# TECHNICALITIES

**negative resistance**

**parametric problems in transistor PAs**

**power grid circuitry**

**magazine newsround**

As circuitry goes the standard transistor PA stage appears, at least at face value, pretty straightforward. Looks can be deceiving. The early radio pioneers faced in many ways an analogous problem when they tried to use tetrodes in RF stages principally worked out for triodes. Using a second grid to isolate the grid and anode circuitry seemed to present no obvious problem until the volts were applied. Things started to produce RF whether they had a drive signal at the control grid or not.

It took a bit of time for some bright spark to work out that electrons travelling from the cathode bashed into the new fangled screen grid knocking off more free electrons than it caught. Secondary emission was born. With a bit of experimentation the pioneers deduced that if the anode volts were dropped to a value a little below that of the screen grid, electrons sailing clean past the screen grid would hit the anode knocking off, like the screen grid, more electrons than were captured and delivered to the anode load. Under these conditions it became possible for the normal state of the circuitry to be reversed: as the anode volts fell, the anode current actually increased. This particular effect is known as negative resistance and a tuned circuit connected to a source of negative resistance will oscillate robustly, the situation occurring whenever the negative slope resistance (Va/−I) was less than the dynamic resistance of the tuned circuit and its load.

In modern times, negative resistance is used to good effect in tunnel diodes, Gunn devices and avalanche diodes generally. However, for the early amateurs who found that anodes could behave like cathodes, screen grids could behave like anodes and that control grids could absorb large amounts of VHF RF power without actually drawing any grid current (the transit time effect) negative resistance was mostly a pain in the power supply.

Which brings me to the caveats surrounding the design of transistor power amplifiers. **Fig 1** shows a pretty bog-standard circuit for a 10W FM transistor PA. For a circuit with so few components and an apparently simple mode of operation — you are not even asking the device to amplify an RF envelope linearly — it is full of pitfalls, due in most part to negative resistance.

There are at least two prominent points of negative resistance in the circuit which only await the right sort of reactance to turn an amplifier into an uncontrollable oscillator. To complicate matters the two modes are quite distinct and tend to appear at opposite ends of the radio spectrum. The first is LF instability due to the fact that an RF transistor driven fairly hard with RF applied to the base has a hefty dose of negative resistance in the collector circuit. Simply, if you drive the transistor with the collector supply disconnected and put an ammeter in circuit connected to a variable power supply (of low impedance) the transistor takes a lot more current for the first volt or so than for other, higher potentials.

The limiting case occurs where the power delivered to the load requires an increase in current with supply voltage greater than the drop in current due to negative resistance. After the limiting case occurs, there are no further problems . . . or are there? That ferrite bead on the 'cold' side of the collector circuit feedthru capacitor turns that section of wire into a substantial

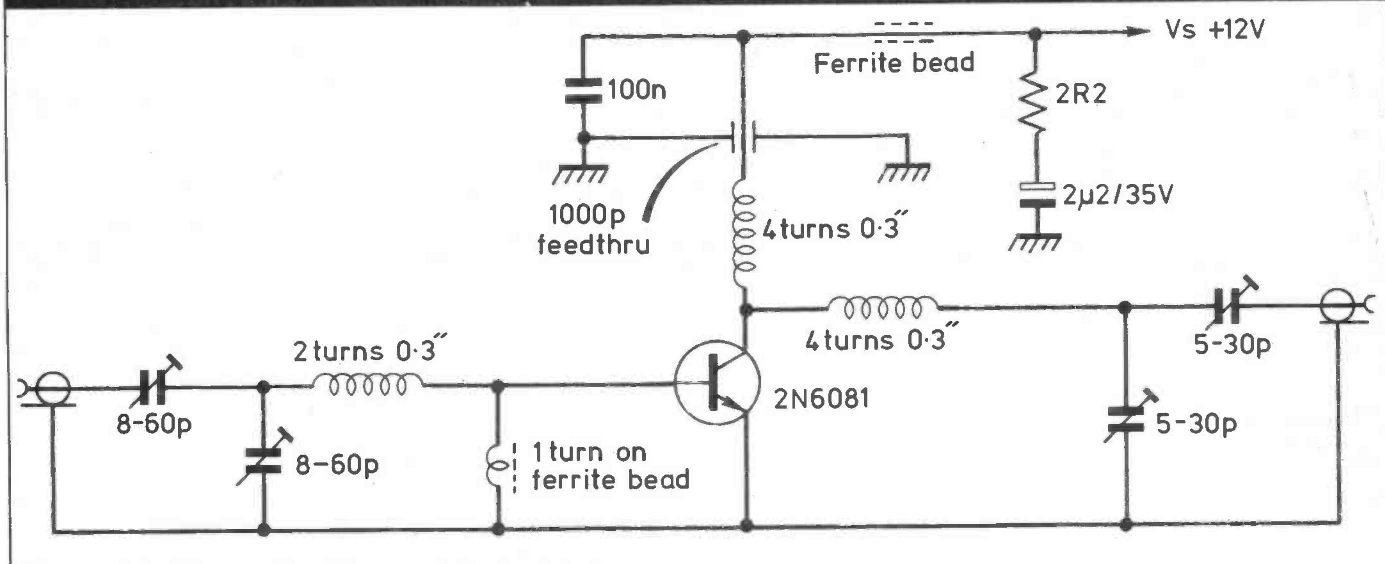


FIG.1. FM 10watt 2m PA. Spot the mistake.