Oct. 31, 1950

R. A. HERRING, JR

2,527,549

CONCENTRIC LINE CONSTRUCTION

Filed Feb. 4, 1943

FIG. 1

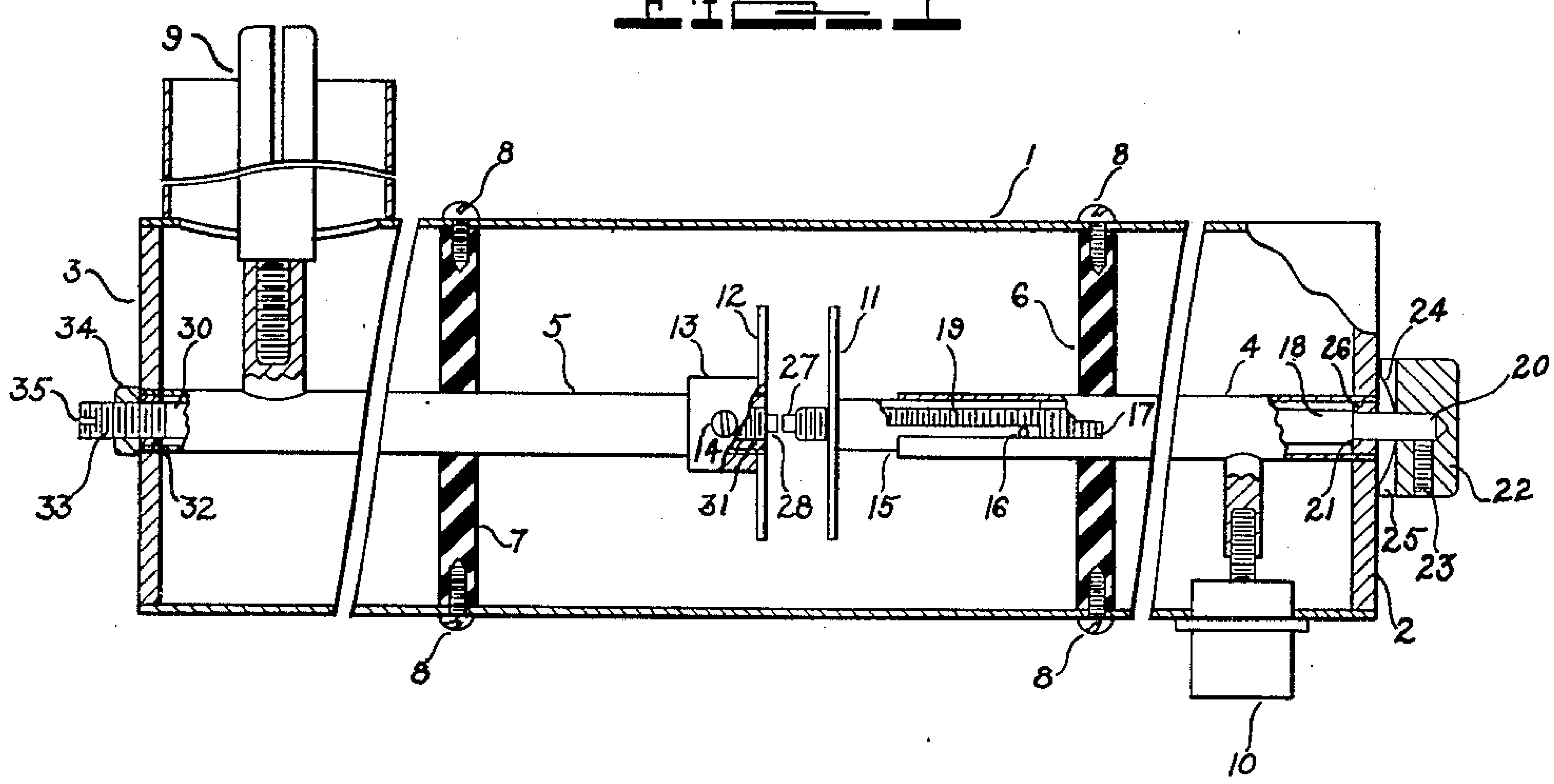


FIG. 2

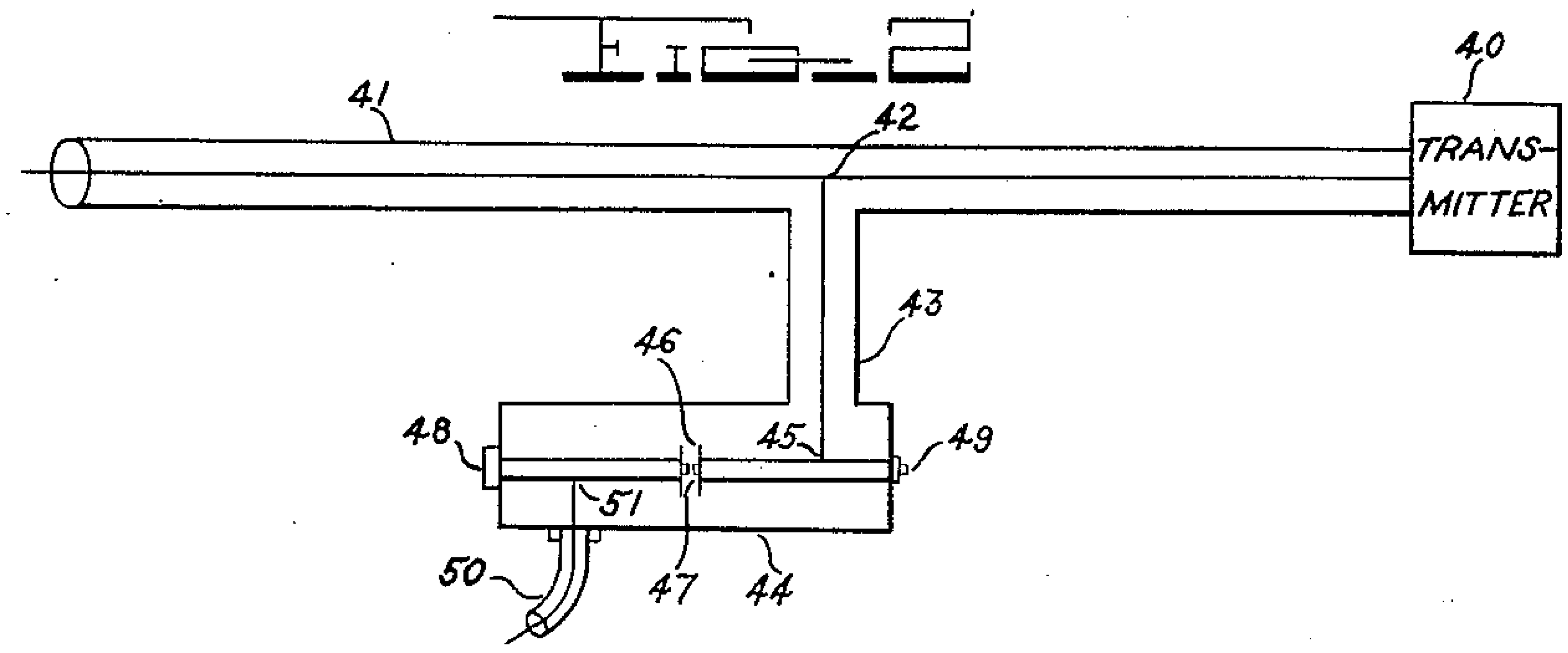
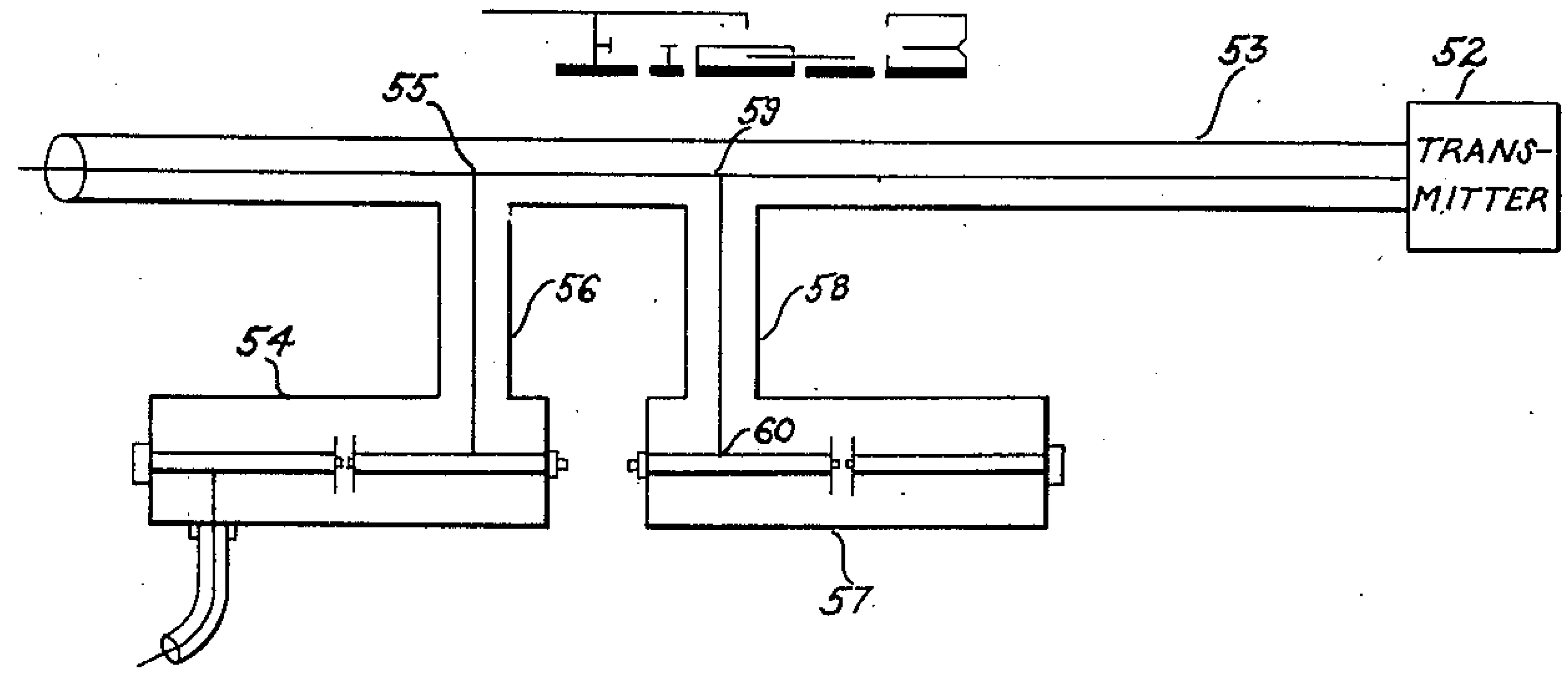


FIG. 3



Inventor
ROBERT A. HERRING, JR.

By [signature]

Attorney

Patented Oct. 31, 1950 2,527,549

UNITED STATES PATENT OFFICE

2,527,549

CONCENTRIC LINE CONSTRUCTION

Robert A. Herring, Jr., Washington, D. C.

Application February 4, 1943, Serial No. 474,663

4 Claims. (Cl. 178—44)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

1

This invention relates to concentric transmission line construction, and is particularly directed to improvements in concentric line sections which may be employed as resonant circuits. The invention is further applicable to resonant concentric tanks useful as protective elements and decoupling elements in duplex transmission and reception with a single antenna. Devices of this nature are known in the prior art and conventionally include a voltage operated switching device for shifting the impedance of the elements in duplex operation.

It is an object of the invention to provide a concentric transmission line construction wherein adjustable circuit elements within the transmission line may be adjusted from outside the transmission line.

A second object of the invention is to provide a concentric transmission line construction including an interrupted central conductor with adjustable circuit elements connected between its separate portions.

A further object of the invention is to provide for the adjustment of internal circuit elements of a transmission line section through an aperture extending from the outside of the section along a bore in the central conductor, and into the space within the section.

Another object of the invention is to provide for tuning and otherwise adjusting a resonant transmission line section by adjustable circuit elements within the section, and to effect the adjustments from outside the section by means which do not disturb the symmetry of the fields therein.

A more specific object of the invention is to provide for adjusting circuit elements within a transmission line section by means of an operating member contained in a bore in the central conductor.

In duplexing systems, especially for pulse transmission and echo reception, it is the practice to couple the receiver to the transmission line through a transformer which effects automatic decoupling during transmission periods. This is accomplished by the use of a resonant tank including a switching element for detuning the tank on the application of high voltage from the transmitter. Similar tank elements may be employed for decoupling the transmitter from the receiver during reception.

In installations of this type it is necessary to tune such a resonant tank to the exact frequency employed by an adjustable capacitor within the section. It is also desirable to adjust the switching element for optimum performance in relation to the transmitting voltage. Means for adjusting these circuit elements from outside the tank are provided by this invention, which will be further understood with reference to the exemplary embodiment shown in the drawing where:

2

Fig. 1 is an elevational view, partly in section, of a concentric line section embodying the invention;

Fig. 2 is a schematic representation of a duplexing system employing the invention in a protective tank, and

Fig. 3 is a schematic representation of a duplexing system employing the invention in a protective tank and in a transmitter decoupling tank.

As shown in Fig. 1, the tank comprises a cylindrical outer conductor or shell 1, conducting end plates 2 and 3 fixed in the ends of the outer conductor, and an interrupted central conductor having spaced portions 4 and 5. The inner and outer conductors are thus short circuited by the end plates at their outer extremities. The central conductor portions are positioned in holes provided in end plates 2 and 3, and are supported intermediate their lengths by spacing members 6 and 7, which comprise diametrically extending bars of insulating material peripherally shaped to engage the inner face of the outer conductor. The spacing members are apertured to receive the central conductor portions, and are fixed by screws 8 passing through the outer conductor.

Connection of concentric lines to the tank section may be made by conventional connector taps 9 and 10. Connector tap 9 may be jointed to a main transmission line by an intervening section and connector 10 may be connected to a concentric line of a smaller diameter.

The spaced central conductor portions are connected by a capacity directly across the gap between them, and for this purpose opposed condenser elements 11 and 12 are mounted on central conductor portions 4 and 5 respectively. The condenser elements, which may be circularly formed conducting plates, are preferably adjustably mounted for tuning the section. As shown, element 12 is integrally attached to collar 13 slidable along the central conductor portion 5, on which it may be permanently positioned by set screw 14.

Condenser element 11 is movably mounted relative to element 12, so that the tank may be tuned by adjusting the capacity across the central conductor portions. It is important that the tuning capacity be directly across the gap in half-wave series gap tanks, since parallel capacity will render the tank difficult of correct adjustment in the field, due to possibility of undesired resonances close to the operating frequency, which almost completely destroy the protective function of the tank. Through the construction disclosed, the parallel capacity is minimized, and further, by mounting the adjustable element for movement longitudinally of the section and parallel to the outer conductor, the capacity between the element and the outer conductor remains substantially unchanged on tuning.

The desired longitudinal adjustment of element **11** is effected by movement of its supporting member **15**, which is slidably mounted within a bore in central conductor portion **4**. Member **15** is internally threaded and is actuated by engagement of rotatable shaft **18**, externally threaded as shown at **19**. Shaft **18** is mounted also within the bore in central conductor portion **4**, and is reduced in its outer portion to form extension **20** which projects beyond end plate **2** and carries tuning knob **22**. At the inner end of extension **20** is provided shoulder **21**, which abuts against a positioning bushing **26** pressed into the end of the bore in central conductor portion **4**. Knob **22** is fixed on extension **20** beyond the outer face of end plate **2** by set screw **23**. Friction spring **24** apertured to receive extension **20**, is contained in slot **25** in the base of tuning knob **22** and simultaneously holds shoulder **21** against collar **26** and prevents accidental rotation of knob **22** and shaft **18**.

On rotation of shaft **28**, member **15** is axially adjusted through their threaded engagement, **15** being prevented from rotating by pin **16** slidably engaged in slot **17** in central conductor portion **4**. Consequently the tuning of the section is easily effected by manual operation of knob **22**.

The spaced central conductor portions **4** and **5** are also connected by a discharge device consisting of opposed spark electrodes **27** and **28**. The electrodes are adjustably mounted to permit variation of the discharge gap independently of the tuning of the section. Electrode **28** is mounted on shaft **30** longitudinally movable in a bore in central conductor portion **5**. Opposing electrode **27** is mounted in a longitudinally fixed position, being carried by shaft **18**.

Adjustment of the gap spacing is obtained by rotation of shaft **30** which is threaded through bushing **31** fixed in the inner end of central conductor portion **5**. The outer end of shaft **30** passes through a centering collar **32** in the outer end of central conductor portion **5**, and extends beyond the outer face of end plate **3**. The end of shaft **30** is slotted for screw driver adjustment, as shown at **35**. When proper gap spacing is obtained, shaft **30** may be locked by a nut **34** threaded onto portion **33** of the shaft.

It will be understood that suitable sealing elements may be interposed between nut **34** and end plate **3**, and between shoulder **21** and collar **26**, if the tank is to be employed in a concentric line system containing pressure. It should also be pointed out that whereas the invention has been shown as embodying a discharge switching element positioned medially of the length of the section in accordance with the teaching of application, Serial No. 452,534 of Varela and Herring, filed July 27, 1942, such is not a necessary feature of this invention.

Operation of resonant sections embodying the invention may be explained with reference to the duplexing systems shown schematically in Figs. 2 and 3.

In Fig. 2, **40** is a transmitter connected to an antenna (not shown) by untuned concentric line **41**. At point **42** a quarter wave section **43** is tapped into line **41**. Point **42** is selected as having a high impedance looking into the main transmission line **41** toward the transmitter during receiving conditions.

Quarter wave section **43** is tapped into the duplexing resonant tank **44** at point **45**. Tank **44** is constructed as shown in Fig. 1, and includes capacitor **46** and discharge gap **47** controlled respectively by tuning knob **48** and shaft **49**. Receiver transmission line **50** is tapped into duplexing tank at point **51**.

In the system shown the duplexing tank comprises a half wave section in which the tap points **45** and **51** are symmetrically placed to match lines **43** and **50**, whose characteristic impedances are identical. The tank is tuned to resonance by knob **48** for the selected operating frequency. Consequently the impedances facing each other are correctly matched and the receiver is properly coupled to the main transmission line with the resonant tank acting as a transformer. The transmitter branch presents high impedance at point **42** and permits efficient reception.

Under transmitting conditions high potentials are present in the duplexing tank. By means of shaft **49**, gap **47** is adjusted to ionize under these conditions, which effectively shunts capacitor **46** by a low resistance. This throws the tank off resonance, and the impedance measured between point **45** and ground is the equivalent of a low resistance and a somewhat higher inductive reactance in series. The length of quarter wave section **43** is adjusted to give anti-resonance with the impedance presented at point **45** so that a high pure resistance is seen at point **42** looking into line **43**. Consequently very little power is drawn from the main transmission line under transmitting conditions. Furthermore, the voltage appearing across the main line is stepped down by the transformer action of the quarter wave line **43**, and is again reduced by the reactive impedance of the tank itself. Through this means the voltage applied to the receiver is limited to a safe level.

Due to the fact that the impedance at point **42** of the main transmission line looking toward the transmitter may vary with transmitter adjustment, it is desirable to control this impedance directly. A duplexing system incorporating the invention for accomplishing this result is shown in Fig. 3.

Transmitter **52** is connected to an antenna (not shown) by untuned transmission line **53**. A receiver protective tank **54** is coupled into the main line at point **55** by quarter wave section **56**. Preferably but not necessarily the protective tank is of the type disclosed in Fig. 1, in which case the operation of this part of the system is in all respects similar to that described in connection with Fig. 2.

In order to decouple the transmitter from the transmission line system for reception, a decoupling tank **57** is connected into the main line by a quarter wave section **58** at a point **59** an odd number of quarter waves from point **55**.

Decoupling tank **57** is a half wave series gap section similar to the one disclosed in Fig. 1, with the exception that tap **10** is eliminated. The tank and its associated line **58** are tuned to resonance on the operating frequency, as above described. In receiving conditions the decoupling tank resonates and presents a pure resistance at point 60, much higher than the characteristic impedance of lines 53, 56 and 58. Hence, at point 59 a low resistance is shunted across the main line, which therefore presents a high impedance at point 55 looking toward the transmitter. Consequently during reception the transmitter is effectively decoupled.

For transmitting, the gap in decoupling section 57 is adjusted to ionize under the conditions then present, whereupon a high pure resistance is presented at point 59 looking into quarter wave section 58. This operation is exactly as described above in connection with the operation of receiver protective tank 44 in Fig. 2 and presents an inconsequential load to the transmitter.

It is therefore apparent that the half-wave series gap tank may be employed as a protective tank or as a decoupling tank, as well as serving both functions in a system as illustrated in Fig. 3.

Although I have shown and described certain and specific embodiments of this invention I am fully aware of the many modifications possible thereof. This invention is not to be restricted except insofar as is necessitated by prior art and by the spirit of the appended claims.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

I claim:

1. In a concentric transmission line section having a metal conductor short circuiting each of its ends, and including a hollow central conductor containing a bore and having an interrupted portion, said bore and interrupted portion constituting aperture means communicating with the interior of the section, adjustable discharge means and adjustable capacitor means connected across the interrupted portion, and actuating means operatively connected with the adjustable means movably mounted in the aperture means.

2. In a concentric transmission line section having a metal conductor short circuiting each of its ends, and including an interrupted hollow central conductor comprising spaced portions, adjustable discharge means and adjustable capacitor means connecting said spaced portions, and movable actuating members operatively connected with the adjustable means mounted within the hollow central conductor, each central conductor portion receiving one of said members.

3. In a concentric transmission line section having a metal conductor short circuiting each of its ends, and including an interrupted hollow central conductor comprising two spaced portions, two movable members mounted within the hollow central conductor, each central conductor portion receiving one of said members, adjustable discharge means connecting the central conductor portions including an electrode connected with one of said portions and an opposing electrode carried by the movable member received in the second of said portions; and adjustable capacitor means connecting the central conductor portions including a capacitor element connected with said second central conductor portion; and an opposing element carried by the other movable member.

4. A concentric transmission line section including an interrupted central conductor comprising spaced portions, a first bore extending from the outside of said section through one of said spaced portions, a second bore extending from the outside of said section through another of said spaced portions, a plurality of circuit elements within said section operatively coupled therewith and actuating means for said circuit elements movably mounted in said first and said second bores.

ROBERT A. HERRING, Jr.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,035,958	Girardeau	Aug. 20, 1912
1,304,868	Franklin	May 27, 1919
2,030,180	Potter	Feb. 11, 1936
2,088,722	Potter	Aug. 3, 1937
2,135,353	Rorden	Nov. 1, 1938
2,143,671	Zottu	Jan. 10, 1939
2,337,219	Zottu	Dec. 21, 1943
2,410,641	Evans	Nov. 5, 1946
2,415,962	Okress	Feb. 18, 1947

FOREIGN PATENTS

Number	Country	Date
183,699	Great Britain	Aug. 3, 1922