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APPLICATIONS FOR AN ACTIVE FILTER

Most experimenters are familiar with the effects of cascaded phase shifters applied to the feedback loop of an amplifier. A useful feature which ends up as a very sharp filter can be the result.

In most applications it has been used in audio work as an accessory to a receiver for CW work. I have been able to study further the usefulness of this device at audio and radio frequencies and would like to present the results for what they may be worth to other amateurs.

When the interest in Teletype was at its peak at W1SNN, construction of a converter led to many tries until a satisfactory unit evolved.

The unit was similar to the many published designs with the exception of the filter. Two active filters were constructed which were incorporated in the converter and the improved selectivity made copy considerably more legible. A plot of these filters is shown in Fig. 3a. The circuit of the filter is shown in Fig. 1.

The active filter is not restricted to audio frequencies. During the development of the filters, the center frequencies were extended over a range of 2 kHz to 1 MHz.

A Table, Fig. 2, indicates component values for the individual filter electronics; Figs. 3b and c are presented to show the response of plots for single filters and a cascaded pair stager tuned to produce a symmetrical pass band with a very respectable shape factor at 80 kHz.

An overall gain of 40 dB can be achieved by setting potentiometer Ra to a point well below a level which will make the filter regenerative.

Two potentiometers ganged and connected as part of the network marked Rb and Rc can serve to adjust the center frequency of the filter if an adjustable filter is required. To accomplish good tracking of these two potentiometers, it was necessary for their values to be a very small percentage of the total resistance for Rb and Rc. Therefore it goes without much further discussion that wide frequency excursions are not permissible for a fixed filter.

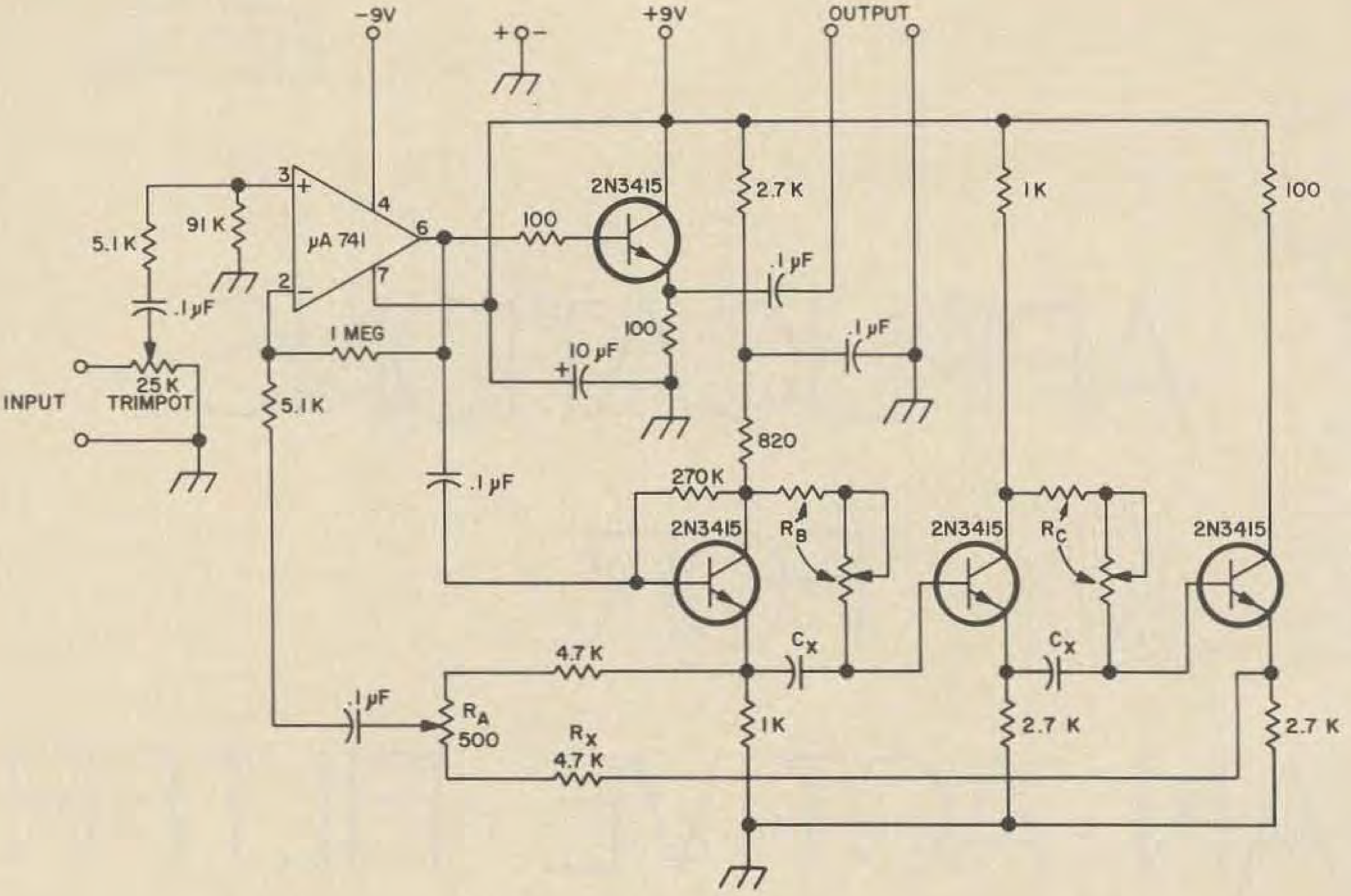

Fig. 1. Phase shift network active filter.

The method just described is used in a receiver where the filters are used in a second conversion (i-f) amplifier. The filter is adjusted so that it passes either a lower or an upper side band by simply a turn of the ganged pots. Selectivity can be sharpened by adjusting Ra for narrow or wide band widths. In my application, a range of 200 Hz to 4 kHz was required.

Some care must be used in construction of these filters at frequencies above 30 kHz. Regeneration will occur if the lead lengths are too long for any of the three potentiometers. It is better to group the pots in a row on a small piece of vector board and build all components around the potentiometers than to run wires to them.

The components used are inexpensive plastic transistors. All resistors and by passes are non-critical. If a frequency above 85 kHz is required a 702 operational amplifier should be used in place of the 741.

The overall gain of each filter is very high (40 dB), therefore, very little signal is required and is controlled by the 25K trim pot at the input of the filter. The output of the filter is decoupled through an emitter follower. In our case a 100Ω output impe-

f, kHz	Rb	Rc	Cx	Gain	3 dB Bandwidth
2.125	200K	200K	370 pF	45 dB	350 Hz
2.975	140K	140K	370 pF	44 dB	380 Hz
10.	50K	50K	330 pF	44 dB	1.4 kHz
50.	10K	10K	300 pF	44 dB	2.4 kHz
60.	11K	11K	300 pF	48 dB	2.0 kHz
85.	15K	15K	100 pF	44 dB	2.0 kHz
100	15K	15K	90 pF	44 dB	2.5 kHz
1 MHz	5K	5K	30 pF	36 dB	4.5 kHz
5 MHz	1K	1K	30 pF	27 dB	8.9 kHz UNSTABLE

Fig. 2. Table of values for a phase shift filter.

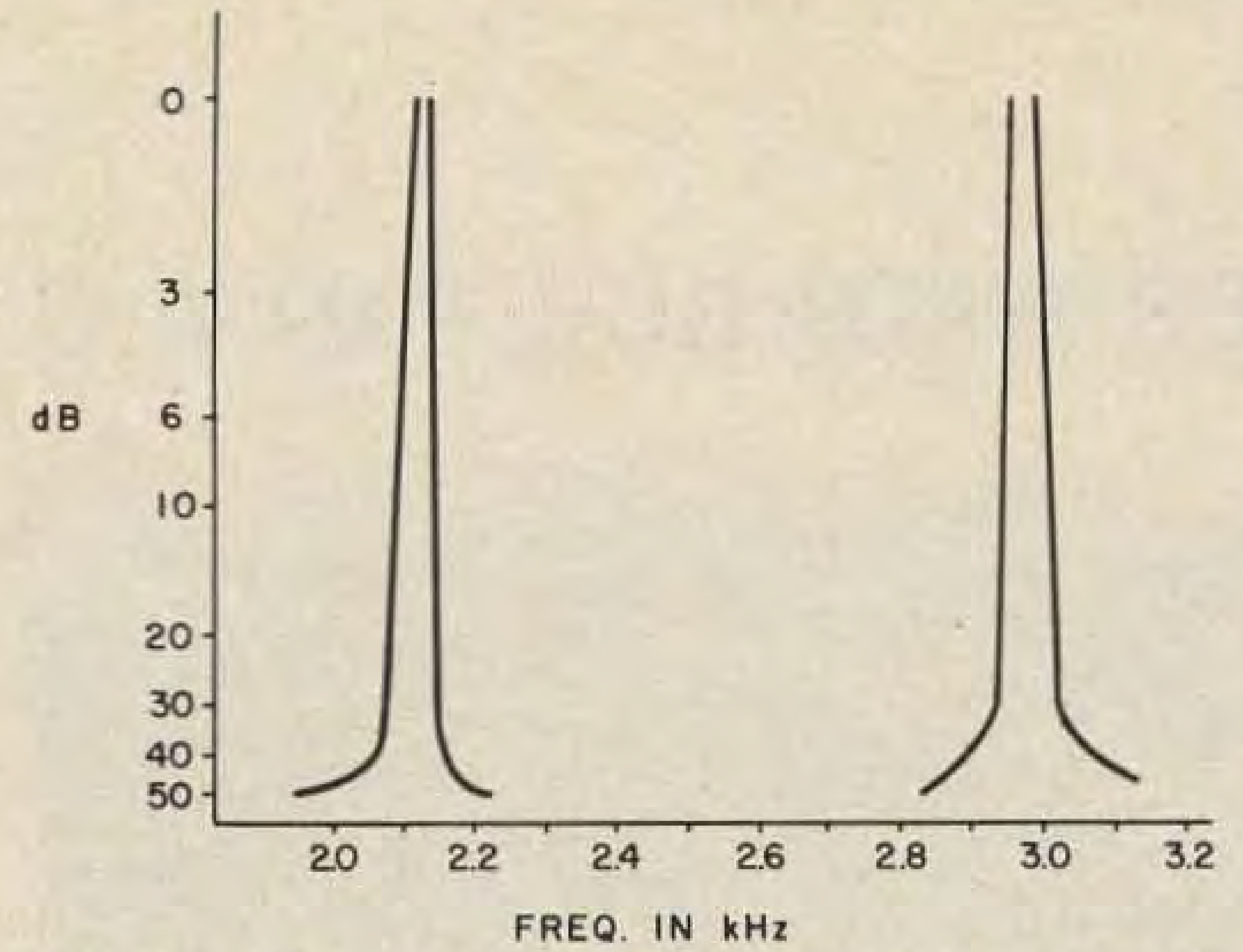

Fig. 3a. Plot of discriminator filter for W1SNN RATT converter.

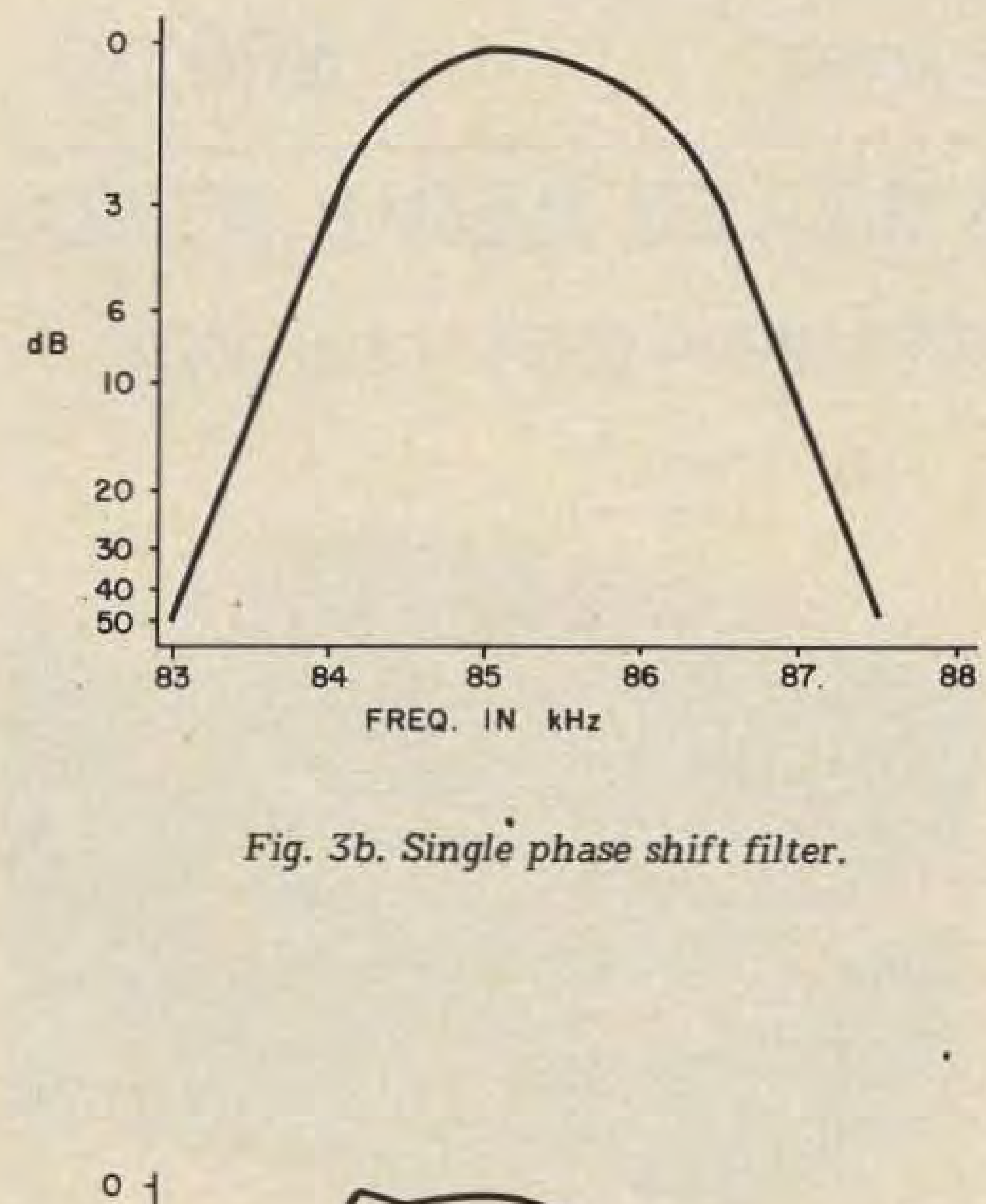

Fig. 3b. Single phase shift filter.

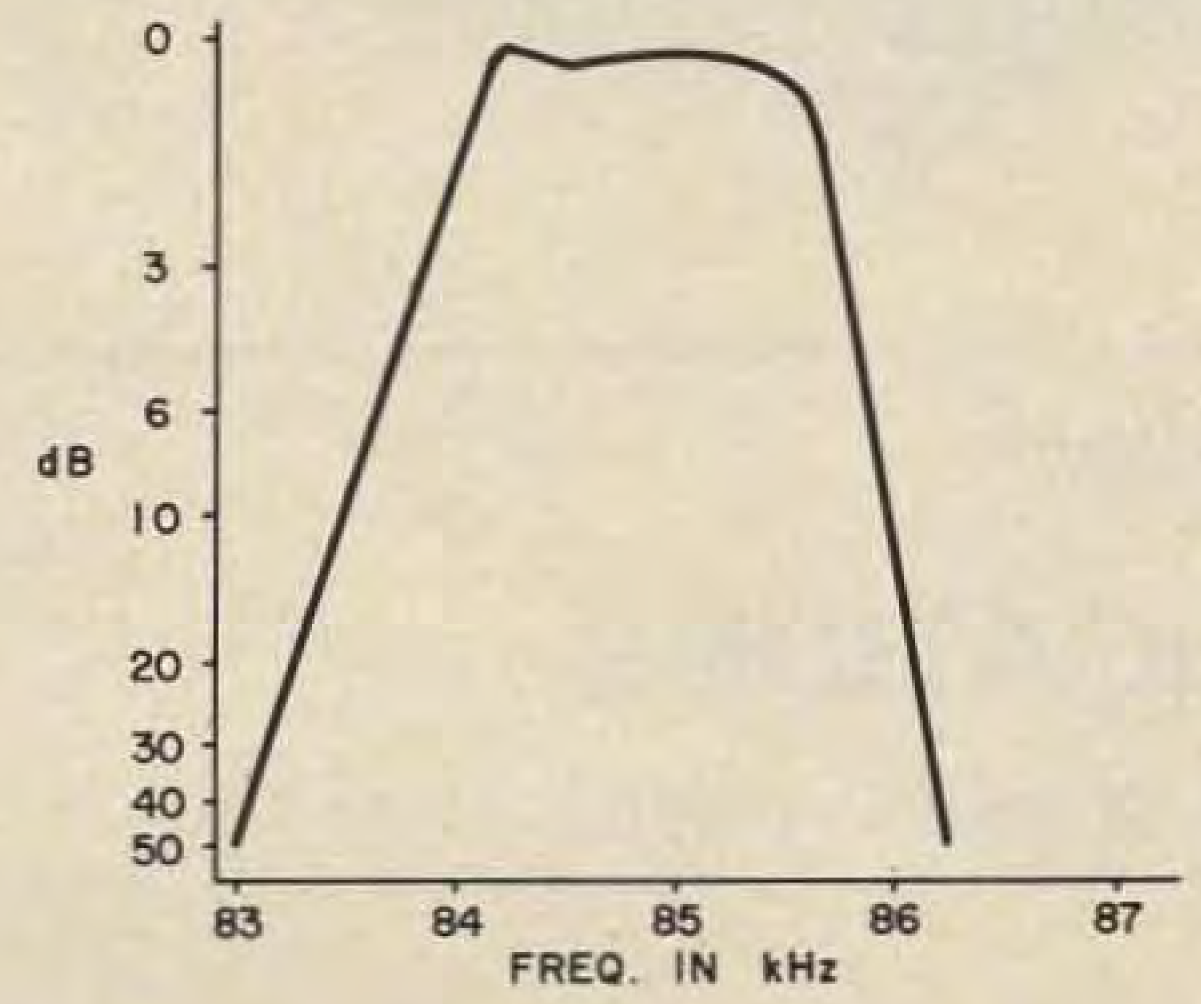

Fig. 3c. Cascaded pair phase shift filter.

dance was required, but higher values can be had by simply changing the value of the emitter resistor.

Do not try to drive a high level signal into this filter, 3 mV in produces 0.3V out, which is sufficient to drive any detector.

A maximum of 12 volts should never be exceeded for the supply voltage; 9 volts is best from a battery since current drawn is very low.

To adjust the filter, first connect a VTVM rf probe to the output; adjust the potentiometers R and Rc to the middle of their ranges; set Ra to about one-third open. If the unit has output with no signal in . . . readjust Ra until it just stops oscillating. Now apply a weak signal from a signal source tuned to the desired center frequency. If no indication of a signal is shown on the meter, sweep the generator slowly through the range of frequencies around the desired frequency. Do not increase the generator level. A signal will be indicated by a very pronounced upswing and over a very narrow range. By adjusting Rb and Rc ganged pots you will be able to center the filter on your desired frequency.

If you find Ra will cause oscillation to occur when it approaches its full-on value, change the value of the series resistor Rx to a higher value, probably, not more than 470Ω more. This adjustment allows control on selectivity or the filter bandwidth before oscillation occurs.

So far we have described only one filter. If a wider bandwidth but a sharper roll off is desired, cascading two of these filters in a stagger tuned configuration will produce the effect.

Greater reduction in signal level will be required. The trim pot at the inputs should be barely open to reduce the input signal for each filter. The use of potentiometers to adjust each filter gets very touchy and fixed values are recommended.

Tune up procedure will be the same as for one filter but now each Rb and Rc value will require trimming each resistor by paralleling with other fixed values.

In this application Ra can be a trim pot set to produce the selectivity response required.

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