May 30, 1939. W. RUNGE 2,160,088

BAND PASS FILTER

Filed Nov. 8, 1934

FIG. 1.

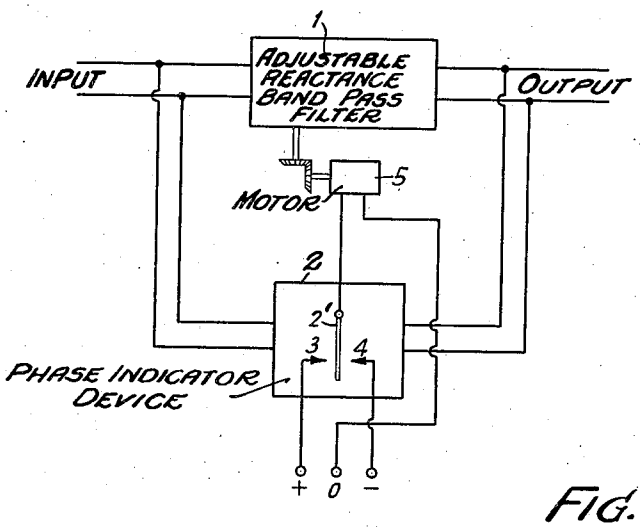


FIG. 3.

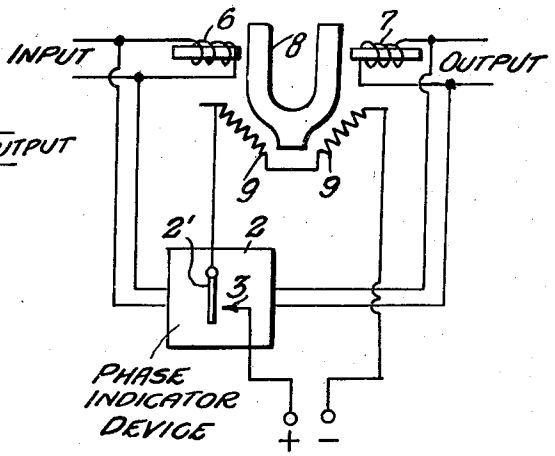
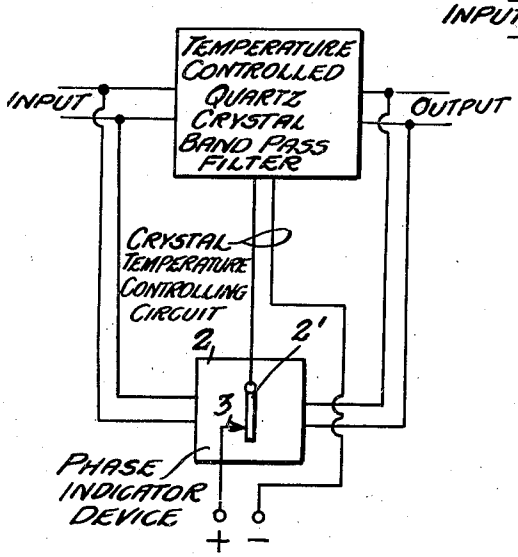


FIG. 2.



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BAND PASS FILTER

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6 Claims. (Cl. 178—44)

This invention relates to an improved band pass filter with means for varying its normal invariable wave length, especially designed for narrow frequency bands.

In the communication arts there frequently arises the demand for a filter adapted to filter or separate from a frequency mixture or spectrum a definite frequency or a very narrow range or band of frequencies, while cutting off or suppressing all other frequencies as thoroughly as feasible. For this purpose, oscillation or resonance circuits or complicated filter chains and filters of a kind known in the earlier art are perfectly suited. However, if for some reason or another the entire frequency band is shifted, the result is that the unvaried or invariable filter separates a wrong frequency range. In fact, in instances of this kind, re-adjusting of the filter is necessary. If the transmission range of the filter is large compared with occurring frequency shifts, this case will not arise. But if the range or band to be transmitted is extremely narrow, for example, if the filter is to be employed for the purpose of filtering from the aggregate frequency spectrum coming in from a station the carrier or the like, the case will often arise where for reasons of a slight frequency change the particular frequency to be filtered out of the spectrum falls out of the range of transmission of the filter. Manual alterations in the filter itself are liable to lead to the identical result. Instead of making re-adjustment by hand in cases of this kind, the suggestion is made according to this invention to insure the re-setting automatically. Fundamentally speaking, such an automatic device may be built in the manner set forth in the following detailed description which is accompanied by a drawing in which Figure 1 shows an embodiment of the invention while Figure 2 shows a modification thereof and Figure 3 shows a further modification.

Referring to Fig. 1, 1 denotes the filter actuated by means of the tuned circuit coupling elements being arranged, 2 is a means to indicate phase differences. This indicator device 2 is actuated by means of the tuned circuit coupling elements being arranged with the oscillations being slightly detuned ahead and above that of the normal tuning of the filter so that it changes the phase difference between the input and the output of the filter inside the range of transmission with the frequency to a marked degree, the filter circuit arrangement 1 may be so chosen that for frequencies whch fall in the middle of the range of transmission of the filter, the needle 2′ of the phase indicator device 2 will be in the position of rest or in neutral, while for higher frequencies it indicates or deflects in one direction, and for lower frequencies in the opposite direction. The indicator device 2 by the intermediary of two contacts 3 and 4 controls the direction of rotation of a motor 5 which, in turn, sets a variable element of the filter 1 until the center of its band-pass range again coincides with the desired working frequency. Instead of adjusting the variable element of the filter mechanically by the rotation of motor 5, it is feasible to connect or disconnect the circuit by means of contacts 3 and 2′ of the phase indicator device 2, for example, a heater body or element located adjacent a quartz crystal of the filter whose frequency is altered by a heater so that the band-pass transmitted by the filter may be shifted by an increase or decrease of temperature as shown in Figure 2. This latter method is particularly recommendable whenever the filter has very low thermal capacity so that it will be rapidly affected by and respond to fluctuations in the temperature of the ambient, for instance, as in the case where resonators used in the filter consist of piezo-electric quartz crystals.

A further modification of the invention is shown in Figure 3 wherein the bandpass filter comprises a pair of reactive impedances 6, 7, coupled by tuning fork 8. The resonant frequency of the fork 8 varies with the temperature so a heating element 9 is placed adjacent to the fork in order to vary the frequency passed through the band-pass filter. The heating element 9 is connected to or disconnected from the power supply +, — by means of stationary contact 3 and movable contact 2′ of the phase indicator device 2 in the same way as in the modification of Figure 2.

The present arrangement is substantially useful in connection with line-synchronized chain broadcasting. If a control frequency falling inside the audible range is transmitted from the master broadcast station over a wire line to the subsidiary station, and if the incoming frequency is there multiplied up to the radiating high frequency, then slight and irregular phase shifts occurring on the line are appreciably amplified by the frequency multiplication and they will later appear in the operation of a chain of transmitter stations inside districts of joint reception in the form of disturbing noises. Providing a narrow band-pass filter, say, with a tuning fork at the output end of the line in order to smooth down these sudden leaps or shifts, then it will be extremely difficult to keep the transmission or band-

pass filter sufficiently constant if selectance is to be kept adequately good. It will be noted that if the transmission filter is chosen so narrow that by its action undesired disturbance will be cut off dependably, great difficulties will be encountered in the attempt to push the constancy of the filter so high that it will actually keep sufficiently in registry with the incoming frequency. According to present day practice the coupling between the tuning fork and the line is made so close that even appreciable departures between the natural frequency of the tuning fork and the incoming frequency will not occasion any disturbances in operation. By the use of the idea underlying this invention, namely, of automatically influencing the frequency of the tuning fork in such a way that it will always register with the incoming line frequency, the said difficulties are obviated.

I claim:

1. A band-pass transmission circuit including a filter having reactive impedance elements at least one of which is variable to vary the normal frequency of said circuit, an input and an output for said circuit, a phase indicator connected between said input and output and means actuated thereby for varying said variable element.

2. A band-pass transmission circuit including a filter having reactive impedance elements at least one of which is variable to vary the normal frequency of said circuit, an input and an output for said circuit, a phase indicator connected between said input and output, and mechanical means actuated thereby for varying said variable element.

3. A band-pass transmission circuit including a filter having reactive impedance elements at least one of which is variable in response to a variation in temperature to vary the normal frequency of said circuit, a heating element located adjacent said variable element, an input and an output for said circuit, a phase indicator connected between said input and output, and means actuated thereby for varying the temperature of said heating element.

4. A band-pass transmission circuit including a filter having reactive impedance elements at least one of which is variable to vary the normal frequency of said circuit, said variable element comprising a quartz crystal and a heating element located adjacent thereto, an input and an output for said circuit, a phase indicator connected between said input and output and means actuated thereby for varying the temperature of said heating element.

5. A band-pass transmission circuit including a filter having reactive impedance elements at least one of which is variable to vary the normal frequency of said circuit, said variable element comprising a tuning fork and a heating element located adjacent thereto, an input and an output for said circuit, a phase indicator connected between said input and output and means actuated by said phase indicator for varying the temperature of said heating element.

6. A transmission band-pass filter having input and output circuit, a filter having reactive impedance elements at least one of which is variable, said filter coupled to the input and output circuits, means for slightly changing the normal working frequency of said bandpass filter, said means comprising a phase indicating device coupled to said input and output circuits, a fixed electrical contact located at each side of said indicator, a movable electrical contact actuated by said indicator, an electrical rotating device connected to the movable contact of said phase indicator, a source of energy connected between said electrical rotating device and said fixed contacts, and a mechanical coupling between said variable element of said reactive impedance elements and said electrical rotating device.

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