3-Channel Mixer

Elementary Electronics

by ROSS TESTER

It is a number of years since we published a microphone mixer — more than five to be exact. So we thought it about time to publish another. This mixer, however, is quite different from any we have published in the past — it should not cost more than six dollars to build.

There are many situations where it would be very convenient to be able to mix the outputs from a number of signal sources. This little mixer, with three input channels, will do a first class job, in spite of its simplicity.

We would envisage that it would be quite acceptable for use at school concerts, speech days, etc. Therefore, it would make an interesting and economical project for members of Youth Radio Clubs, etc.

Each channel has an input impedance of 280K and is suitable for use with any medium to high impedance dynamic microphone. It will give approximately 30mV out for 5mV in, thus making it suitable for feeding into the preamplifier of a PA amplifier, tape recorder, etc.

The input impedance is too low for crystal microphones, but it should be possible to modify the circuit to suit. For any input intended for a crystal microphone the potentiometer and associated resistor should be increased to 4.7M. The unit can use a mixture of crystal and dynamic input channels if desired.

However, be aware that such high impedance circuits are much more prone to hum pick up. Where they are used it may be necessary to shield the mixer completely, inside a metal box. For these, and other, reasons the dynamic microphone is generally to be preferred to the crystal type.

Another possibility is to use one of the channels for a crystal pickup, rather than a microphone. A crystal pick will have a much higher output than a dynamic microphone, and also requires a much higher load impedance to deliver a proper bass response. The easiest way to cope with these two requirements is to connect a resistor of about 2.2M in series with the active lead from the pickup. This resistor may need to be shielded to prevent hum pick up.

The front panel of our mixer. The layout is not critical and other panel arrangements could be used.

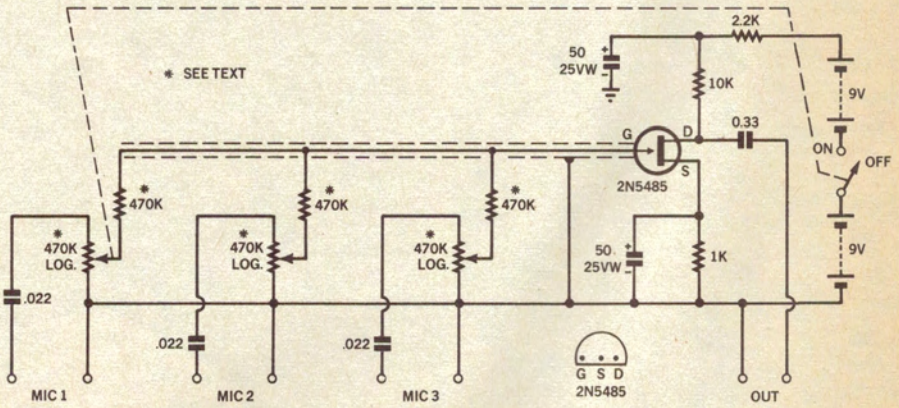
How does this mixer circuit work? It is what is called a passive system, since it does not depend on active devices such as valves or transistors for the mixing functions, as such. It consists simply of three pots, as volume controls, and three resistors of the same value.

In its crudest form a mixer might consist of just three pots, with their moving arms connected together and fed to the amplifier input. Such an arrangement would work — in a fashion — but would suffer from very serious interaction. For example, if the moving arm of any one pot was turned to the full off position, it would kill the output of the other two.

This is the reason for the isolating resistors in series with the arm of each pot. Even when a pot is turned fully off, there is enough resistance between it and the rest of the circuit to minimise its effect. Note that we say minimise, because it will have some effect. However, it will be slight, and of little practical importance.

As might be expected, a simple circuit like this must impose some penalty. The penalty is an overall loss in the network, and this is one reason we follow it with an amplifying stage.

The amount of loss depends on the number of input circuits we provide. In the simplest case, where we mix only two inputs, the loss will be two to one in the worst situation. That is to say, with one input turned full on, and the other right off, only half the signal fed to the input will appear at the output of the mixer. With the three stages shown, and two turned off, the loss is three to one.



The circuit of the mixer. The mixing circuit proper consists of the three 470k pots and their associated 470k isolating resistors. The amplifier stage helps make good the losses in the mixer network.

Output from the mixer network goes to the amplifier stage, a 2N5485 FET in this case. The high input impedance of the FET is well suited to this application, since it minimises any loading on the mixer network.

The voltage gain of the mixer is determined by the gain of the FET, less the losses in the mixer circuit. The gain of individual FETs varies widely, but we would expect it to be somewhere around 20. In our case, a 5mV signal fed to one channel, with the other two off, gave an output of 27mV, or an overall gain of a little over 5. Allowing for a 3 to 1 loss in the mixer, this gives a gain in the amplifying stage of about 16.

The output impedance is approximately equal to that of the drain resistor, or 10K. This means that a main amplifier with an

input impedance of around 50K would not seriously load the mixer. As the impedance is reduced below this point there will be some increase in distortion but, considering the limited signal level in this part of the circuit, it should be safe to work into a 20K load without a serious increase in distortion. It would be unwise to go below this value.

Note that the supply line to the FET drain is decoupled with a 50uF electrolytic capacitor and a 2.2K resistor. The main purpose of this is to minimise a rather disturbing "crack" which can occur in the speakers if the mixer should be switched on or off while the main amplifier is running. Even with this network there may still be a "thump", and it is a good idea to turn the main amplifier gain down before switching the mixer on or off.

Perhaps the best place to start in the construction of the mixer is the metalwork. A simple "L" shape bracket, as shown in the illustrations on the right, should present no problems, even for the novice.

We made our mixer on a piece of scrap aluminium measuring 7½in (190mm) wide by 5¼ (133mm) deep, bent at right angles 2in (51mm) from the top. This gave us a compact unit, which could be used as it was, or built into a case. However, these dimensions are not critical, and, providing adequate care is taken with shielding, no problems should result from any change in layout. In fact, a change may be preferred, as some operators find it annoying to have the jacks emerging close to the control pots.

Once the holes are drilled, the aluminium can be bent as indicated. Hold it in a vyce, between two pieces of metal with a good straight edge. Line the aluminium up with the straight edge, and tighten the vyce. Then, with a block of wood, bend the aluminium until it is as close as possible to a right angle. Then take a hammer and a block of wood, and strike the block while moving it back and forward along the bend until it is square.

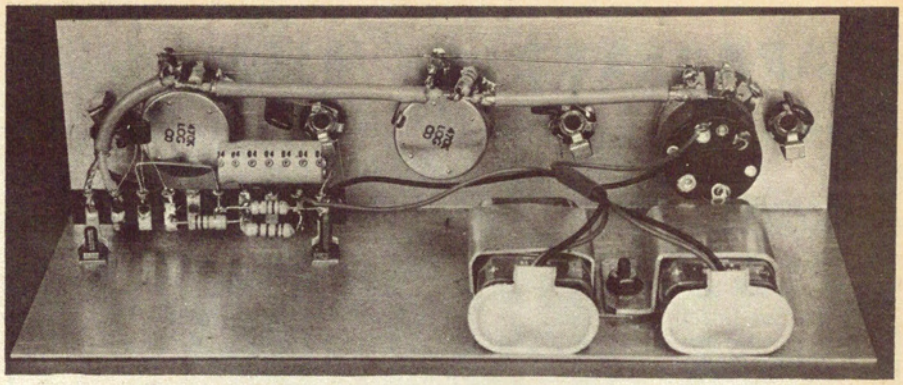
Next, the pots and jacks should be fitted, and the input components soldered between them. Wire the tag strip before mounting it, soldering the FET in place last to minimise risk of damage to it due to excessive heat.

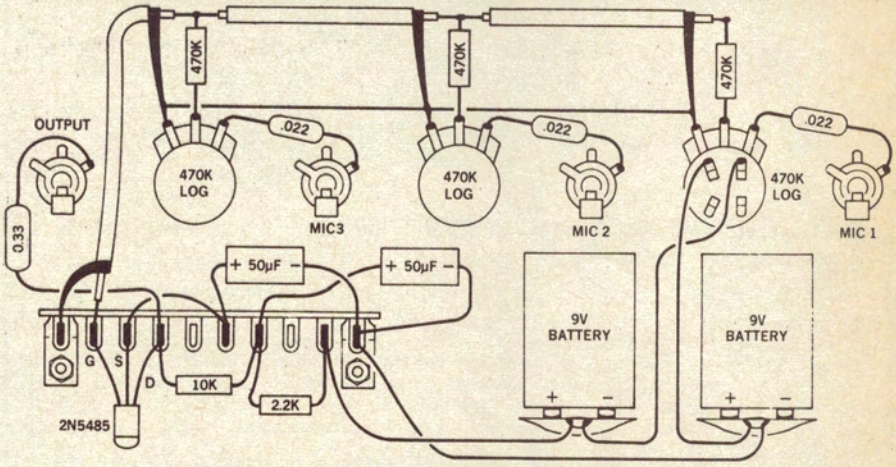
It should be possible to wire the mixer completely using only the circuit diagram, but for those with limited experience we have provided a photograph and a detailed wiring diagram. Using all these sources of information, even the beginner should have no trouble.

We used countersunk-head screws to fix both the tagstrip and battery clamps. The head should be flush with the underside of the base, so as not to scratch any surface they might be put on. Four rubber feet in the corners would also preclude this from happening.

Shielded wire should be used for all the signal circuits. This is necessary to minimise hum pick up from stray AC fields, and also RF energy from any nearby radio or TV transmitters. If hum or RF pickup should still be a problem, it may be necessary to enclose the wiring completely, in a metal box.

For those not used to handling shielded cable, a few points may help. When soldering to either the inner conductor, or the outer braid, take care not to damage the insulation between them, which has a low





A photograph and wiring diagram of the mixer, presented together for comparison. Compare them with the circuit on the opposite page.

PARTS LIST

Resistors: (1/2 watt)
1 x 1k
1 x 2.2k
1 x 10k
1 x 470k
2 x 470k log pots
1 x 470k log pot with switch

Capacitors:
3 x .022uF LV ceramic or polyester
1 x 0.33uF LV ceramic or polyester
2 x 50uF 25VW

1 x 2N5485 FET
3 x input sockets (see text)
1 x output socket (see text)
2 x 9V batteries with connectors (Eveready 216 or sim)
3 x knobs to suit
3 x ½in, ⅛ Whitworth csk head screws and nuts.
1 x 10 lug tagstrip (E-8-E)
2 x battery clamps (see text)
1 piece 18-20SWG aluminium, size to suit.
1 length shielded cable, approx 8in. (200mm)
1 length tinned copper wire (or hookup wire), approx 6in. (150mm)
1 sheet Letraset (for front panel labels if required).

Note: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may generally be used providing they are physically compatible. Components with lower ratings may also be used in some cases, providing the ratings are not exceeded.

melting point. Experiment on a few scrap lengths first.

If the outer shield is simply wrapped around the insulation, it is quite easy to separate the two. If it is braided, we suggest that you push the strands of the braid apart until there is a hole large enough to allow the inner conductor to be pulled through it. Again, experiment with a scrap.

We have not shown any diagram for the battery clamps. These are made by bending a piece of thin metal around the batteries themsleves, and then drilling the mounting holes. You may use thin aluminium, as we did, or tinplate, etc. They are both secured to the chassis by the same screw, and the batteries are clamped underneath.

The batteries in are connected in series, with the on-off switch between them. Putting the switch in this position is convenient because the switch now also serves as an anchor point for the connection between the two batteries.

Some readers may think we have forgotten part of the wiring around the input sockets, as these appear to have only one connection made to them, rather than the two shown in the circuit. The explanation is simple; mounting the sockets on the metal panel makes contact to one side of them, and we use the metal panel as a common conductor.

Note that, while we can employ this technique in a simple battery operated device like this, there are many situations where it would not be satisfactory. Particularly where AC from a power supply may flow through the metal chassis, there is a high risk of hum pick up. In such cases all such terminals should be insulated from the chassis and wired to a common point.

After finishing the wiring unscrew the tagstrip and battery holders, remove the nuts from the potentiometers and sockets, and lift the whole of the circuitry out. Then you will be able to polish the front of the panel with some fine emery cloth, which removes the marks and scratches from it. Then, to provide a neat finish, "scratch grain" the panel with a wire brush. This is done by holding the aluminium over the corner of a bench, and scratching the surface with a wire brush, in one direction only.

Taking care not to touch the front again, make up the lettering using "Letraset" or similar rub-on lettering. The "Letraset Printpack" is an economically priced pack well suited to small jobs of this kind. Even the dots which mark the pot positions are made this way. The Letraset Printpak No 8 would be the best to buy. It contains type 3 and 4mm high, which would be suitable for most panel marking.

Finally, give the whole panel a fine coat of clear flat enamel from a spray pack. This protects the surface from fingermarks and also stops the letters from lifting.

Then re-assemble the circuitry on the panel. It may seem a little odd to remove it all after the job is completed, but if the lettering is done in the preliminary stages it will almost certainly be damaged in some way. In any case, the way we assembled the circuitry makes it easy to remove in one lump.

And that's about all there is to it. Follow our instructions carefully and you should have a versatile little unit which will increase the usefulness of any amplifier by a very large factor.