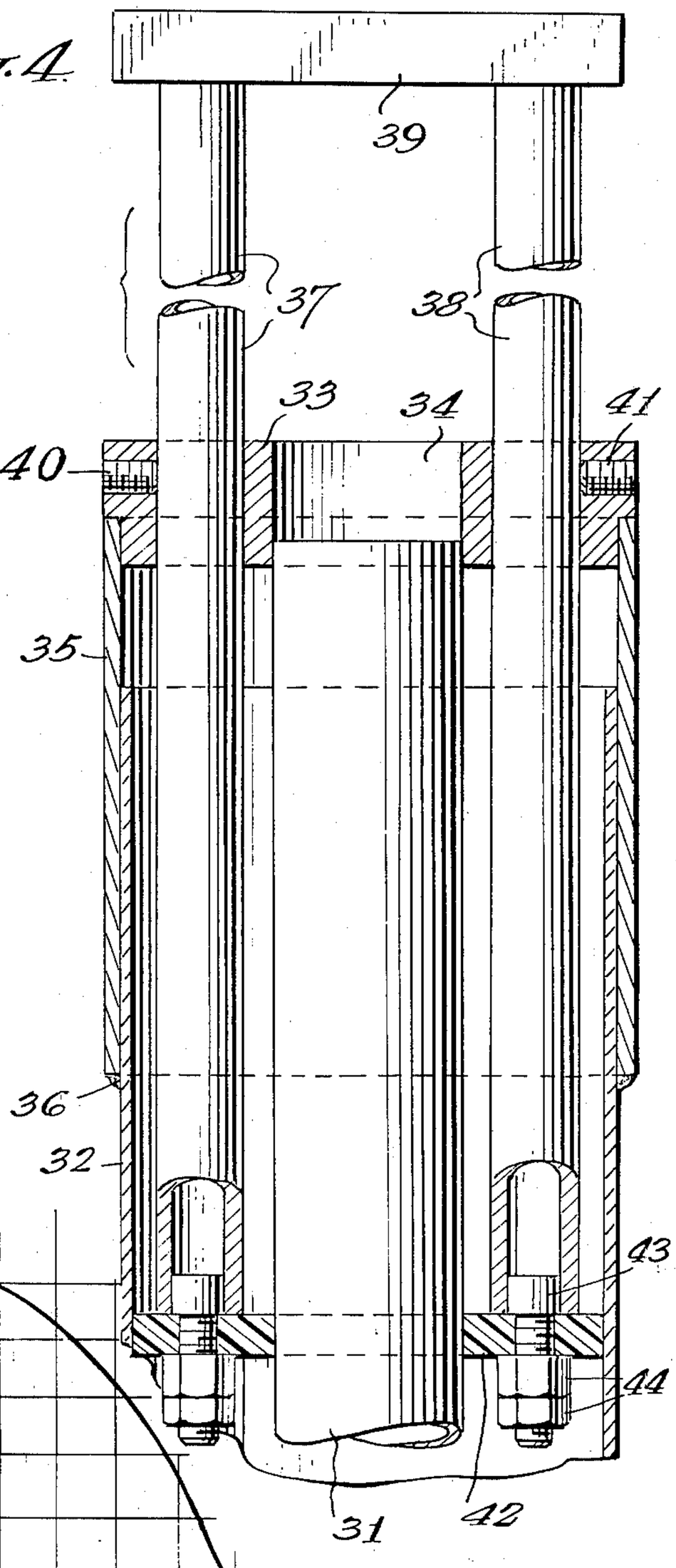


Fig. 5.

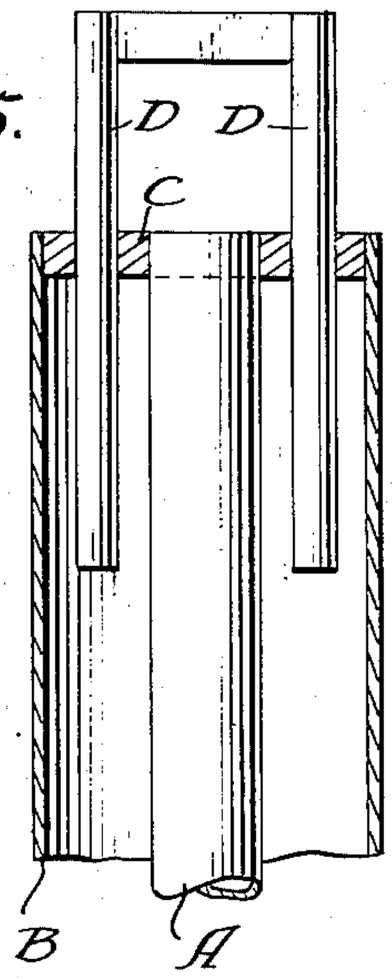
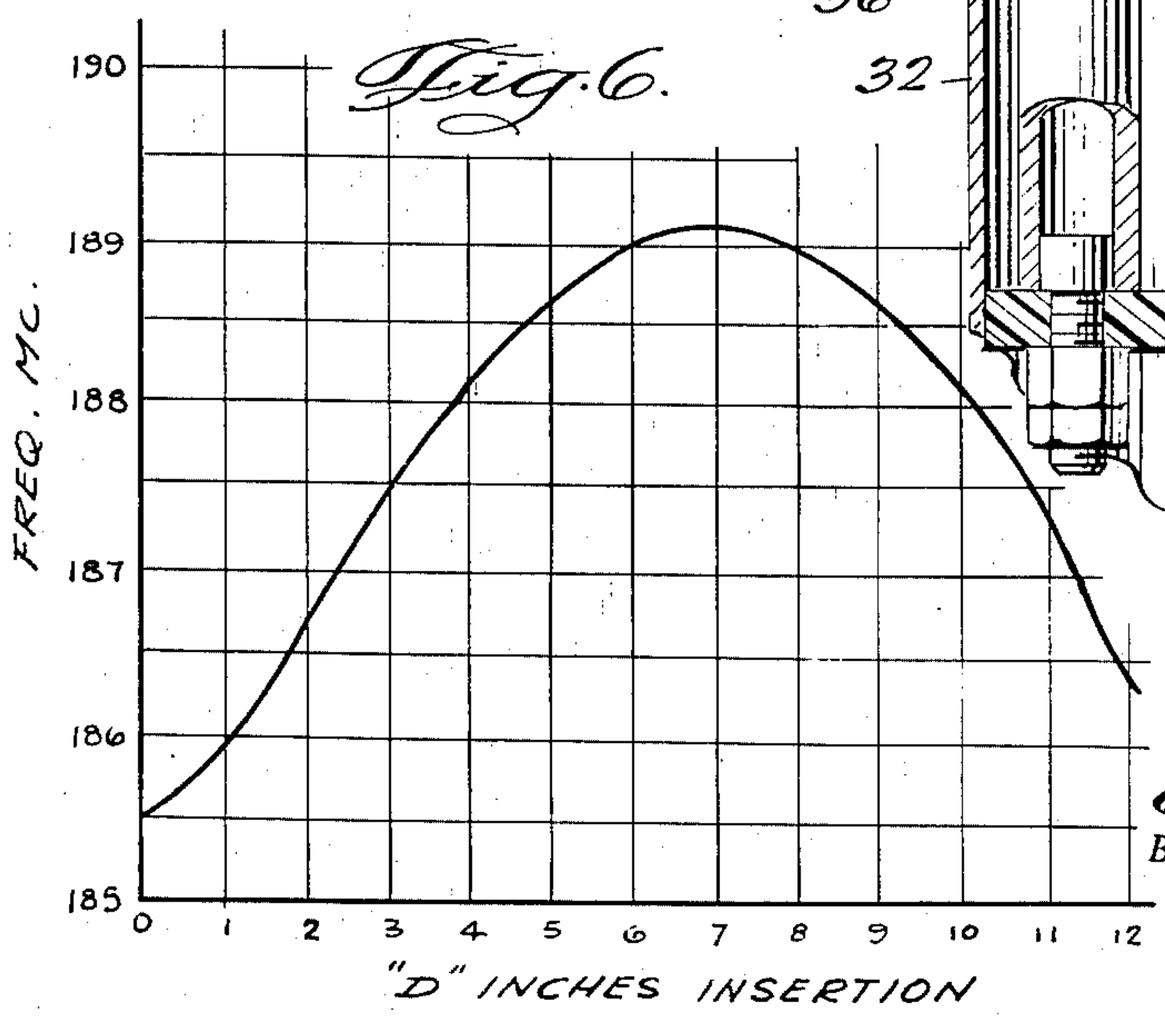


Fig. 6.



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COAXIAL STUB TUNER

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4 Claims. (Cl. 333—82)

The present invention relates to a fine tuning method particularly applicable to coaxial stub filters.

Heretofore, coaxial stub filters and various arrangements thereof, referred to as diplexers, duplexers, and the like, have been difficult to tune. It has been common to employ annular shorting plates provided with spring contact fingers for retaining them in position, or they have been soft soldered into position. Often times in attempting to fix such shorting plates into position there has been some change so that the optimum tuning has not been accomplished.

It, therefore, would be desirable to provide some means to facilitate tuning coaxial stub filters or similar structures. In accordance with the present invention it is proposed to provide coarse or fine or vernier tuning in an improved assembly.

It is, therefore, an object of the present invention to provide a convenient means to facilitate tuning coaxial stub filters.

Another object of the invention is to provide a vernier tuning means for coaxial devices to vary the characteristic impedance thereof.

Still another object of the invention is to provide a tuning means for coaxial devices having coarse and fine tuning means.

Other and further objects of the invention subsequently will become apparent by reference to the following description taken in conjunction with the accompanying drawings, wherein:

Figure 1 shows the invention applied to a typical duplexer or diplexer as seen in longitudinal cross-section;

Figure 2 is a view as seen in the direction of the arrows along the line 2—2 of Figure 1;

Figure 3 is a view seen in the direction of the arrows along the line 3—3 of Figure 2;

Figure 4 illustrates another embodiment of the invention as seen in longitudinal cross-section;

Figure 5 is a diagrammatic representation of the tuning devices shown in Figures 1, 3 and 4; and

Figure 6 is a curve illustrating the characteristics of the invention relative to the diagrammatic representation shown in Figure 5.

The arrangement shown in Figure 1 represents a conventional duplexer or diplexer having a plurality of coaxial line sections, some of which are provided with coupling flanges for connection to other coaxial lines. For example, the arrangement shown in Figure 1 may have a coupling flange **11** arranged to couple the device to another coaxial line which might be connected to a transmitter. The intermediate coupling flange **12** connects the device to a coaxial line leading to the antenna element per se, while a third coupling flange **13** connects the device to another coaxial line which is either connected to a receiver or to a second transmitter. These coaxial devices comprise an outer conductor **14** connected to the flanges **11, 12** and **13**, and have inner coaxial conductors **15.** Located at right angles to the interconnecting inner conductor **16** are two similarly arranged tuning stubs or

devices, only one of which needs to be described. A transversely arranged inner coaxial member **17** is connected to the transverse conductor **16.** Adjacent the end of the conductor **17** and its outer conductor **14** is an annular ring **18** which is held in adjustment by a clamp ring **19** surrounding the outside of the outer conductor **14.** The annular ring **18** is provided with vernier tuning devices which are best seen by reference to Figures 2 and 3. The annular shorting member **18** is provided with a slit **21** which extends past the center from one annular edge. The shorting member **18** is originally adjusted to approximately the proper tuning position. Thereupon the clamp ring **19** is tightened. The annular shorting member **18** along one diameter thereof carries two threaded rods **22** and **23** which engage threaded openings in the annular member **18.** Suitable lock washers and lock nuts **24** and **25** are provided for each threaded rod **23.** The effect of the threaded rods is to alter the characteristic impedance of the portion of the line in which they are located, thereby providing a variable length of coaxial line that has a different impedance. As the rods are extended into the space between the inner and outer conductors **14** and **17** comprising the cavity to be tuned, the electrical length thereof will be shortened. The rods are of a diameter at least equal to ¼ the space between the inner and outer conductors.

In Figure 4 there is shown a coaxial transmission line having an inner conductor **31** and an outer conductor **32.** A suitable tuning device is mounted at one end of these coaxial conductors, which includes an annular shorting member **33** having a central opening **34** for engagement with the central conductor **31.** The annular ring **33** is secured to a cylindrical cap **35,** which is adjusted to approximately resonant position and soldered into position at **36.** Two longitudinally movable tuning rods **37** and **38** are connected together by a transverse member **39** so that these rods can be moved simultaneously. The position of the rods **37** and **38** upon proper adjustment may be fixed by suitable set screws **40** and **41.** Where the rods of this kind extend an appreciable distance into a coaxial line, such as the conductors **31** and **32,** it is sometimes desirable to insure the positioning of the free or inner ends of the rods **37** and **38** so that they at all times will be properly spaced substantially midway between the inner and outer conductors **31** and **32.** Thus, in the arrangement shown in Figure 4 the inner ends of the rods **37** and **38** are connected to an annular ring **42** of insulating material secured in position to engage the inner and outer conductors **31** and **32.** The ends of the rods **37** and **38** are provided with threaded stud members **43** which are engaged by two lock nuts **44.** Thus, Figure 4 illustrates another embodiment of a tuning device having the same function as the tuning device shown in Figures 1, 2 and 3.

In Figure 5 is diagrammatically shown a tuning arrangement for coaxial lines having an inner conductor A and an outer conductor B and an annular shorting member C provided with two adjustable rods D. To illustrate the characteristic operation of the invention, the curve in Figure 6 shows a range covered when a tuning device such as that diagrammatically shown in Figure 5 was used to tune a second harmonic filter for an FM stage. Thus, the curve **6** shows the relation between frequency in megacycles and the distance of insertion of a pair of rods D. It is believed that no further explanation of the operation is required in view of this graphical representation in Figures 5 and 6.

Those skilled in the art will appreciate that in some instances a single adjustable rod may suffice, and that in other cases more than two rods may be used at different radii. While the rods have been shown midway between

the inner and outer conductors, some latitude is possible in positioning the rods closer to one of the coaxial conductors than to the other conductor.

While for the purpose of illustrating and describing the present invention certain particular embodiments have been shown in the drawings, it is to be understood that the invention is not to be limited thereby since such modifications or variations are contemplated as may be commensurate with the spirit and scope of the invention set forth in the accompanying claims.

I claim as my invention:

1. A tunable coaxial stub filter comprising a coaxial line having spaced inner and outer coaxial conductors and a coaxial half-wavelength stub having inner and outer conductors forming a longitudinally uniform annulus and terminating at one end on the inner and outer conductors of the line, respectively, the other end having an annular conducting plate extending between the inner and outer conductors, and longitudinally slideable in the coaxial cavity thus formed, a plurality of conducting rods of transverse dimension equal to at least ¼ the thickness of the annulus carried by said plate and extending perpendicularly through said plate approximately midway between the conductors and parallel therewith and adjustable in longitudinal position in the plate, the annulus being otherwise free of conducting elements, means for locking the longitudinal position of the plate for coarse tuning of the stub, and means for locking the longitudinal position of the rod in the plate for fine tuning of the stub, so that the half-wave resonant frequency of the stub is increased in the first portion of the insertion of the rods.

2. A tunable coaxial stub filter compirsing a coaxial line having spaced inner and outer coaxial conductors and a coaxial half-wavelength stub having inner and outer conductors forming a longitudinally uniform annulus and terminating at one end on the inner and outer conductors of the line respectively, the other end having a shorting member connecting the inner and outer conductors, a plurality of conducting rods of transverse dimension equal to at least ¼ the thickness of the annulus extending through the shorting member into the annulus approximately midway between the inner and outer conductors, the annulus being otherwise free of conducting elements, and means to adjust the longitudinal position of the rods to tune the stub so that the half-wave resonant frequency of the stub is increased in the first portion of the insertion of the rods.

3. A tunable coaxial stub filter as set forth in claim 2 wherein the adjusting means comprises a connecting member affixed to the outwardly extending ends of the rods for simultaneous adjustment of the rods.

4. A tunable coaxial stub filter as set forth in claim 2 having an annular insulating ring within the stub, the inner ends of the rods being seated in the insulating ring to maintain their relative positions.

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