CHAPTER XXI

The Grid as Traffic Regulator

SUPPOSE you have acquired a new three-valve set, consisting of :—

No. 1 valve : a high-frequency magnifier ;
No. 2 valve : a rectifier ;
No. 3 valve : a low-frequency or power magnifier.

And suppose, as sometimes happens, you find a difficulty in obtaining any but a very feeble result, or even perhaps no result at all, notwithstanding that the connexions have all been properly made, all joints and contacts good and firm, the plus and minus properly attended to, the whole high-tension battery fully connected up, and all the filaments glowing with adequate but not excessive brightness. You may then perhaps try whether you cannot get a result by turning the rheostat or regulator of the No. 1 valve to zero, so that its filament is dark and it is no longer in action : you will then be working with only two valves and without a high-frequency magnifier, and yet from neighbouring stations you may now get a result. This

will not always happen, but with some sets it does. Not that this is a right way of working, but it shows what was the matter. For now, having got the other two valves to give a result, if you switch on the No. 1 valve again, you will probably find that the loud speaker again becomes faint or is silent. You ask yourself the reason of this, and conclude that the high-tension battery is too strong for that valve. Two travelling plugs are probably provided, and by moving the wander plug which feeds the No. 1 valve down a long way, to lower studs on the H.T. battery, so as to apply a much lower potential to the No. 1 anode, you may be able to get it into helpful action; and after that you can proceed as usual.

Some valves seem able to work in spite of harsh treatment, but it cannot be well to depend on that or to overstrain their capabilities. Everybody knows that the filament current must be adjusted, neither too strong nor too weak, but regulation of anode potential seems less attended to, and too little facility for this is generally provided. The result is distortion, if nothing worse. Too much reaction is no remedy, but is an additional defect. Good and pure and clearly articulated reception cannot thus be obtainable, though mere loudness can.

The fact is that the anode potential may be too high or too low for the grid potential. There is a best relation between anode and grid potential: if the anode is too high, it overpowers the grid; if the anode is too low, it is overpowered by the grid.

Consider more closely what is happening.

Electrons are given off by the filament as negatively charged particles, and are attracted up by the positive anode. The grid stands in their way as a controller of current or regulator of traffic. The grid connected to the aerial is subject to fluctuations of potential; it may have a steady bias, but its potential is bound to fluctuate according to the received impulses: the whole reception depends on that. When a grid is negative, it drives the electrons down or prevents their rising: when a grid is positive, it helps them upwards, and encourages them to shoot through to the anode beyond. It is the anode current which you ultimately utilize, and on which you are dependent.

But it is no use getting a strong anode current unless it is properly controlled and modified by the grid; and the grid potential must be strong enough to perform the regulation effectively. The electrons, which are the current conveyors, must be disciplined and controlled by the grid in accordance with the

received fluctuations of potential, that is, in accordance with all the voice peculiarities impressed on the ether waves by the sending microphone and the emitting valve apparatus. The anode may be so strong as to haul up all the electrons in spite of the efforts of the grid to keep them down. That is a common danger, especially with No. 1 valve. On the other hand, the grid may be so strong as not only to repel electrons when it is of negative sign, but to attract them so strongly when it is of positive sign that none or hardly any are able to escape its clutches. There are thus two opposite or alternative dangers, and the potentials must be adjusted so as to avoid them both.

It is manifest that the grids of the series of valves are inevitably of different strength: accordingly the anodes should be of different strength too. No. 1 valve receives the aerial fluctuations unmagnified, and from a distant station they may be very weak. Grid No. 2 receives magnified fluctuations, and in No. 3 they are still more magnified.

The grid potential in No. 3 or No. 4 valve may be so strong as to monopolize all the electrons to itself, not allowing a sufficient number to go through to the anode: in that case magnification will cease; the valve will actually diminish the current which other-

wise might have been obtained. Such a state of things is extremely unlikely in the No. 1 valve; the unmagnified oscillations in the aerial are bound to be rather feeble: they are probably insufficient to excite the grid too strongly, anyhow. A very moderate potential in the anode is sufficient to do the work: indeed, a moderate potential is wisest; for it will then not overpower the grid. And this is the basis of the plan known as "Unidyne," which refrains from applying a high potential to the anode, even to the anode of the second valve. Nevertheless, the second valve can stand a greater amount of anode potential, since the grid is already receiving a magnified impulse; and if we are to use the third valve, a high potential to the anode becomes necessary. Without high potential you cannot expect the third valve to magnify.

ANODE POTENTIAL TOO HIGH

So far, we have mainly considered the case of a grid too strong for the anode; it not so much regulates the traffic as stops it, absorbing too much of it into itself. But now take the converse case—the more usual case when a high-tension battery is employed—that is, when the anode potential is too strong for the grid.

The electrons given off from the filament are now rushed up violently to the anode; and the grid placed between them in order to regulate the traffic, now stands helpless like a policeman standing in the middle of the North Western Railway trying to regulate the Scotch and Irish mails. The speeds to be dealt with are beyond the grid's control. There is plenty of current; but the current is steady, paying no adequate attention to the fluctuations of the grid, and therefore paying no adequate attention to the received messages. Everything is in working order; but the valve-property is out of action, the grid is no longer a regulator or controller of traffic. The remedy obviously is to weaken the anode potential. And if you want to receive from a feeble or a distant station, which is only able to make the grid voltage oscillate slightly, it will be well to reduce the anode potential a good deal. Hence doubtless it is that the Unidyne is efficient in picking up distant stations.

The anode potential of the other valves, to which grid alternations are supplied, may be higher, but still not too high. It is always important that the anode shall not overpower the grid. When listening to a strong near station that is unlikely to happen; but when listening to a far-off station it is likely enough.

One might imagine that the feebler the impulses received, the more anode potential ought to be supplied; whereas the fact is just the reverse; and perhaps many amateurs overdo their high tension, especially with the early valves of the series.

To sum up:—The more distant or feeble the station listened to, the lower ought to be the H.T. potential applied to the anode of the first valve. It is possible that constructors do not allow sufficient reduction of the numbers of cells of the H.T. battery put into action on the anode, especially the anode of the first valve. Too high a potential is detrimental. The H.T. battery ought to have studs all along so as to be capable of ready adjustment down to quite a low potential—even down as low as four or six volts—and thus be made to suit different circumstances. The function of the No. 1 valve is clear reception. If it does not receive all the fluctuations clearly, subsequent magnification, so far from remedying the defect, only increases it. Given clear reception, it can be magnified by subsequent valves as much as desired. We must not depend for magnification on the receiving valve, and must not try to force it, either by reaction or by high potential or too bright a filament or in any other way.

A set at Egham, in Surrey, with a small aerial, that will not ordinarily receive Liverpool, is found able to do so when the potential on the first anode plate is reduced to 12 volts. With higher potential on the first plate, it can only respond to comparatively near stations, like London or Bournemouth, or, of course, to a high-power station like Chelmsford.