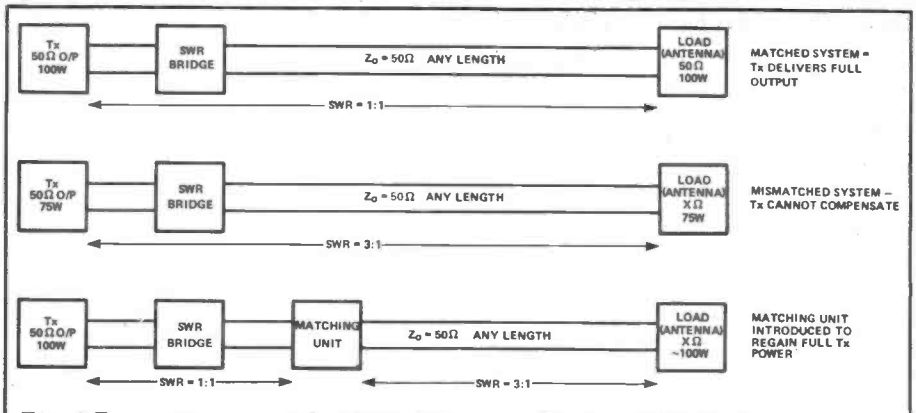

Fig. 2 Transmitter can only give full power with a suitable load

power into what is now an impedance mismatch, and so its power output reduces.

The best way of looking at it is to say that the reflected power meter is telling you by how much the TX power output has reduced ie. it has dropped by 25 watts, so that we now have 75 watts of output into the mismatch rather than 100 watts.

If you also had an RF ammeter in the line after the reflectometer you would see that its current reading had dropped, which verified the drop in power going to the load. Of course you would get a different absolute reading depending on where in the feeder the ammeter was, but we are only interested in the relative current.

So subtract the reflected power from the forward power in watts and you will have the actual power being passed on to the load.

Getting power back

If your TX is equipped with an adjustable output network (ie. tuning and loading controls) such as many valved rigs have, you will almost certainly be able to adjust these controls to compensate for the mismatch, and regain your full power output of 100 watts. In effect, what you are doing is adjusting the TX output circuit so that its impedance equals that which exists at the line, and it can therefore deliver maximum power output again.

Most rigs specifiy the maximum SWR that can be handled, and this is an indication of how far you can compensate — if the SWR you have got at the end of the feeder is outside this range it will be necessary to take additional steps as we will see.

Semiconductor PAs

Those of you with solid state PAs aren't going to be so lucky. Due to the current driven nature of semiconductors, rather than voltage (as in valves) they can only deliver their maximum power when they are seeing the impedance for which they were designed, or something very close to it. This is normally 50 ohms, and in the majority of cases you probably haven't got any controls to adjust anyway. So if you try working into our theoretical 3:1 SWR system, the PA cannot be returned to compensate for the impedance mismatch, with the result that it will draw excess current, overheat and lead to an expensive repair bill. If it is working into a reactive mismatch such as there might be with an aerial connected, things can be worse although that doesn't concern us here.

To overcome this sort of damage, the great majority of solid state PAs have some form of SWR protection circuit built in these days. When an SWR of possibly 2:1 or more is detected by an inbuilt bridge, the drive to the PA is reduce to protect it. This is in addition to the reduction in power that the mismatch will produce itself. Obviously some form of matching network, external to the system, will have to be introduced.

Adding an aerial

Moving on a bit, if we now replace our resistive load at the end of the cable with a real aerial, you will know that if the aerial has the same impedance at its feedpoint as that of the feeder cable, then you will feel extremely happy, because the meter will be indicating an SWR of around 1:1. The aerial can of course present a much higher impedance and still be resonant, either by design, or depending on where you are feeding it etc., so lets assume that the resulting impedance is such that the SWR is 3:1.

At this point, note that just because there *is* an SWR present, it doesn't mean that the antenna is losing the power being sent to it. What the SWR is telling you is that there is a mismatch present between the source (TX) and the load, however it has arisen.

We have already said that you should not rely on everything a reflectometer tells you. Let's say that your SWR meter normally reads 1;8:1, and despite all your valiant efforts it won't go any lower on a particular aerial. If some friendly person came along in the night and soldered a 50 ohm resistor across the feeder in place of the aerial, you would have a nice 1:1 SWR reading the next morning! A bit extreme, but if your cable had deteriorated, and small resistances had developed in all the joints etc, it is perfectly possible for the system to start looking like a resistance of near 50 ohms. A low SWR can sometimes be very bad news.

So, at this point, although the theory is outside the scope of this article, try to bear in mind that an SWR of 1:1 does not necessarily mean that the antenna is resonant, or that it will radiate more power, or that the system is efficient. Many aerials, depending on the design, will radiate just as much power with an SWR of 20:1 on the feeder as 1:1. Basically, an aerial will radiate all the current that gets applied to its feedpoint, even when the feeder is mismatched at the antenna feed point, and even with the antenna off resonance.

Going back to our newly generated mismatch with an antenna connected, if we have a PA with tuning and loading controls we will probably be able to compensate for the mismatch by twiddling with the controls, and end up delivering 100 watts again.

The ATU?

If we have a semiconductor PA or if the adjustable TX won't load up properly then we have a problem. As you are no doubt aware, this is wher an 'ATU' comes in. Firstly, the ATU doesn't do what it says — it does not tune the aerial (at least not when there is a coaxial feeder involved)! It would more correctly be termed an Aerial Matching Unit or AMU, as what it does is to introduce some more variables into the system and allow the impedance seen by its output (which is currently a mismatch to the TX) to be transformed into the correct impedance at is input terminals for the TX, again usually 50 ohms to suit the cable which will be connecting the two together.

Another point arises here and that is the correct way of using the matching unit. Normally you firstly tune up the TX into a (50 ohm) dummy load, both to get it tuned for its optimum output, and secondly to avoid poluting the airwaves with carrier. Having done that you then adjust the matching unit, with a reflectometer inserted between the TX and matching unit, for an indicated SWR of close to 1:1, thus showing that the TX is now seeing 50 ohms again.

If you have a filter in the line for harmonic rejection, you shouldn't then readjust the TX controls, as you may destroy the 50 ohm impedance you have just created. Otherwise if you move frequency a little you can either readjust the AMU, or the TX, providing the latter