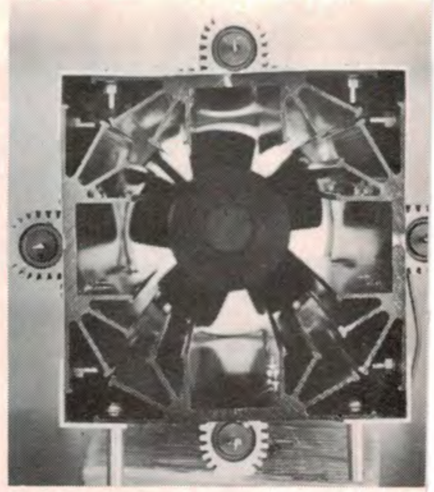
by LEO SIMPSON & BOB FLYNN

High power dummy load



Looking down the heatsink tunnel of our new 200W/ch load box.

One of the most important pieces of test equipment for assessing amplifier performance is a dummy load. In its simplest form it is just a single resistor but practice demands a good deal more than that.

At first thought the idea of a load box for audio amplifiers is simple enough. Just obtain a few resistors of adequate power rating, a selector switch or two and a suitable box to put it all in. Nothing complicated. Well it sounds easy when stated like that but when the subject is examined more closely the design of a load box is not all that straightforward.

This project arose when we decided to replace the dummy load box used in the EA lab for quite a few years. We made quite a few enquiries in looking for a commercial unit which would satisfy our needs but there appears to be little in the way of dummy loads made for audio amplifier testing. This is surprising since a number of companies make very fine distortion measuring equipment. What about a load box?

One of the reasons why we had to replace the existing load box was that it just did not have sufficient capacity to test the power amplifiers of today. The final straw came when we tested the Perreaux 5150B amplifier featured in the January 1984 issue. This monster had a power output in excess of one kilowatt with one channel driven! With both channels driven the total power was around 1.8 kilowatts.

This load box provides four load resistance values. The shunt terminals enable connection of a capacitance substitution box for stability testing of amplifiers.

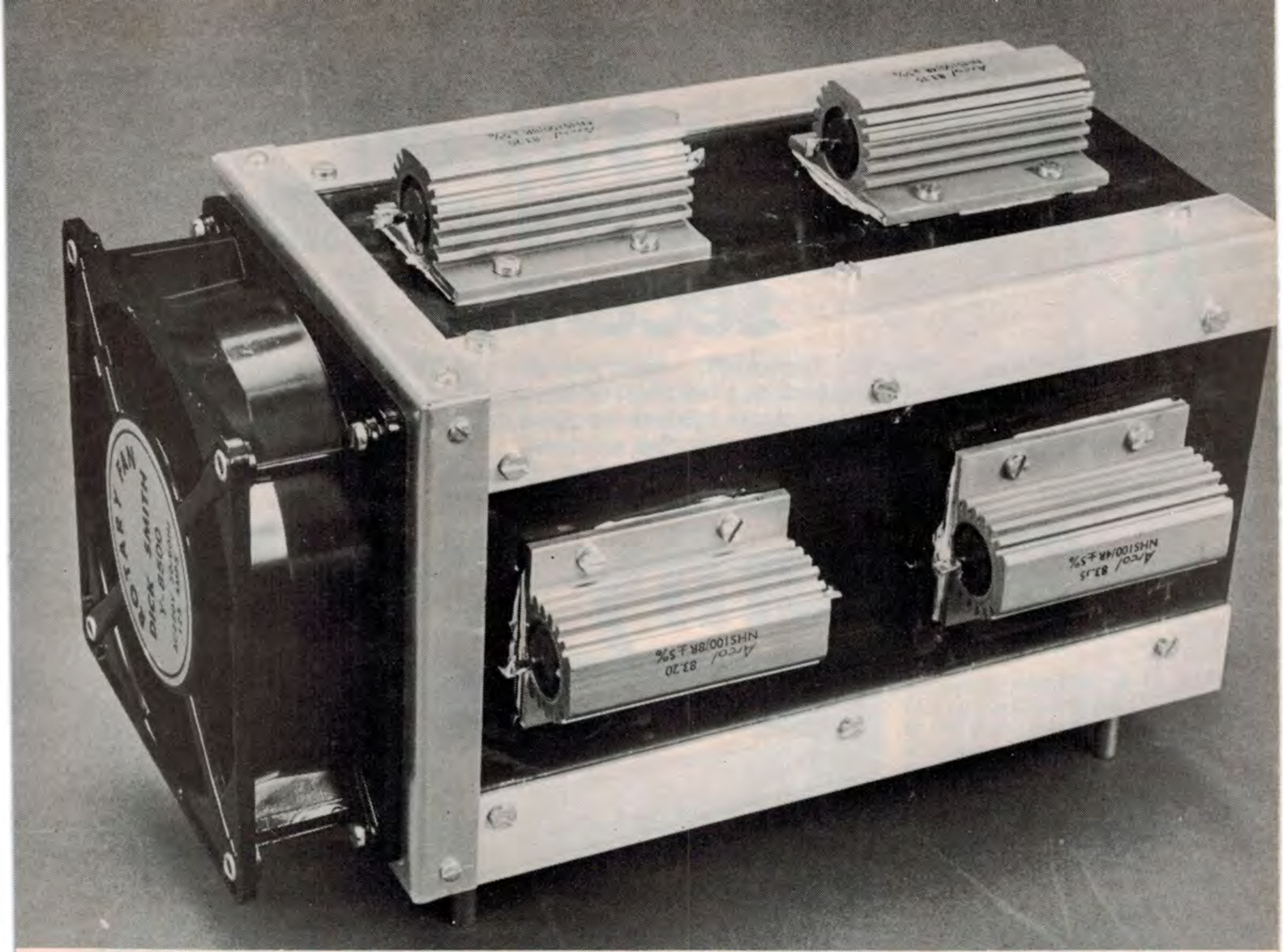
Our poor old load box just wasn't in the race with this monster so we had to make other arrangements. We actually used modified jug elements immersed in a bucket of water (see "Circuit & Design Ideas" in this month's issue).

Power rating is one problem; the load value is another. Our previous load box had the ability to provide loads of 2, 4, 8 and 16 ohms and this had served us well over the years. The provision of 2Ω and 16Ω load values may seem unnecessary these days but there is good reason to have them.

It may be thought that a 2Ω load is too severe for most amplifiers but it could easily occur if two 4Ω loudspeaker systems are placed in parallel. In fact, most manufacturers do not rate their amplifiers for this load value and will sometimes arrange the speaker switching so that when two pairs of speakers are in use they are connected in series. We think that is cheating of course.

We always test EA amplifier designs into a 2Ω load impedance. It is a good test of the ruggedness of the output stage and while the amplifier in question may not be able to wishstand full power into this load for more than a few seconds it should be able to survive without any damage. The worst that should happen is that the fuses blow.

The 16Ω load is less useful but it can be used as a good pointer to the headroom of an amplifier when driving 8Ω loads. In this case, we test for maximum power,



Fan cooling was the only way to ensure that resistor temperatures remained within limits.

into 16Ω loads and double the figure to gain an idea of the headroom or margin over steady-state full power then driven into 8Ω loads.

As it turned out, with the resistor values we used it is easy to provide the 16Ω load condition anyhow.

The range of load values and the final power rating have to be considered together since there must ultimately be a compromise between the total cost of the load box and its power rating. As may be seen from a glance at the accompanying circuit diagram, the new EA load box uses 4Ω and 8Ω resistors switched in series and in parallel to obtain the various load values.

This approach is economical because it means that we can standardise on just two values of resistor and the power dissipated will always be shared equally between two resistors (for one channel). This means that the power which can be dissipated is twice the rating of the individual resistors.

Non-inductive resistors

We also wanted the load box to be non-inductive. Ordinary wirewound resistors have only a relatively small value of inductance but that is sufficient to significantly alter the performance of most amplifiers. The residual inductance will usually exacerbate any crossover distortion and will also mean that the load is no longer the designated value at high frequencies.

Non-inductive resistors are obtainable but as might be expected they are more expensive than the equivalent inductive sort.

With the above considerations in mind, we finally opted for a nominal load box capacity of 200W for each channel. This would allow us to test the vast majority of amplifiers presently made. The unusual cases like the Perreaux model mentioned above could be handled in other ways.

The resistors we used are made by the Ashburton Resistance Company Ltd, of Cornwall, England. Branded Arcol, they are distributed in Australia by Mayer Krieg & Co, 49/51 Brodie St, Rydalmere NSW 2116.

These Arcol resistors are wirewound using a copper-nickel alloy or nickel chrome alloy, depending on resistance value. They are housed in a finned aluminium extrusion which aids heat dissipation. The type we used is non-inductively wound and is rated at 100 watts. Arcol resistors are available in ratings up to 300 watts in air-cooled types while there is a water-cooled type capable of dissipating up to 900 watts.

Load switching

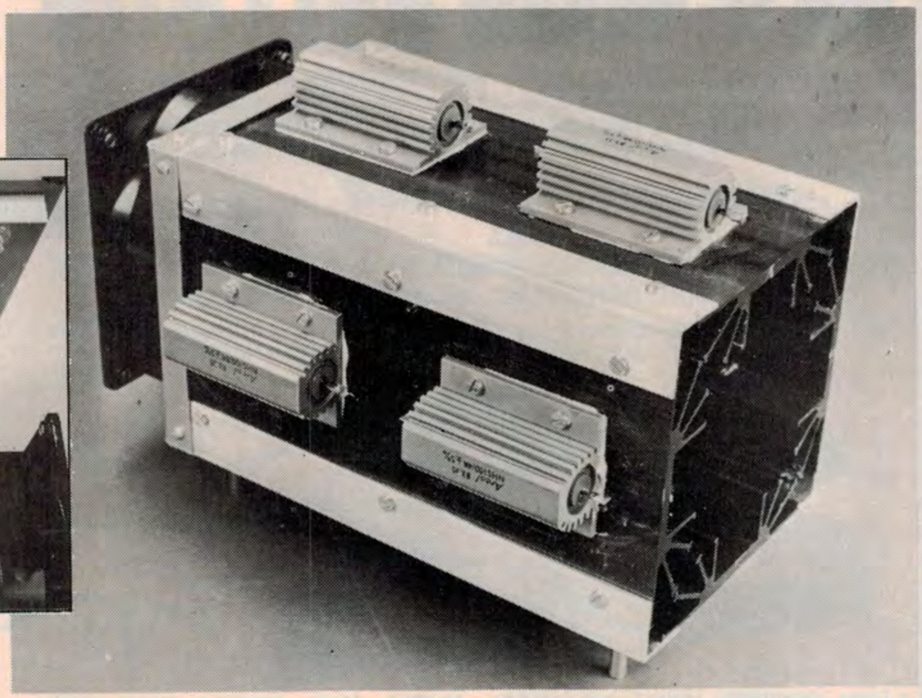
It is desirable to be able to switch the load value while the amplifier is delivering full power. This means that the switch must be rated to break and make the full load current which could be 10 amps or more.

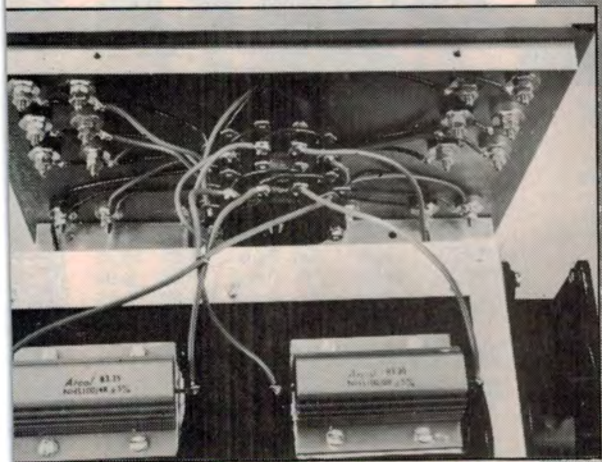
We wanted to be able to switch the load in both channels of a stereo amplifier simultaneously which meant a fairly hefty switch, particularly as we intended to use the load box to switch three pairs of loudspeaker systems as well.

The switch we used is an NKK type HS-16-4 which has a contact rating of 12 amps at 125 volts AC. It is nominally a 4-pole 11-position switch but has an adjustable stop to restrict the rotation to any desired number of positions.

At right is another view of the heatsink assembly before mounting in the box.

Pictured below is the heavy duty 4-pole switch rated at 12 amps.





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Our sample switch was kindly supplied by STC-Cannon Components Pty Ltd, 605 Gardeners Road, Mascot NSW 2020.

Cooling

We realised that cooling a dummy load box of this capacity would be a problem. After all, 400 watts is almost half the rating of a small domestic one-bar radiator and they get red-hot! Accordingly, we decided to use a forced-air cooling system using a standard computer ventilation fan.

We made up a heatsink tunnel using four single-sided heatsinks (DSE Cat. No H-3426 or equivalent) 225mm long. These were bolted together with the aid of aluminium angle extrusion. As can be seen from the photographs, the eight resistors were bolted in position, two to each heatsink. The fan, also from Dick Smith Electronics (Cat. No Y-3500), was then bolted onto one end of the assembly.

Photos tell the rest of the assembly story. In use we have found that the fan cooling works very well and limits the surface temperature of the resistors to about 90° Celsius when running at 200 watts per channel.

This suggests that we should be able to use the load box for even higher powers. The NHS100 resistors are rated at 100 watts for a maximum surface temperature of 200°C. With fan cooling we should be able to use the load at powers of up to 300 watts per channel while still keeping the resistors comfortably within their temperature ratings.