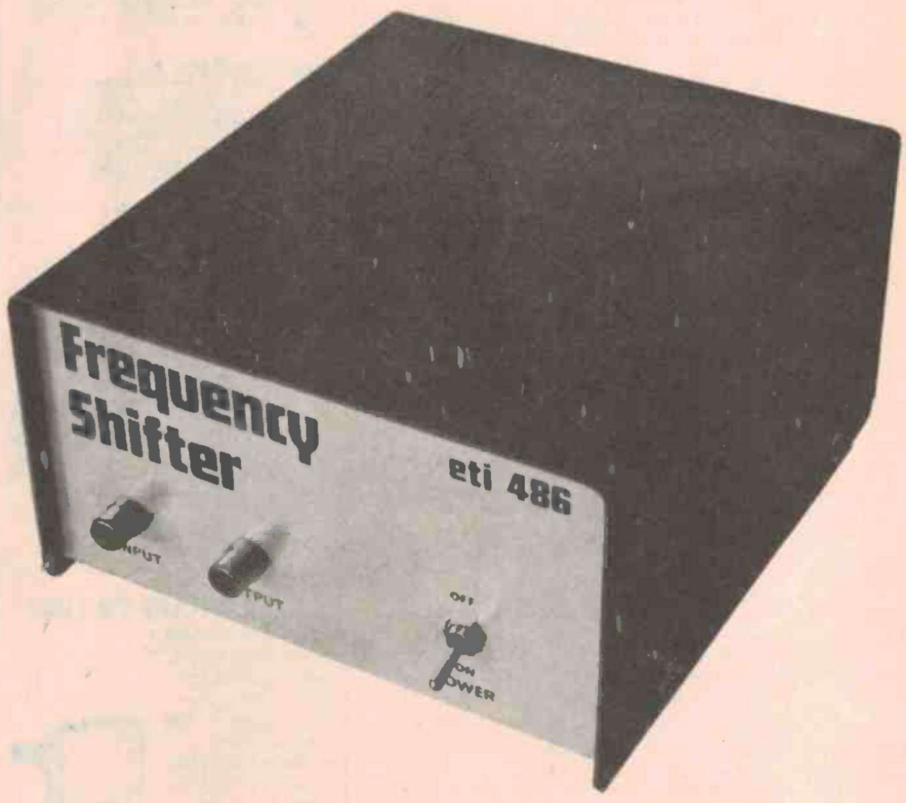
HOWL-ROUND STABILIZER

Feedback problem in halls can be corrected by the use of this clever gadget.

ANYONE WHO HAS USED a microphone in public address work has come across problems with feedback. These are caused by the level of sound reaching the microphone from the speaker approaching or exceeding that from the person originating the sound. As the reflected sound approaches the level of the original signal, the sound becomes distorted or 'coloured', then audible ringing occurs and finally complete oscillation or howl-round occurs as the reflected sound exceeds the level of the original signal.

The most effective method of eliminating this problem in most cases is to use the correct location for the speakers and the correct choice of microphone. Also the use of the microphone is important so if you are in charge of a sound system don't be afraid to tell the singer or speaker how to use the microphone as a good performer will take advice.

However in certain environments the most effective use and selection of microphone/speakers does not help the problem of feedback. These are the halls and rooms which have little sound-absorbing material on the walls and are very 'live'. If a frequency response curve is drawn for such a room it will be found that there are many peaks and troughs, normally only 4 or 5 Hz apart, along with perhaps major resonances.



The printed circuit layout for this project is on page 108.

Solutions

There are various electronic devices which have been developed to deal with this problem, the main ones being the graphic equalizer, the variable notch filter and the frequency shifter. The first two (especially the notch filter) are ideal for eliminating major resonances. These however also alter the frequency response of the original sound. They can also help if the offending 'echo' is actually a direct path and not dependent on the room (i.e. if the speakers are behind the microphone). The other method, frequency shifting, is described here.

With a frequency shifter the echo signal is of slightly different frequency on each path round the loop and cannot directly reinforce itself so that while on the first echo it may strike a room resonance the second time it will probably be in a null. This tends to even out the frequency response of the room and allows 5 to 8 dB higher levels to be used in the average room. Also the onset of howl-round is not as dramatic as with the conventional system and the distortion which normally occurs below the howl-round level is not as noticeable. The system does not however do a great deal for howl-round not associated with room resonances.

Only a small shift is normally required and it does not matter if it is an increase or a decrease. We chose to increase the frequency by about 5 Hz as it is easier to tell if a vocalist is flat rather than sharp. As the frequency response of the unit is good it is suitable for vocal work as well as general public address use. The frequency shift and the slight amplitude modulation cannot be detected by most people.

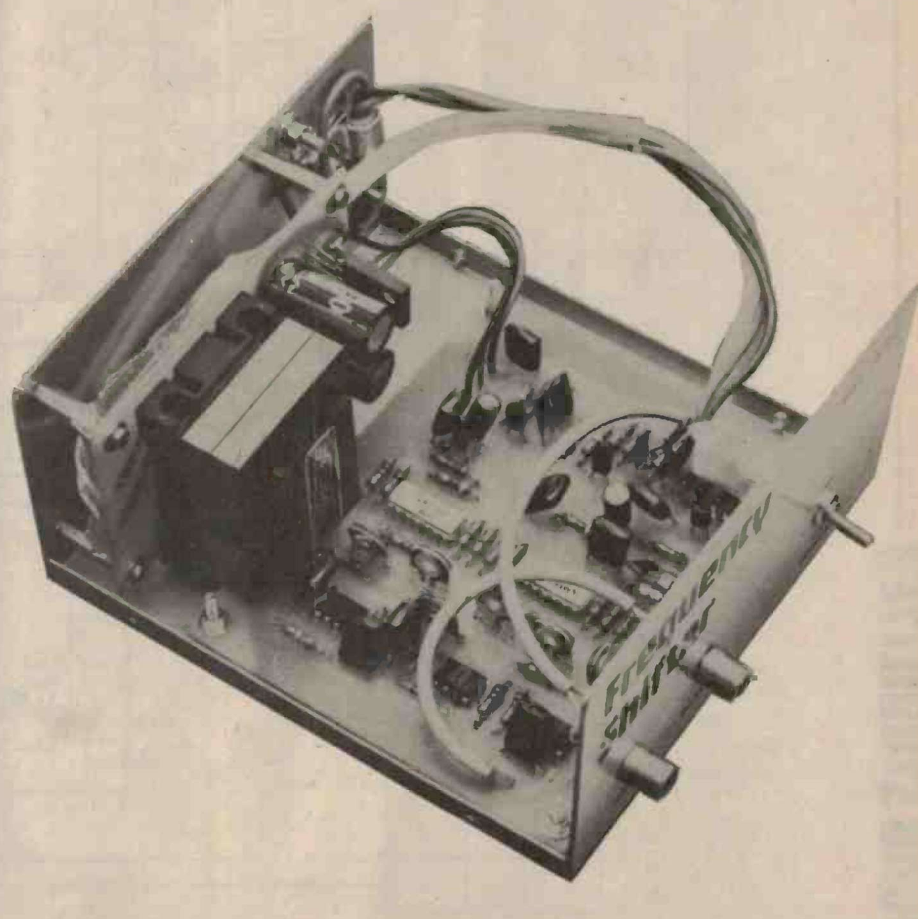
Alignment

Equipment needed – a sensitive AC voltmeter (100 mV or less) or preferably an oscilloscope and an audio oscillator.

1. Check the output of the 5 Hz oscillator and adjust RV1 until it stops. If it cannot be completely stopped, try a link across C9.
2. Apply a signal of about 1 – 2 V amplitude at about 1 kHz to the input and measure the output of IC3 at pin 2. (If your meter does not reject DC, measure at the junction of C17 and R36). Adjust RV3 to give the minimum output.
3. Measure the output of IC4, pin 2 (or the junction of C18 and R37) and adjust RV5 for minimum output.
4. Measure the output of the 5 Hz oscillator on pin 6 of IC1 and adjust RV1 until it starts, then adjust to give about 1.25 V RMS.
5. With no input signal, measure the output of IC3 (or the junction...) and adjust RV2 for minimum output.
6. Measure the output of IC4 (or...) and adjust RV4 for minimum output.
7. If an oscilloscope is available, monitor the output with a 1 – 2 V input signal and adjust RV6 to give the minimum amplitude modulation. Alternatively, by using an amplifier and speaker, RV5 can be adjusted by ear. The unit is now set up.

SPECIFICATION – ETI 486

Frequency shift	5kHz upwards
Maximium input voltage	3V
Frequency response +½ dB, –3dB	30Hz – 20kHz
Signal to noise ration re 3V output	70 dB
Distortion @ 1kHz, 2V out	0.25%
Amplitude modulation	100Hz – 10kHz < 1dB
Phase shift network 50Hz – 20kHz	$90^{o} \pm 5^{o}$



HOWL-ROUND STABILIZER

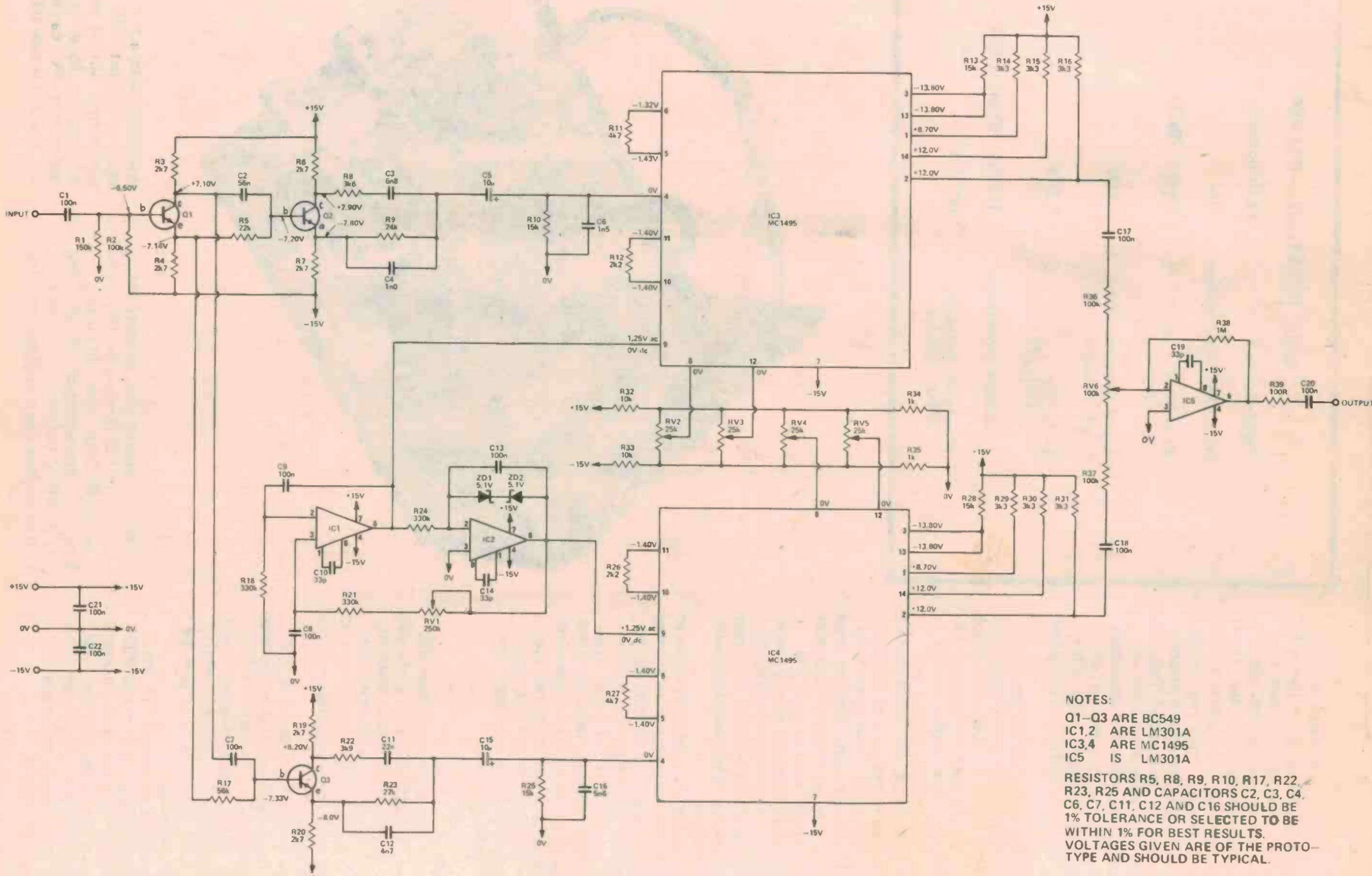


Fig. 1. The circuit diagram of the phase shifter. For the power supply see project ETI 581

NOTES:

Q1–Q3 ARE BC549
IC1,2 ARE LM301A
IC3,4 ARE MC1495
IC5 IS LM301A

RESISTORS R5, R8, R9, R10, R17, R22, R23, R25 AND CAPACITORS C2, C3, C4, C6, C7, C11, C12 AND C16 SHOULD BE 1% TOLERANCE OR SELECTED TO BE WITHIN 1% FOR BEST RESULTS.
VOLTAGES GIVEN ARE OF THE PROTOTYPE AND SHOULD BE TYPICAL.

HOW IT WORKS – ETI 486

There are numerous methods of generating a frequency shift in an audio signal. Most however require coils and precise tuning which rules them out for a project. With this method only resistors and capacitors have to be accurate, yet it gives a result adequate for the purpose.

The audio input is split into two circuits which provide a frequency-related phase shift as shown in Fig. 4. The amplitude however remains constant. Due to the different component values in the two networks the phase shifts are not the same but differ by 90° at all frequencies (50 Hz – 20 kHz +/– 5°).

IC1 and IC2 form a quadrature sine wave oscillator with the frequency set by R18, R21, R24, C8, C9 and C13. Amplitude stability is provided by ZD1 and ZD2 along with RV1 (see adjustment section). The outputs from these two op amps are the same amplitude but 90° phase shifted.

We now multiply (the MC1495 is a four-quadrant multiplier) one of the audio signals by one of the 5 Hz outputs and the second audio input by the second 5 Hz signal. When we multiply two waveforms together the output consists of the sum of the two frequencies and their difference. This means that if the audio signal is 100 Hz the output will contain a 95 Hz signal and a 105 Hz signal. These will beat with each other to produce a 10 Hz beat note as shown in Fig. 2. Due to the phase shift between the inputs of the multipliers the 105 Hz components of the outputs are in phase, while the 95 Hz components are 180° out of phase. Therefore by adding the outputs of the two multipliers in IC5 the 95 Hz components cancel out, leaving only the 105 Hz signal. Provided the multiplier inputs have the 90° phase relationship there will always be a 5 Hz shift, independent of frequency.

Due to the inability to maintain exactly the 90° phase relationship, the 95 Hz, or lower sideband, will not completely cancel and the result is a slight beat giving rise to an amplitude modulation effect (we had about 1 dB). This is not normally noticeable on speech or music.

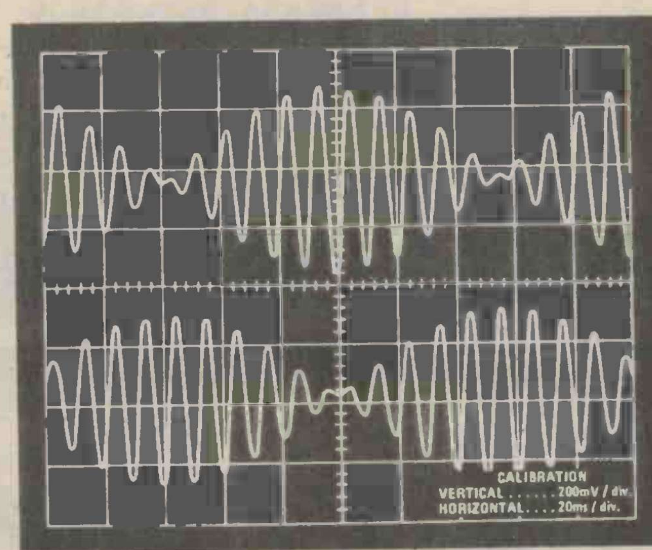


Fig. 2. The output of IC3 (top) and IC4 (lower) with a 100 Hz input signal. Note the phase difference.

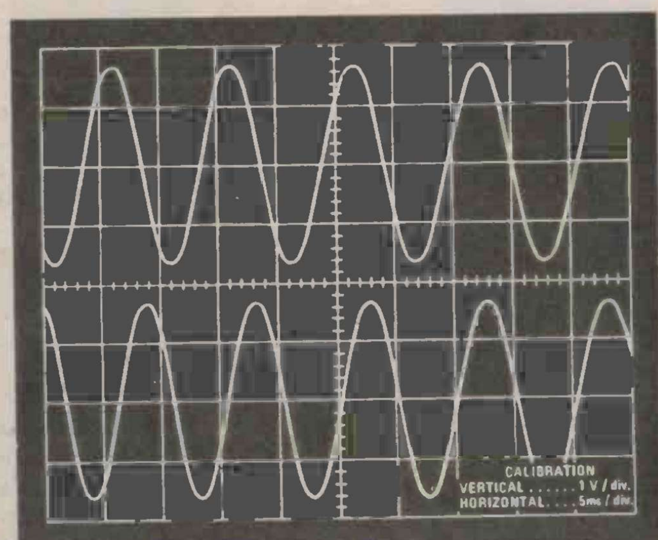


Fig. 3. The input signal (top) and the output (lower). Note the difference in frequency.

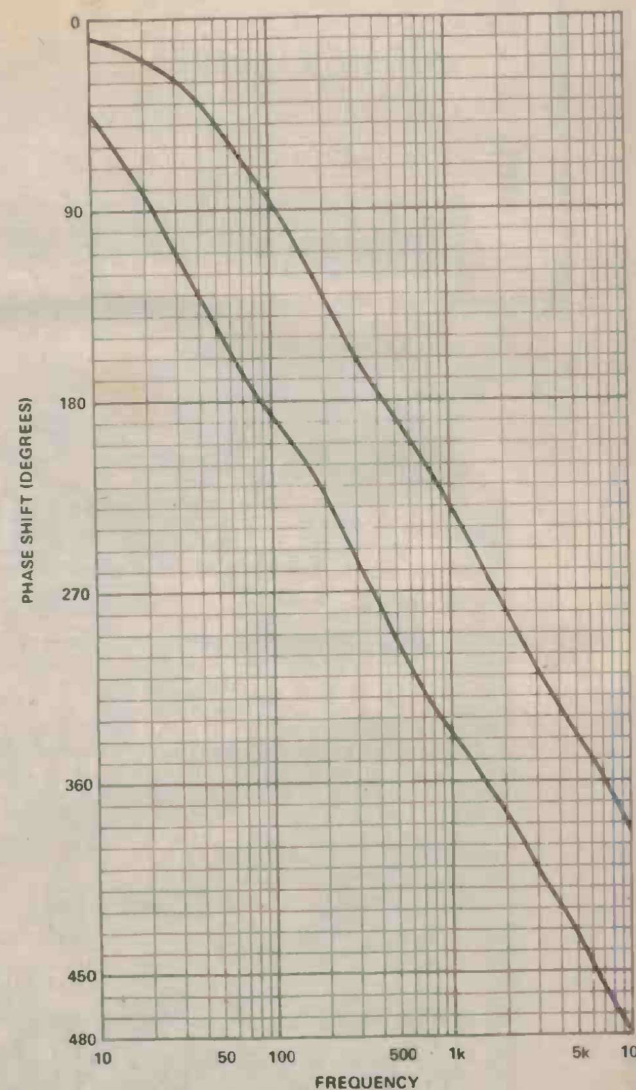


Fig. 4. The phase response of the two filters.

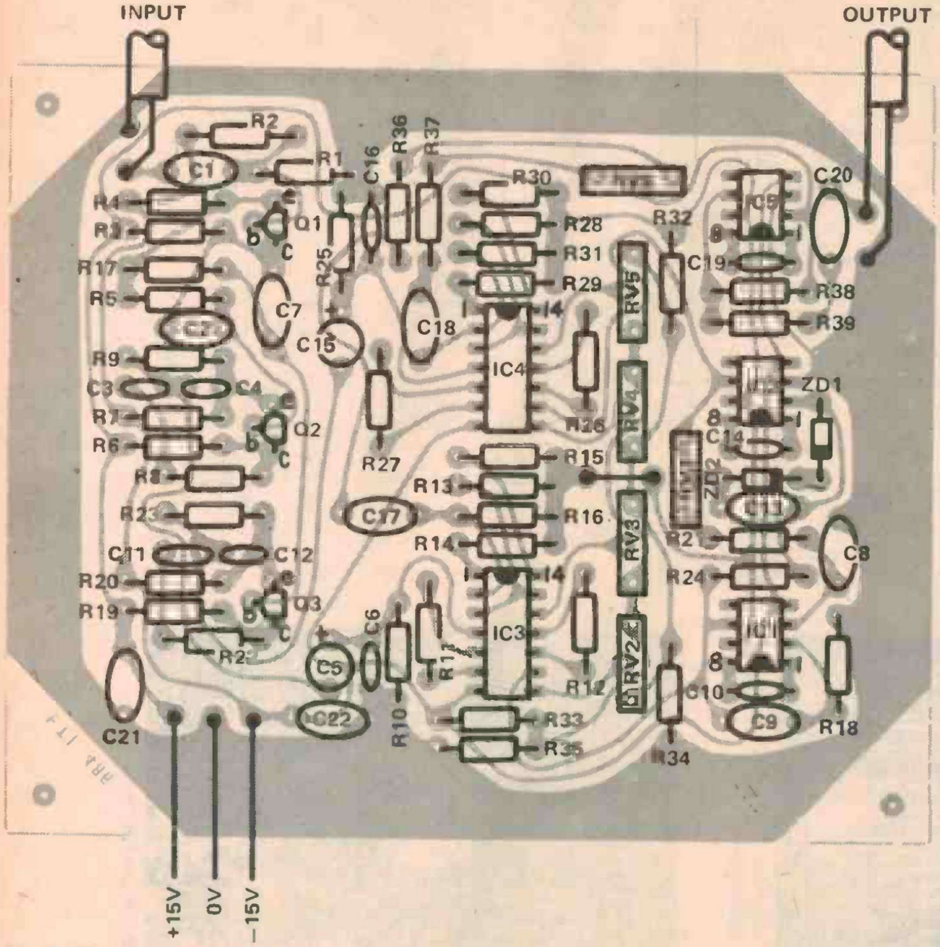


Fig. 5. The component overlay.

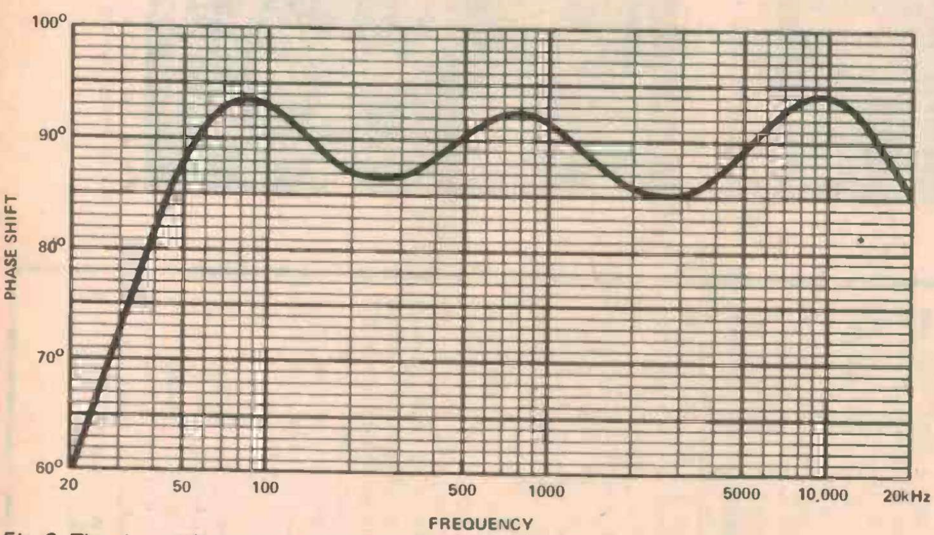


Fig. 6. The phase difference between the two filter networks.

PARTS LIST – ETI 486

Resistors all ½ W 5%

R1	150k
R2	100k
R3,4	2k7
*R5	22k
R6,7	2k7
*R8	3k6
*R9	24k
*R10	15k
R11	4k7
R12	2k2
R13	15k
R14–R16	3k3
*R17	56k
R18	330k
R19,20	2k7
R21	330k
*R22	3k9
*R23	27k
R24	330k
*R25	15k
R26	2k2
R27	4k7
R28	15k
R29–R31	3k3
R32,33	10k
R34,35	1k
R36,37	100k
R38	1M
R39	100R

Potentiometers

RV1	250k trim
RV2–RV5	25k trim
RV6	100k trim

Capacitors

C1	100n polyester
*C2	56n polyester
*C3	6n8 polyester
*C4	1n0 polyester
C5	10µ 25V electro
*C6	1n5 polyester
*C7	100n polyester
C8,9	100n polyester
C10	33p ceramic
*C11	22n polyester
*C12	4n7 polyester
C13	100n polyester
C14	33p ceramic
C15	10µ 25V electro
*C16	5n6 polyester
C17,18	100n polyester
C19	33p ceramic
C20–C22	100n polyester

Semiconductors

IC1,2	LM301A
IC3,4	MC1495
IC5	LM301A
Q1–Q3	BC549
ZD1,2	5.1V 300mW

Miscellaneous

PC board ETI 486
Power supply ± 15V 40mA (ETI 581)

* For best results the components should be as accurate as possible, preferably 1% tolerance or selected to be within 1%.