Gramophone Pick-Ups

A Guide to Convenience and Worth-While Results

By "CATHODE"

BEFORE going on to the matter of connecting the now-popular gramophone pick-up in circuit, it seems desirable to treat, at least briefly, the subject of pick-ups in general, and of their output. The reader will then be in a position to decide for himself the type of circuit best fitted to suit his own particular requirements.

The amount of amplification necessary to give the best results from a pick-up naturally depends upon a number of factors. The most important of these are:—

(1) The design of the pick-up—that is, its voltage output under normal circumstances.

(2) The type of needle to be employed.

(3) The grid-swing necessary to properly load the power-valve employed.

These can be dealt with in turn. Of the numerous designs of pick-ups which have at various times been introduced, only two major types have survived. Of these, the single acting type illustrated in Fig. 1 usually has the greater output, but suffers from certain disadvantages. It will be seen that this pick-up derives its electrical output as a result of a vibrating reed varying the magnetic flux between two pole pieces, both located at one side of the reed (the reed is, of course, caused to vibrate by its mechanical connection with the needle which follows the record groove). The disadvantages are obvious. Firstly, serious amplitude distortion results from the fact that the flux varies as the square of the distance of the reed from the pole pieces; secondly, the major part of the flux necessarily passes through the reed, and is likely to cause saturation; thirdly, as the pull on the reed is in one direction only, a stiff and heavy reed and a powerful restoring force are necessary to ensure that the reed will not fall on to the pole pieces.

Advantages of Double-acting Movement.

THE double-acting, or differential, movement is, for the reasons outlined above, fast ousting its rival. Here the flux in the armature when at rest is zero, as the diagonal fluxes from the pairs of opposite pole-pieces cancel out. When the armature is displaced, the greater part of the flux concentrates in one path, thus inducing an E.M.F. in the coil C (Fig. 2), but a certain residue still flows in the reverse direction and tends to correct the amplitude distortion which the single-acting pick-up necessarily gives rise to as a result of the square-law principle mentioned previously. There is still a certain tendency for the armature to stick over on the pole-pieces, but this is so small that it is unnecessary to strengthen the reed to resist it. The necessary retorting force can be supplied by the rubber damping pads D.

This ability to reduce the size and strength of the reed is of importance in another direction. Frequency distortion, or the tendency to give undue prominence to certain parts of the musical scale, resolves itself largely into a question of resonance in the reed. Any vibrating system involving mass and a restoring force will resonate at one fundamental frequency (and possibly at harmonics of this frequency), which is determined by the magnitude of the mass and of the restoring force. If the pick-up is to have good characteristics this major or fundamental resonance should lie outside the range of fundamental frequencies used in speech and music.

Frequency Adjustment.

SINCE the resonance cannot well be lowered to 30 cycles or less, it must be raised above 3500 cycles. Lessening the mass or increasing the restoring force both have the effect of increasing the resonant frequency; but too great a restoring force is undesirable, tending as it does to heavy record wear and restricted output. Thus the usual and proper process of design is to reduce the mass of the reed to the lowest possible amount and then to add just sufficient restoring force in the form of rubber damping to raise the frequency to the desired figure and to maintain the reed centrally in the gap between the pole pieces. The rubber pads also, of course, absorb a certain amount of energy and thus reduce the effect of the inevitable minor resonances.

As already pointed out, it is desirable, before essaying to design or decide upon a suitable amplifying circuit, to have some idea of the voltage output which may be expected from the pick-up to be used. The more sensitive pick-ups usually develop a maximum voltage slightly less than one volt, but those who desire more precise information may find Table 1, covering a number of commercial pick-ups operating from a fairy deep-cut test record, of some use.

Table 1.

Make.	Volts (r.m.s.) 250 cycles	1000 cycles	2000 cycles	4000 cycles
Amplion ...	0.1	0.4	0.15	0.05
B.T.H.	0.85	0.4	0.55	0.8
Blue Spot ..	0.85	0.4	0.25	0.05
Brown No. 3	0.15	0.2	0.35	0.15
Brown No. 2	1.4	0.75	1.6	0.05
Burndept ..	0.1	0.05	0.05	0.1
Celestion ...	0.4	0.3	0.35	0.05
G.E.C.	0.35	0.25	0.85	0.05
Igranic	0.55	0.25	0.6	0.05
Igranic (tone-arm model)	0.8	0.4	0.85	0.15
Loewe	0.15	0.05	0.05	0.05
Philips	2.7	1.5	1.0	0.05
Varley	0.3	0.35	0.05	0.05
Webster ...	1.5	0.75	0.6	0.5

Considering Voltage Output.

THE reader, in studying the table, should not fall into the common error of measuring the quality of a pick-up by its maximum voltage output. As a matter of fact, some of the best of the pick-ups whose characteristics are given have only a very small output of any frequency. What is important is that the voltage output shall be substantially the same at all frequencies in the audible range. A slight rise in output toward the extremities of the range is sometimes of advantage in counteracting the deficiencies in recording at these frequencies. The fact that the output is small is of no importance whatever, since, except where an existing amplifier providing only a small gain must be used, any deficiency in this respect is easily made up by increasing the gain of the amplifier.

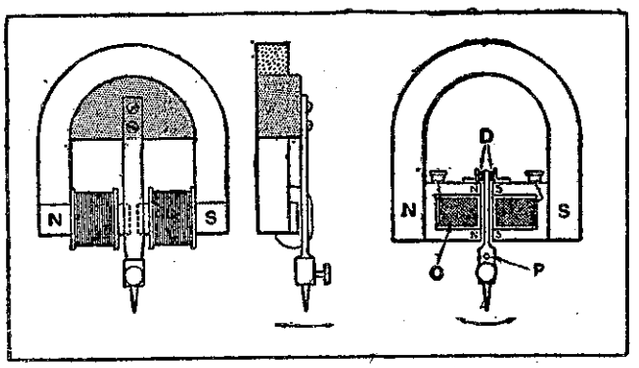

Fig. 1 (left).—Single-acting or unbalanced armature pick-up. Fig 2 (right).—Differential or balanced armature pick-up.

The effect of the needle on the output must not be overlooked. A soft-tone needle having a relatively large amount of "whip" or spring" will reduce the output appreciably. As a guide to the relative outputs to be expected from various types of needle, in Table 2 are the results of some measurements with H.M.V. needles.

Table 2.

Needle.	Relative output. (per cent.
Tungstyle, extra loud	100
Tungstyle, loud	90
Tungstyle, soft	80
Steel, extra loud	85
Steel, loud	80
Steel, half-tone	75
Steel, soft	45

The Tungstyle needles appear to offer advantages, but their relatively high mass tends to lower the resonant frequency and bring it within the audible range. The steel "half-tone" needle is a good compromise: its weight is small. yet there is not enough "give" to reduce the output seriously.