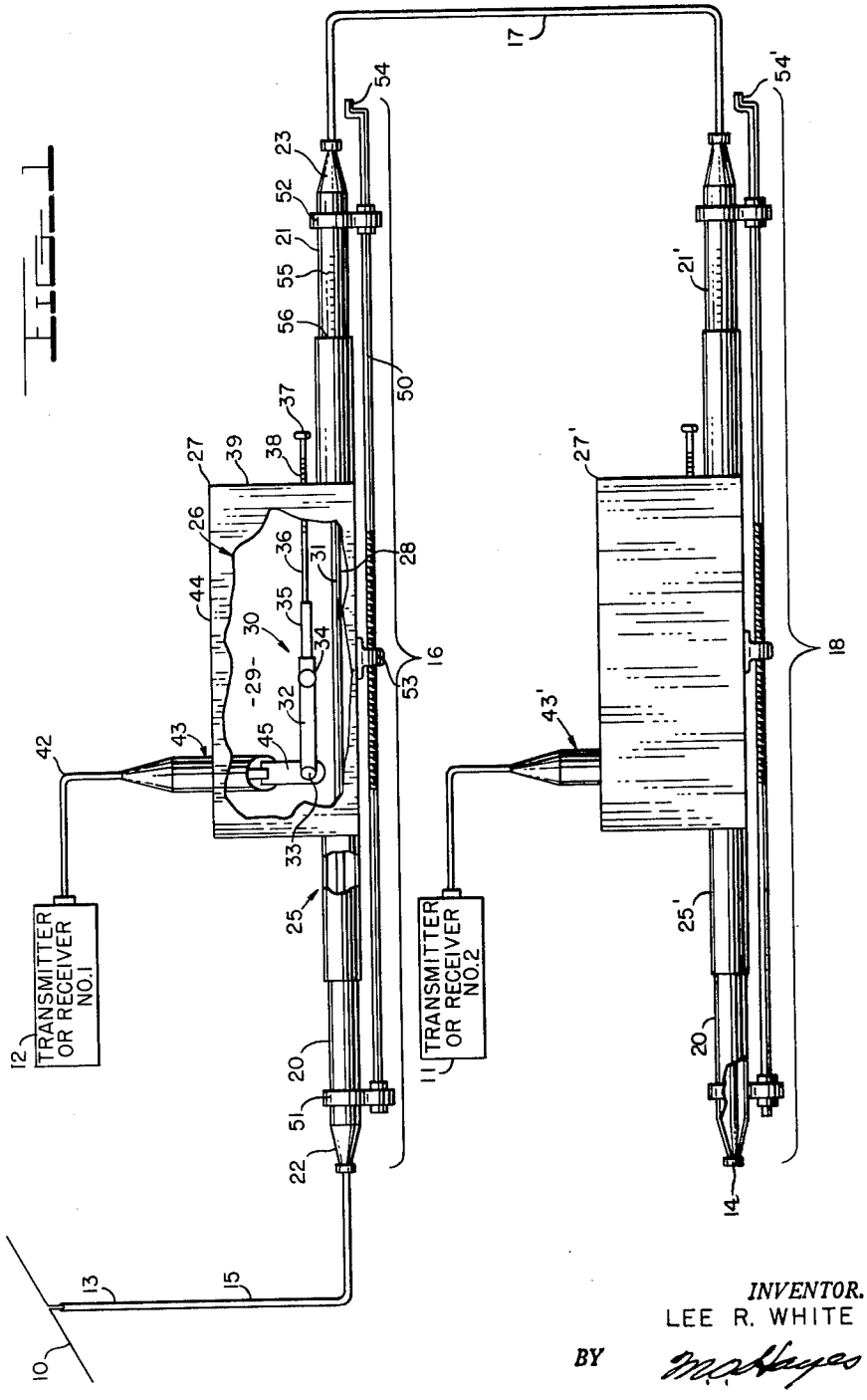
Dec. 28, 1965 L. R. WHITE 3,226,723

ANTENNA FEEDING SYSTEM

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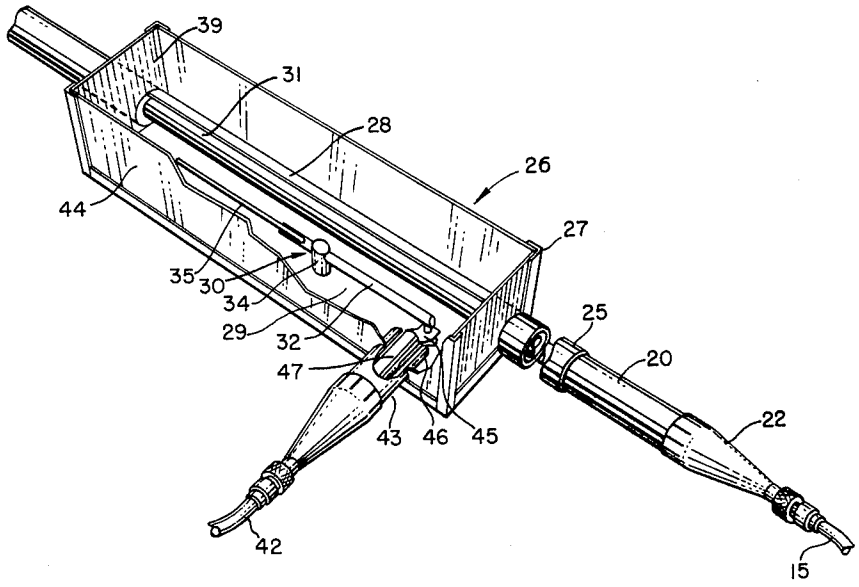
INVENTOR.
LEE R. WHITE
BY
ATTORNEY

Dec. 28, 1965 L. R. WHITE 3,226,723

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FIG. 2



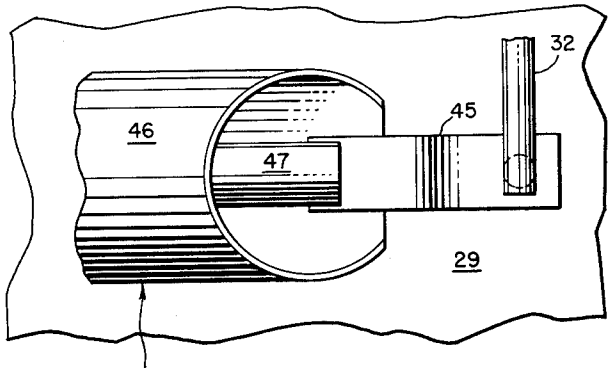
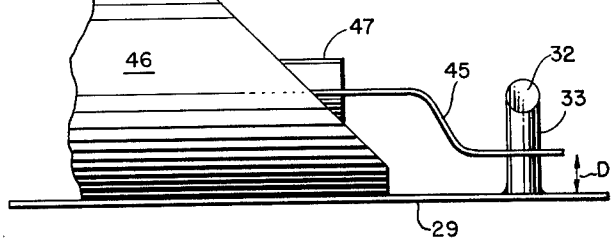


FIG. 3

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FIG. 4



INVENTOR.
LEE R. WHITE

BY

ATTORNEY

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ANTENNA FEEDING SYSTEM

Lee R. White, 2118 University Ave., Madison, Wis.

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This invention relates to a coupling system for the transfer of radio frequency energy. While not limited thereto, the invention is particularly useful in the simultaneous transmission or reception of a plurality of signals of different frequencies with a single antenna.

In the past it has been customary to provide each radio frequency translating device (e.g., transmitter and receiver) with a separate antenna. However, the use of radio wave energy has been extended to so many different purposes and the number of units for each purpose has been so increased that in many places it has become physically impossible to provide a separate antenna for each equipment. For example, on shipboard installations thare are a limited number of possible antenna locations which permit desirable directional characteristics. It has, therefore, become necessary to employ one antenna for a plurality of equipments. The use of a single antenna for a plurality of translating devices also has the obvious advantage of economy.

For maximum effectiveness at the higher frequencies, the physical dimensions of an antenna should be properly related with the wavelength of the energy thereon. A single antenna, however, may be suitable for use at any one of a band of frequencies. It is therefore an object of this invention to provide means for coupling a plurality of simultaneously operable transmitters or receivers to a single antenna, the transmitters or receivers being tuned to different frequencies.

It is another object to provide means for coupling differently tuned transmitters or receivers to a common antenna without interference by one transmitter or receiver with another.

It is a further object to provide means for coupling a wave translating device to an antenna in such a manner as to maximize the transfer of energy.

It is a further object to provide coupling means between a wave translating device and an antenna, the coupling device being physically adjustable to present a low impedance to the transfer of energy having the frequency of the translating device and a high impedance to energy of other frequencies.

In pursuance of these and other objects which will be apparent to those skilled in the art, there is provided a coaxial transmission line which is shorted at one end and connected to a load, e.g., an antenna, at the other end. A plurality of wave translating devices are each coupled through an adjustable quarter wave element to a different portion of the transmitter line. The distance of each quarter wave coupling element from the shorted end of the line is adjustable by suitable means, independently and without altering the distance of the remaining coupling elements from the shorted end of the line, to provide optimum transfer of energy between the corresponding wave translating device and the line. When the apparatus is properly tuned, in a manner to be described hereinafter, the plurality of translating devices are simultaneously operable at different frequencies with a single antenna.

A better understanding of the invention may be obtained from the following description of one embodiment taken with the appended drawings wherein:

FIGURE 1 is a coupling system connecting two translating devices and a single antenna.

FIGURE 2 is a perspective view of a single coupling device, parts being broken away to illustrate internal details.

FIGURE 3 is a fragmentary plan view of a part of the coupling device illustrating details of construction.

FIGURE 4 is an elevational view of the same.

Referring now in greater detail to the drawings, and in particular to FIG. 1 the invention is shown as applied to a single antenna **10** coupled to a plurality of wave translating devices **11** and **12**. The antenna **10** is connected to one end **13** of a coaxial line the other end **14** of which is shorted. The coaxial line section **15**, having a solid dielectric, connecting the antenna **10** to a larger 50-ohm coaxial line unit, generally designated **16**, having an air dielectric. The other end of unit **16** is connected by a conventional 50-ohm coaxial line **17** to a second coaxial line unit generally designated **18** which is similar to unit **16**. The other end **14** of unit **18** is shorted.

The coaxial line units **16** or **18** include enlarged stationary end sections **20** and **21** provided with conventional tapered transition sections **22** and **23** for connection with coaxial lines **15** and **17**. An intermediate tubular section generally designated **25** of the coaxial line unit **16** is telescopically engaged with the end sections **20** and **21**, thereby permitting longitudinal displacement of the intermediate section **25** along the line unit **16**. It is to be understood that both the inner and outer conductors of the enlarged section **25** are telescopically engaged with the inner and outer conductors, respectively, of the end sections **20** and **21**.

An intermediate portion **26** of the outer conductor of line section **25** is enlarged to provide a coupling cavity. In FIG. 1 and also in the perspective view of FIG. 2, the enlarged portion **26** is shown as a metallic rectangular box **27** constructed around the outer conductor of line section **25**. A semi-cylindrical portion of the part of the outer conductor of line section **25** within the box **27** is cut away leaving a semi-cylindrical shell **28**. The lower wall **29** of box **27** extends tangentially from the lower edge of the shell **28**.

A coupling element **30** is disposed in the box **27** adjacent the exposed side of the inner conductor **31** of line section **25** and in parallel relation with the conductor **31** and the wall **29**. One end of the main portion **32** of the coupling element **30** is electrically connected with the wall **29** of box **27** by a post **33** of conductive material. The other end is securely supported by a post **34** of insulating material. An extensible portion **35** of the coupling element **30** is telescopically engaged with the main portion **32** to permit adjustment of the effective electrical length of the coupling element. Normally, the coupling element **30** will be adjusted in length to approximately one-fourth the wavelength of the energy to be coupled. An adjusting extension rod **36** of an insulating material is connected to one end of the extensible portion **35**, the other end of rod **36** extends outside the box **27** and is provided with a hand knob **37**. Calibrations **38** on the rod **36** are provided for reading against the edge **39** of the box **27** or any suitable pointer.

The wave translating device **12** is connected to the coupling element **30** by means of a flexible coaxial line **42**, an air filled coaxial coupling line **43** which extends through the side wall **44** of box **27** into the interior thereof, and a strap **45**. As shown to advantage in FIGURES 3 and 4, the coupling line **43** is disposed with its outer conductor **46** adjacent to the bottom wall **29** of box **27**. The end of the outer conductor **46** is beveled and the inner conductor **47** is slotted to receive the conductive strap **45**. The strap **45** is appropriately formed to make contact with the post **33** at a short distance D from the wall **29** of box **27**.

The entire intermediate conductor section **25** of the coaxial line unit **16** is longitudinally adjustable in position

on the stationary end sections **20** and **21** by means of screw rod **50** journaled in brackets **51** and **52**. A nut **53** is in threaded engagement with the screw rod **50** and is fixed to the intermediate section **25** of the unit **16**. A crank handle **54** permits manual adjustment of the position of intermediate section **25** without changing the length of the coaxial line unit **16**. Calibrations **55** on the end section **21** may be read against the edge **56** of the intermediate section **25**.

Coaxial line unit **18**, for wave translating device **11**, is the same in construction as coaxial line unit **16**. It is to be understood than any reasonable number of coaxial line units may be interposed between antenna **10** and short circuit **14**. It will be noted that the adjustment of the position of the intermediate line section **25'** of unit **18** does not alter the distance of intermediate line section **25** of unit **16** from the shorted end **14** of the composite line. Since each coupling element is fixed to its corresponding intermediate line section, the construction shown permits the independent adjustment of the distance of any one of a plurality of coupling elements from the shorted end **14** of the composite line without disturbing the corresponding distance of the other coupling elements. The distance of a coupling element from the shorted end of the line in terms of wavelength affects the degree of energy transfer between the element and the antenna. The positions of maximum energy transfer for any one frequency are about one-half wavelength apart along the line.

Each coupling element **30** is normally adjusted in length to substantially one-quarter wavelength at the frequency of the corresponding wave translating device. There is a high impedance to the coupling of energy of any other frequency than that to which the coupling element is tuned. Therefore, energy of several different frequencies may be simultaneously present on the line and energy of each frequency will be coupled by a correspondingly tuned coupling element substantially as though there were no other energy or coupling elements on the line.

A system constructed in accordance with the teaching of this invention for use with four translating devices simultaneously oeprable in the range of frequency values from 200 to 400 megacycles functioned satisfactorily and will be described. Conventional 50-ohm coaxial transmission lines **15** and **17** were connected to 50-ohm air dielectric transmission lines **20** and **21** having an outside diameter of 1⅝ inches. The rectangular metal box **27** was 18 x 5 x 4½ inches in size. The two telescoping sections between which the rectangular metal box is located was capable of moving 13 inches; thus a total change of 26 inches in the line length or one-half wavelength at 230 megacycles is possible on each side. Intermediate line section **25** was of sufficient length on either side of box **27** to cover the entire exposed section of inner conductor **31** at either extreme position of adjustment and to still maintain permissible maximum adjustment.

The optimum spacing between the centers of the inner conductor **31** and the coupling element **30** was found to be 1½ inches in this frequency range. The center line of the coupler **30** was $1\frac{3}{16}$ inches above wall **29** of box **27**. In order that the composite line have a continuous 50-ohm impedance from the antenna **10** to the shorted end **14**, the diameter of the exposed portion of the inner conductor **31** within the box **27** is preferably increased. The strap **45** was connected to the coupler post **33** at a distance D of about $\frac{9}{32}$ of an inch from the wall **29** of box **27**. While it might be desirable to have the dimension D adjustable, it was found not to be necessary. Decreasing the dimension D decreased the range of frequencies of energy that would be transferred between the coupling element **30** and the line, and increased the criticalness of adjustment. It was determined that a plurality of signals having a frequency separation of 5 percent or more could be simultaneously present in the system without interfering with each other.

While a presently preferred embodiment of the invention has been shown and described in some detail, it will be understood that modifications and changes as will be known to those skilled in the art may be made without departing from the spirit of the invention as defined in the 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.

What is claimed is:

1. A system for coupling a plurality of radio wave translating devices which are tuned to different frequencies to a single antenna, comprising: a coaxial line shorted at one end and connected to the antenna at the other end, the outer conductor of said line including a plurality of enlarged sections forming a like member of cavities through which the inner conductor of said line passes, a quarter wave coupling element for each translating device in a corresponding one of said enlarged sections and in electrical coupled relation to said inner conductor, means for adjusting the length of each coupling element and means for adjusting the distance of each coupling element from the shorted end of the line.

2. A system for simultaneously coupling a plurality of wave translating devices of different frequencies to a single antenna, comprising: a coaxial transmission line shorted at one end and connected to the antenna at the other end and including a plurality of intermediate telescoping sections adjustable in distance from the shorted end of the line without changing the total length of the line, a part of the outer conductor of each intermediate telescoping section being enlarged, a coupling element therein parallel with the inner conductor and connected at one end to the enlarged outer conductor, and separate connecting means between each translating device and a point on its corresponding coupling element.

3. In a system for coupling a wave translating device to an antenna, a coaxial line having a semi-cylindrical portion of the outer conductor cut away exposing the inner conductor, a conductive sheet extending tangentially from one cut edge of the outer conductor, a quarter wavelength coupling element connected at one end to the conductive sheet and extending in parallel spaced relationship with the conductive sheet and the exposed inner conductor, and a connector between the translating device and a point on the coupling element.

4. In a system for coupling a wave translating device to an antenna, a coaxial transmission line shorted at one end, the coaxial line including end portions and an intermediate portion telescopically engaged therewith, crank means for varying the position of the intermediate portion of the line relative to the shorted end without changing the total length of the line, a part of the outer conductor of the intermediate portion of the line being enlarged, a coupling element therein parallel with the inner conductor and connected at one end to the outer conductor, and connecting means between the translating device and a point on the coupling element.

5. A system for simultaneously coupling a plurality of electrical devices operative at different frequencies to an antenna comprising a coaxial line having a given predetermined length, means coupling said antenna to one end of said line, said line including a plurality of intermediate portions having an enlarged outer conductor, a respective coupling element comprising a resonant length conductor and located in the cavity enclosed by each of said enlarged portions parallel to and in electrical coupled relation to the inner conductor of said coaxial line, means electrically connecting each of said electrical devices to a respective coupling element, means for saparately moving each enlarged coaxial line portions and the coupling elements therein relative to one end of the line without changing the overall length thereof.

6. A system for simultaneously coupling a plurality of electrical devices operative at different frequencies to an

antenna comprising a coaxial transmission line including a plurality of separated intermediate telescoping sections separately adjustable in distance from one end of said line without changing the overall length thereof, means connecting said antenna to one end of said coaxial line, each of said telescoping sections including a portion having an enlarged outer conductor, respective coupling elements resonant to a different frequency located in the cavity enclosed by each of said enlarged portions in electrical coupled relation to the inner conductor of said coaxial line, means electrically connecting each of said electrical devices to a different one of said coupling elements.

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ELI LIEBERMAN, *Acting Primary Examiner.*

DAVID J. GALVIN, JAMES L. BREWRINK, NORMAN H. EVANS, *Examiners.*

G. S. BLACK, F. M. STRADLER, A. D. MESSENHEIMER, *Assistant Examiners.*