July 29, 1952 R. V. POUND 2,605,399

ULTRAHIGH FREQUENCY MIXER

Filed Sept. 27, 1945

FIG. 1

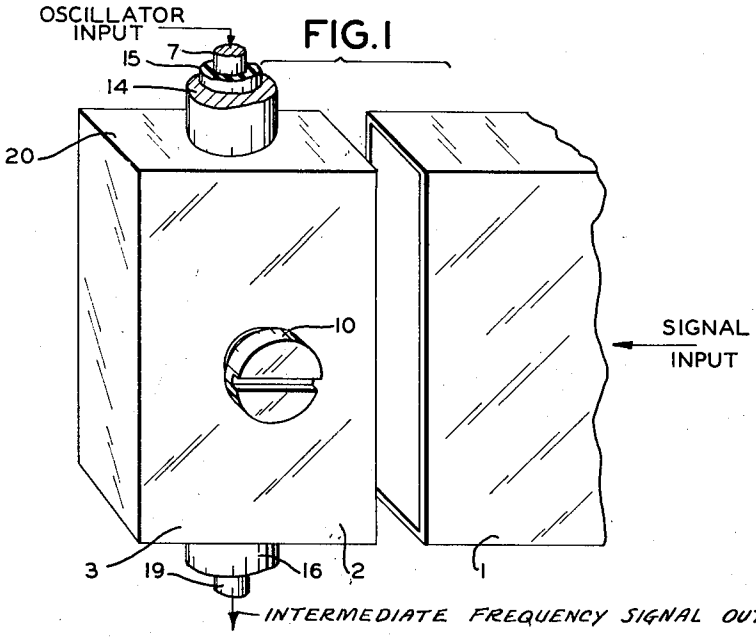
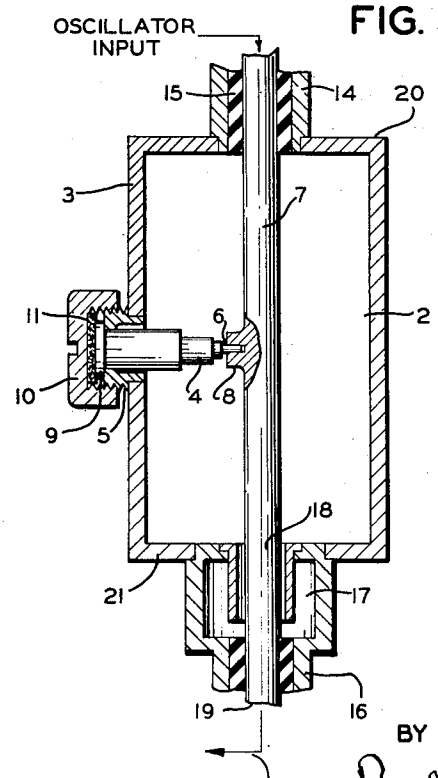


FIG. 2



INVENTOR
ROBERT V. POUND

BY

Ralph L. Chappell

ATTORNEY

Patented July 29, 1952

2,605,399

UNITED STATES PATENT OFFICE

2,605,399

ULTRAHIGH FREQUENCY MIXER

Robert V. Pound, Cambridge, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

Application September 27, 1945, Serial No. 618,978

4 Claims. (Cl. 250—20)

1

This invention relates to mixers of electromagnetic waves and more particularly to a mixer whose mixing cavity has a cross-conductor, at one end of which electromagnetic energy is coupled in and at the other end of which energy of the desired output frequency is coupled out.

The conventional crystal mixer at frequencies of the order of 3000 megacycles per second uses a section of tuned coaxial line as the mixer cavity. The crystal is set into the coaxial tube with one end in series with the inner conductor of the coaxial line and the intermediate frequency comes out the other end of the crystal through what amounts to a series-tuned circuit. Signal coupling from a wave guide can be made through a slot or loop in the coaxial tube, coupling to the T-R box, or by a coaxial line to waveguide adaptor. Oscillator coupling is by means of a probe. Impedance matching devices are built in to effect maximum signal power transfer. The construction is complex and adjustments upset matching.

The present invention provides a mixer of simple construction which is fixed tuned, passes a broad band of frequencies, and requires a minimum of matching. It can be connected directly across a wave guide carrying signal energy, thus, eliminating the need for a special coupling device such as a coaxial line to waveguide adaptor, which adaptor is often used when the conventional mixer described above is used.

An object of this invention is to provide a mixer which is fixed tuned, broad banded and matched for maximum power signal transfer, and allows adequate beating oscillator coupling.

Another object is to provide a mixer of simple construction, which can be connected directly across a wave guide carrying signal energy, eliminating the need for special coupling devices.

These and other objects and features of this invention will become apparent upon consideration of the following detailed description when taken together with the accompanying drawings, the figures of which illustrate a typical embodiment of this invention.

Fig. 1 shows in perspective how the mixer connects to a wave guide carrying the signal input.

Fig. 2 is a sectional view of the mixer looking at the end which can be connected directly to a wave guide of the same cross-sectional dimensions.

In Figure 1, rectangular wave guide 1 carries input signals of electromagnetic energy into mixer 2 in the direction of the longitudinal axis.

2

The electric vectors of the signal waves are in the transverse plane of the wave guide and are perpendicular to the broad face 3 of the mixer 2. In Figure 2, a conventional crystal assembly 4 is suspended in crystal holder 5 mounted in the broad face 3 of mixer 2. The crystal assembly 4 is lined up parallel to the electric vectors with its metallic tip 6 in electrical contact with cross-conductor 7, being held by metallic fingers 8. The head 9 of the crystal assembly 4 is in electrical contact with the crystal holder 5 which in turn is in electrical contact with the broad face 3 of mixer 2. The crystal holder cap 10 screws on the crystal holder 5 to hold the crystal tip 6 in firm electrical contact with fingers 8. A felt strip 11 is between the crystal head 9 and the cap 10.

Cross-conductor 7 at its upper end is an extension of the central conductor of coaxial line section 14 into which the oscillator input is coupled, coaxial line 14 has insulation 15 between inner and outer conductors. Cross-conductor 7 at its lower end extends to become the central conductor of coaxial line section 16 by which the beat frequency signal output is taken from the mixer 2. A folded half-wave choke 17, half-wave at signal frequency, presents a short circuit to signal and oscillator frequencies at point 18 where conductor 7 leaves mixer 2 and thus only the beat frequency signal appears at the signal output 19.

The location of conductor 7 with respect to the longitudinal and transverse axes of the mixer 2 is fixed for a desired frequency range so as to provide signal matching to the wave guide 1, and thus provides maximum power transfer. It will be noted that the position of coaxial lines 14 and 16 with respect to the narrow faces 20 and 21 and of the crystal assembly 4 with respect to the broad face 3 of mixer 2 are dependent on the location of cross-conductor 7.

In brief then the operation of the mixer is as follows. Electromagnetic wave radiation from wave guide 1 of signal frequency is directly coupled into mixer 2. Oscillator input energy from coaxial line 14 is coupled into mixer 2 as electromagnetic wave radiation at oscillator frequency through cross-conductor 7 extending through mixer 2. The resultant electromagnetic wave radiation in mixer 2 will impress a resultant frequency voltage signal across crystal assembly 4, which voltage signal is modulated at an intermediate or beat frequency. The beat frequency signal comes out of cross-conductor 7 through coaxial line 16 with choke 17 acting

to short out the signal and oscillator frequencies from appearing in the output coaxial line 16.

The mixer is inherently broadbanded because it has no resonant elements or frequency sensitive dimensions.

Although there is shown and described only a specific mixer which is an embodiment of this invention, the many modifications possible thereof will be readily apparent to those familiar with the art. Therefore, this invention is not to be limited except insofar as is necessitated by the prior art, and the spirit of the invention.

What is claimed is:

1. A mixer comprising, a cavity resonator, a conductor extending through said resonator, means including said conductor for introducing electromagnetic wave energy into said resonator, additional means for introducing electromagnetic wave energy into said resonator, means including said conductor for extracting a signal from said resonator and means conductively connected between the wall of said resonator and said conductor for detecting the beat frequency of the electromagnetic wave radiation in said resonator.

2. A mixer comprising, a cavity resonator formed of a section of rectangular wave guide having broad and narrow walls, a cylindrical conductor extending through said resonator between the narrow walls thereof, means for introducing electromagnetic wave energy into said resonator, the electric vectors of which are normal to the broad walls of said resonator, means including said conductor for introducing local oscillations into said resonator, a crystal cartridge electrically connected between one broad wall of said resonator and said conductor for detecting the beat frequency of said wave energy and said local oscillations, and means including said conductor for extracting a beat frequency signal from said resonator.

3. A mixer comprising, a cavity resonator formed of a section of rectangular wave guide having broad and narrow walls, a cylindrical conductor extending through said resonator between the narrow walls thereof and insulated therefrom, rectangular wave guide coupling means for introducing electromagnetic wave energy into said resonator, the electric vectors of said wave energy being normal to the broad walls of said resonator, a first coaxial line including said conductor as the inner conductor for introducing local oscillations into said resonator, a crystal cartridge electrically connected between one broad wall of said resonator and said conductor, said cartridge being positioned substantially equidistantly between the narrow walls of said resonator and oriented substantially parallel to the electric vectors of said wave energy, and a second coaxial line including said conductor as the inner conductor for extracting a beat frequency signal from said resonator.

4. A mixer comprising, a cavity resonator formed of a section of rectangular wave guide closed at one end and having broad and narrow walls, a cylindrical conductor extending across said resonator between the narrow walls thereof and insulated therefrom, wave guide coupling means arranged adjacent the other end of said resonator for coupling electromagnetic wave energy at a signal frequency into said resonator, the electric vectors of said wave energy being normal to the broad walls of said resonator, a first coaxial line including said conductor as the inner conductor connected to one narrow wall of said resonator for coupling local oscillations into said resonator, a crystal cartridge electrically connected between one broad wall of said resonator and said conductor for detecting the beat frequency of said signal frequency and said local oscillations, said cartridge being positioned substantially equidistantly between the narrow walls of said resonator and oriented substantially parallel to the electric vectors of said wave energy, a second coaxial line including said conductor as the inner conductor connected to the other narrow wall of said resonator for extracting a beat frequency signal from said resonator, and filtering means cooperatively arranged with said second coaxial line to permit the transmission of only said beat frequency signal along said second coaxial line.

ROBERT V. POUND.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
2,142,159	Southworth	Jan. 3, 1939
2,408,420	Ginzton	Oct. 1, 1946
2,423,390	Korman	July 1, 1947
2,436,830	Sharpless	Mar. 2, 1948
2,451,876	Salisbury	Oct. 19, 1948
2,469,222	Atwood	May 3, 1949

FOREIGN PATENTS

Number	Country	Date
116,110	Australia	Nov. 19, 1942