

NEW LIFE FOR AN OLD CRO

A frustrating moment for any enthusiast is when his faithful old valve type CRO breathes its last smoky breath—usually as the result of a faulty power transformer. But don't give up: it may be possible to give it a new lease of life by pressing into service an oddment transformer from a receiver or amplifier.

by NEVILLE WILLIAMS

Most of the older generation oscilloscopes obtained their EHT from a winding on the main transformer—usually an extension of one side of the normal HT secondary to somewhere between 700 and 1200 volts, depending on the needs of the particular CR tube. Since the total current drain is very small—typically only a couple of milliamps—the additional winding could be of very fine wire, the main problem being to provide adequate insulation.

Unfortunately, the winding methods and insulation of an earlier decade have not always proved to be “adequate” in longer term, with human perspiration on the wire, organic insulating materials and the atmospheric environment conspiring to produce a deterioration, leading either to an ultimate open—or short-circuit.

With all transformers tending to be expensive, nowadays, and with “specials” particularly so, the chances of obtaining an exact replacement at a reasonable figure are remote, to say the least. Either an emergency measure has to be worked out or else the instrument has to be discarded. The following suggestions are based on just such a situation.

If it is at all feasible, there is actually much to be said for having the existing transformer partially or totally rewound. It will mount back into the same physical position and therefore preserve the magnetic orientation that was originally selected to minimise hum deflection and modulation of the CR beam.

Many early oscilloscopes used two thermionic rectifiers, one for the HT supply, the other for EHT. In many cases, each had to be provided with its own heater supply, separate from that for the deflection amplifiers and for the CR tube itself. Having in mind that CRO power transformers usually have to be as compact as possible, the provision of up to four heater windings, three of them specially insulated, plus a normal secondary and EHT overwind (and primary, of course) can prove to be quite a “shoe horn” exercise.

The job of repairing or rewinding will be vastly simplified if the thermionic rectifiers are replaced with their solid-state counterparts, thereby obviating the need for one and possibly two specially insulated heater windings. This will ease the

pressure on winding space and reduce the load on the transformer by 10 to 20 watts. Little change will be needed to the physical wiring since, in many cases, it will be possible simply to withdraw the thermionic rectifiers and wire the solid-state devices to the appropriate socket pins.

In a conventional circuit such as Fig. 1, the HT rectifier diodes need a PIV (peak inverse voltage) rating of at least 2.8 (say 3) times the RMS input. Thus diodes rated at 1000 PIV (for example the EM 410 or the G.E. type A14P) could cope with an HT secondary up to about 330V RMS per side. For voltages higher than this, and up to 400 RMS, it would be possible to use diodes type ERB-24 rated at 1200PIV and available from Paris Radio, 7 Burton St, Darlinghurst, NSW 2010.

It should be noted that the forward resistance of silicon diodes is much lower than that of a thermionic rectifier. For a

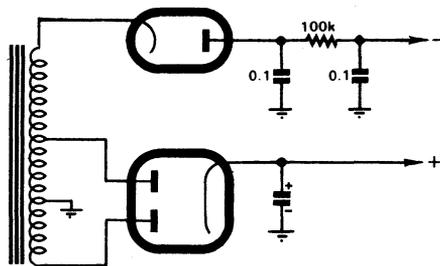
given RMS input, the DC output will be noticeably higher and the stress on the first filter capacitor proportionately greater. A series resistor should be wired between the rectifier output and the input to the filter, as in Fig. 2. The resistor would typically need to be 200 ohms at from 10 to 20W, depending on current drain—this to protect the capacitor and restore the DC rail voltage to its original figure.

For the EHT rectifier, there are several options. The first is to use a now traditional copper oxide/selenium stick rectifier conventionally assembled in a 4in to 5in bakelised paper tube. Apart from the possibility of them being available on an oddment basis, we discovered that Radio Despatch Service in Sydney (for example) still stock and sell the well known SenTerCel “K/8” series rectifiers, which can take over from any likely thermionic rectifier in an old style oscilloscope. The K/50 has an RMS input rating of 1200V max, a PIV rating of 3400 and a current limit of 5mA mean. It will typically deliver 1420V DC mean into a maximum storage capacitor of 1uF. Higher numbers (K/60 etc) have progressively higher voltage ratings, the same current limit and a progressively lower input capacitor limit.

As a possible alternative, Radio Despatch offered us the more modern silicon stick rectifier also made by ITT and type numbered TV18-10K80 4372. Intended for use in TV sets, it sells for something less than \$1.80 and is therefore much cheaper than the older K/8 series. Unfortunately, it presents two problems which must be at least watched: firstly, the forward current limit is 200uA, making the rectifier suitable only for oscilloscopes having very high resistance voltage dividers across the EHT supply.

The second point is that the turn-on voltage of the stack of silicon chips is around the 100V mark—a characteristic which causes them to read open circuit both ways on a multimeter. It also tends to reduce the EHT output by about 150 volts—insignificant in a TV set but enough to be a nuisance in some oscilloscopes.

The third option is to use two or more ordinary silicon diodes in series to build up the overall PIV rating to a figure of not less than 3 times the RMS input. If the diodes are of the avalanche protected type such as the 1N5062 (A14N) or A14P, a simple series connection is permissible. Ordinary diodes would need to be shunted individually with a 1 meg resistor in parallel with a 0.01uF high voltage disc capacitor to equalise leakage and capacitive characteristics. In practice, this would probably be the least



Illustrating the HT and EHT supply arrangements commonly used in old-style oscilloscopes. The most frequent cause of failure is an open or short circuit in the extended EHT winding.

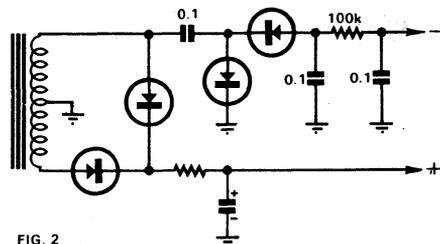


FIG. 2

Where the EHT winding opens, with no other complications, some oscilloscopes can be restored to limited operation by voltage doubling from one side of the HT secondary. Note the option of substituting semiconductor rectifiers for the normal thermionic type.

expensive of the options, with the further advantage that it would deliver the highest DC output for a given input.

In cases where the EHT winding has simply open-circuited, without shorted turns or other trauma, an oscilloscope can sometimes be got back into service by resorting to a voltage doubling arrangement as shown in Fig. 2. If the normal HT secondary voltage is around 350V per side, as is often the case, it is possible to derive something between 700 and 900V for the CRO tube, depending on the rectifiers and filter capacitors used and the load imposed by the tube and by its supply and control divider. While such a voltage may be below optimum, it may well restore a usable trace to the screen.

In this circuit, single 1000 PIV diodes should be adequate in both positions for all likely HT secondary voltages, with the ERB 24 1200 PIV diodes available as a bonus.

The 0.1 μ F capacitors must, of course, have an adequate rating, the input coupling capacitor in particular having to withstand the sum of the DC and peak

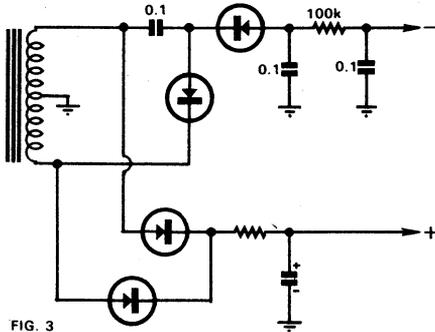


FIG. 3

This simple modification of Fig. 2, providing voltage tripling, will often permit an oscilloscope to operate normally from its original transformer (EHT winding open) or from a substitute transformer.

AC—about 4.3 times the RMS input.

While the voltage doubling circuit of Fig. 2 is a well known arrangement, our extension of it in Fig. 3 is not. In fact, we cannot recollect having seen the arrangement before, even though it would have been a simpler way of getting EHT for a whole generation of oscilloscopes, than by providing a rather vulnerable EHT winding.

The circuit involves returning the first EHT rectifier to the far end of the HT secondary winding, instead of to earth. By so doing, the coupling capacitor is charged towards the peak voltage of the total secondary; this is added to the AC peak of the upper half-secondary and passed by the second rectifier to the filter. In effect, the circuit acts as a tripler, rather than a doubler, of the half-secondary voltage, producing a filtered EHT typically around 1200V.

The coupling capacitor in particular should be rated at not less than 2000V, while the first rectifier would need a PIV rating of the same order. However, neither figure represents any great

problem and, in practice, the system works well and is a totally adequate substitute for the extended secondary arrangement of Fig. 1.

In fact, it makes it possible to power an oscilloscope from transformers which were quite commonplace in the days of valve receivers and amplifiers: with HT secondaries of between 325 and 385V per side, at between 50 and 100mA DC loading.

The one special requirement is that a separate heater winding will be required for the cathode-ray tube. If the transformer has a 5V winding, it will almost certainly be insulated reasonably well. It can be used to power a 4V CR tube through a dropping resistor and may even deliver enough voltage, when lightly loaded, to cope reasonably with a 6.3V heater.

Alternatively, the transformer may have two 6.3V windings and there is nothing to be lost by using one of those in the fond hope that the insulation will stand up to the 1200V odd of EHT on the CR tube heater/cathode. If possible, use a winding on the outside, so that there will be only the inner layers of insulation to worry about. One comforting thought is that, if a breakdown should occur, the series filter resistor (0.1meg or higher) will limit the possible current flow.

While an oddment transformer may solve the voltage problem, careful thought must be given to its mounting position within the instrument. It is logical to mount it in the same position as the original but this means more bolting it in the same area. It means mounting it so that the laminations are in the same plane as the original and the windings on the same axis—however this may conflict with the physical arrangement of the replacement transformer.

Where it is impossible to duplicate the original orientation, basic guidelines can be stated: Locate the transformer centrally beneath the CR tube with an orientation such that the tube could be imagined as passing through the bobbin. In this position, the lines of force will tend to be along the axis of the beam instead of across it. Further, have the laminations at right angles to the chassis rather than in the same plane, to minimise propagation of the stray field.

And here one final hint: In the oscilloscope which was responsible for this whole exercise, the original and the replacement transformer were orientated as described but located under the steel chassis. We found that the stray field could be markedly reduced by placing a thin aluminium plate between the transformer and the steel chassis. Fairly obviously, the aluminium plate (copper would be even better) was acting as a shorted turn to the stray field radiating upwards towards the tube and into the steel chassis. It's a very simple measure to try and well worthwhile if it helps get rid of that last vestige of hum deflection.