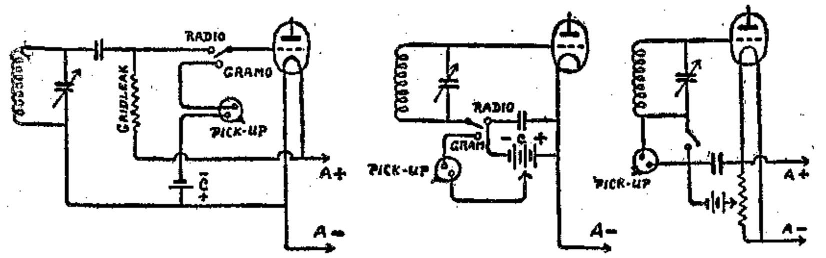


Figures 3, 4 and 5.

The method of designing such an amplifying circuit as will permit the pick-up to properly load the output valve or valves will no doubt be fairly obvious. Assume that a single output valve of the 171 or 171A type is used in the output stage. Such a valve will, at maximum plate volts, have a grid bias of approximately 40 volts, so that the grid swing will have a peak value of 80 volts, or a R.M.S. voltage of 56 volts (the R.M.S. or root mean square voltage is 0.707 of the peak voltage). Now our table will tell us the maximum B.M..S. voltage which the particular pick-up in use may be expected to develop. We will assume that that in this case it happens to be O.5 volts. Then 56÷0.5=112, that is, an amplification of 112 must be provided, between the pick-up and the grid of the last valve. If a transformer is used preceding the last valve, this in itself will provide an amplification corresponding roughly to its ratio, say, 3.5 to 1. The amplification still required will be 112÷3.5 =36.

There are valves with an amplification factor as high as this, and if one of these were used to precede the transformer, the pick-up could be connected directly in its grid circuit. The writer would prefer, however, in such an instance, to use two stages of amplification preceding the power-valve, and to reduce the ample voltage which would then be available by means of a suitable volume-control. It is very comforting to have amplification in hand to cope with such eventualities as a very lightly recorded disc.

Adapting a Receiver for a Pick-up.

It will be appreciated that there is always a certain doubt as to whether a single amplifying valve preceding the power-valve is adequate, especially where the power-valve is of really adequate size. There are circumstances in which one is necessarily limited to an amplifier of this size, however (e.g., where a "detector and one audio" receiver is to do service as amplifier), and in such cases it is well to remember that the amplifying valve should be one having a high amplification factor, while the pick-up should be chosen from those having a comparaticely high output.

Where a receiver of the "detector and two audio" type is available, a choice is available between a two-valve amplifier and a three-valve amplifier. Assuming, of course, that the amplifier is also to do service as a radio receiver, it will be clear that to provide a three-valve amplifier will necessitate employing the detector valve as one of the amplifying valves. This may conveniently be done with either a grid detector or a plate-bend detector by switching in the pick-up at a convenient point, at the same time adjusting the bias applied to the grid so as to enable the valve to operate efficiently and without distortion as an amplifier.

Figure 3 shows a suitable circuit for the introduction of the pick-up into the grid circuit of a grid detector. All that is necessary is a switch (single-pole double-throw or equivalent or a plug and socket arrangement, whereby the grid may be changed over from its usual connection (to grid condenser and leak) to the pick-up. The circuit is completed to filament through a bias battery, which may consist of a single dry cell unless the detector valve has a lower impedance than usual. It should be noted that in this circuit, unlike the case where it is a plate-bend detector which is to be converted, the switch is at high oscillating potential.

Care must therefore be taken to avoid long wandering leads, while it is wise to choose a switch of small dimensions, a large mass of metal being undesirable. Any risk of impairing the performance of the set as a wireless receiver can be obviated by fitting the switch on a small block of ebonite, which can in turn be mounted on the baseboard in close proximity to the grid terminal. Convenience is sacrificed, but a panel switch is in this case likely to be a source of trouble, unless it can be wired with short leads.

An anode-bend detector is more readily and conveniently modified, since the switch and pick-up may be introduced at a point of low oscillating potential. A suitable circuit is shown at fig. 4. Here, with the switch in the "radio" position, the low-potential end of the tuned circuit is returned to filament direct through the full bias voltage, while for gramophone reproduction it is completed through the pick-up, and a lower voltage tapping. The presence of the tuned circuit in series with the pick-up will not, of course, have any effect, as the current generated by the pick-up is of audible frequencies, and these will be unaffected by the tuned circuit.

Only a very simple alteration is necessary where the grid voltage on a plate-bend detector is controlled by a potentiometer. As can be seen from Fig. 5, all that is necessary in this case is to provide a switch by means of which the pick-up may be short-circuited when not in use. When potentiometer settings for the alternative methods of reproduction have been determined, it is convenient to mark appropriate positions of the control knob.

Omitting the Detector Stage.

It may be desired, in cases where a pick-up having a considerable output is employed, to avoid pressing the detector into service. Naturally, where the radio receiver to be employed as amplifier is of the detector and one audio type this is impossible, but where the receiver has two audio stages, these are usually adequate to give satisfactory results from the more sensitive pick-ups without having recourse to the detector for further amplification. The pick-up is inserted at some appropriate point in the grid circuit of the first audio valve. In the case of a stage of resistance-capacity amplification, a suitable arrangement would be that shown on Fig. 6, while for a transformer-coupled stage, the circuit of Fig. 7 would be suitable; there is no need to alter the bias of an audio stage when the pick-up is introduced as it is already adjusted for distortionless amplification.

It has been assumed, so far, that it is desired to leave the pick-up permanently connected in circuit. Where it is desirable to keep it available for other purposes (e.g.. testing receivers) while being able to use it at will, a plug and jack arrangement is the most convenient. The pick-up is connected to the plug, and the jack permanently wired into circuit. Generally speaking, the reader will experience little difficulty in adapting the circuits already given to plug and jack operation. For example, a transformer-coupled first audio might have the connections from transformer to plate and B+ made through a closed double-circuit jack (the transformer being connected to the two outer springs). The insertion of the plug would then place the pick-up in series with the transformer primary and break the connections to plate and B+.

A rather more difficult application is that shown in Fig. 8, where a closed double-circuit jack is again used, this time to connect a pick-up in the grid-circuit of a plate bend rectifier, at the same time automatically adjusting the bias to a proper value for amplification. Here, the lower spring (the shorter of the two connecting with the plug) is connected to the low potential side of the tuned circuit. The next spring up (a short one) is connected to a point on the bias battery suitable for plate bend rectification. The third spring up (another short one) is left unconnected, and the top spring might also be left unconnected were it not for the necessity of providing some form of volume control. As it is, it will be seen that it is connected to one terminal of a variable resistance which operates as a volume control, the other terminal being connected to the lower spring; lastly, and let it not be forgotten, the frame of the jack is connected to a low value of bias on the battery or other source of negative grid voltage.

Volume Control.

The mention of volume control brings us rather aptly to a discussion of the two usual methods of accomplishing this very necessary function. It is well-nigh impossible to do without some form of volume control. In the circuit of Fig. 8 a variable resistance of high value was shunted directly across the pick-up; the method is illustrated more clearly in Fig 9a. This arrangement, however, is open to certain objections. Where the pick-up in use is one inclined to shrillness—that is, one having a resonance peak at the higher frequencies—it is unobjectionable. In fact, it may be advantageous so long as there is not too much reduction of volume necessary.

In the case of a more normal pick-up where the high-frequency response is already rather feeble, a shunt resistance may well have the effect of wiping out the higher frequencies altogether. The effect of shunts of various resistances is shown graphically in Fig. 10. Remembering that we wish to preserve frequencies up to 5000 or 6000, the desirability of avoiding low shunt resistances is not hard to see.

For this reason, then, a potentiometer control of volume is to be preferred. This, method of control is illustrated in Fig. 9b. There is still a shunt re-

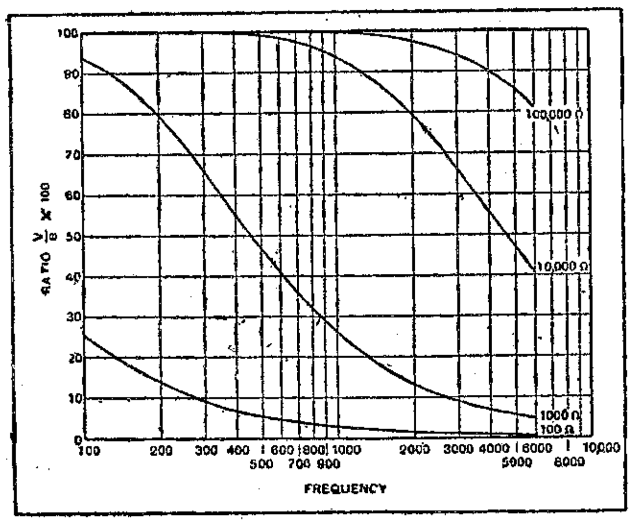
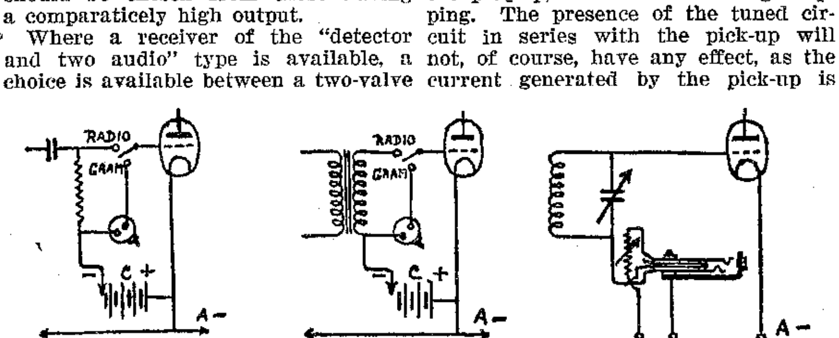


Fig. 10.—Calculated curves showing high frequency cut-off for various values of R in Fig. 9. It is assumed that the pick-up impedance is purely inductive and an inductance of 0.6 henry has been taken as a basis for calculation.



Figures 6, 7 and 8.