Some Pickup Design Considerations

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A discussion of one of the causes of unequal wear on the two sides of a stylus—and a suggested cure for it—by a writer who has built and sold pickups commercially over a long period.

IN THE AUGUST (1951) issue, Mr. Ginn asks if anyone else has ever put a spring on a pickup arm to counter the unwanted force which acts toward the center of the record when offset heads are used, claiming that such a spring improves matters.

He and other Æ readers may be interested to learn that in the pre-war German Telefunken pickup, a spring was fitted into the arm bearing and produced an outward-acting force. For its time, that pickup was of an advanced design, having the tip only of a sapphire stylus fixed into a small soft iron armature, the latter being pivoted on a V-shaped spring member.

The needle force was about 30 gms., a great improvement over the 100 gms. then customary. The frequency range, owing to the smallness of the moving parts, went well above 10,000 cps. From a Hi-Fi point of view, the main defect of that pickup was that sapphire did not have the wearing properties then claimed for it, so that "rattle" distortion gradually developed and soon became serious. Sapphire replacement was unfortunately too specialized a job for the enthusiast.

There was also a trace of hysteresis distortion which seems to be common to most moving-iron pickups. (It was not a moving-coil pickup as some people think.) In moving-iron pickups it is especially important to keep the armature midway between the pole tips. Any lateral-acting force tends to displace the armature from its central position, and there is no doubt that the outward bias spring fitted into those pickups was intended by the designer to counter the force mentioned.

It is not known whether the production department knew what the spring was for, or how critical its strength was, but in some of the Telefunken Pickups the writer used prior to the war for high-quality demonstrations the spring was much too strong. In consequence, upon reaching the eccentric groove at the end of the record, the pickup would come out of the groove and skate back across the record. Since record surfaces and sapphire points are vulnerable, this condition was somewhat less than ideal.

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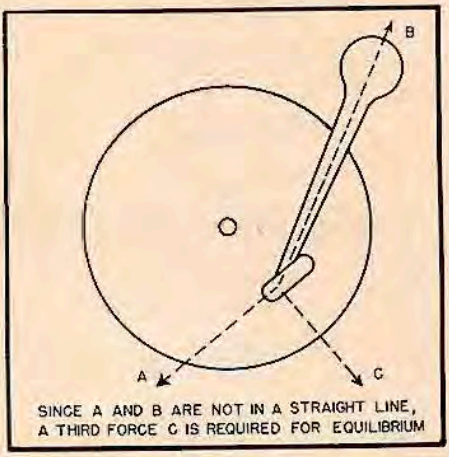

Fig. 1. Diagram of the forces acting on the stylus of an offset-mounted phonograph pickup.

Anyway, for safety sake, this user eased back the adjustment as far as possible, and if still too strong, sometimes removed the spring altogether.

The Forces Involved

There may be readers who are not clear as to the origin of the inward-acting force. In *Fig.* 1, *A* is the direction of the frictional force between the record and the stylus. This is along the groove at the point of contact, i.e., tangential to the record radius just there. When a pickup with offset head is correctly situated for minimum angular tracking error, that tangent is approximately parallel to the line of the head, and therefore misses the arm bearing by approximately the same angle that the head is offset.

If the arm bearing is frictionless, it can only pull, and that only in the direction from the stylus, i.e., in direction *B*. Since *A* and *B* are not exactly in line, there is a tendency for *AB* to straighten out, causing the head to move toward the record center unless a third outwardly acting balancing for such as *C* is provided to ensure equilibrium.

Normally this third force is provided automatically by the guiding action of the groove on the stylus. *Figure* 2 shows the mechanics involved, and that the point is pushed sideways in the process. This is undesirable.

Apart from springs, the required out-

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ward force can be obtained by deliberately departing from a level motor board, and so raising one side of it that the pickup will be climbing "up hill" very slightly as it plays through the record. By careful adjustment of the slope, the downhill force can be made to provide force *C*.

Arm-bearing Friction

Another means of achieving the same result—and one employed by the writer in a pickup designed in 1939—is to introduce deliberately a slight friction into the arm bearing. This method is only suitable for use with normal records which start at the outside. When playing such records, the head traverses the record from the outside toward the center. Any friction in the arm bearing then resists that motion and so provides an outwardly acting force during operation.

In moving-coil pickups which have no iron in the moving parts, the exact angular position of the coil is (within reason) not material from an electrical or magnetic point of view. Nor is there any unstable magnetic effect trying to

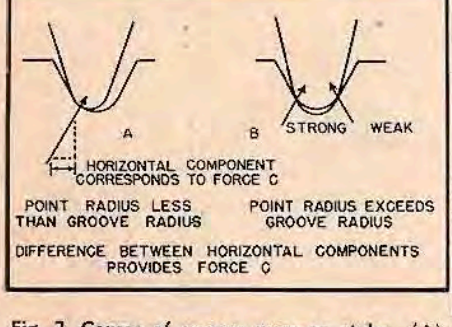

Fig. 2. Causes of uneven wear on stylus. (A) for great differences in pressure on the two sides, and (B) for small differences in pressure.

aggravate any departure from the central position. This permits extremely free mechanical mounting of the moving parts thereby reducing the forces which the groove wall must exert on the stylus at large low-frequency amplitudes. It also diminishes tendencies to set up arm resonances, and lowers their position in the frequency scale. If this freedom is overdone, however, the mounting becomes too "sloppy," and the coil may tilt excessively, causing the stylus to lean over sideward if there is any accidental unbalanced lateral force.

It must also be remembered that if forces toward or away from the turntable center predominate, one side of the stylus will be doing most of the work. Not only is the push-pull effect of the lateral-cut method of recording impaired, but only one side of the groove will be doing most of the work of moving the pickup and therefore wearing out prematurely.

Since the force *A*, primarily involved, is friction between the record and the stylus, it will vary with the record material and with the needle force. It therefore tends to disappear as the needle force is diminished. Since for the present, we are likely to have to continue with pickups which press down on the record even if only slightly, some trace of force *A* will remain. The subject of eliminating its by-product therefore warrants attention.

Simple Test for Balance

If anyone wishes to test whether the lateral forces in his own pickup are balanced, a simple approximate method is to rest the stylus on the uncut edge of a record and allow slight rotation of the turntable. Prominent inward or outward force will then cause the pickup to slide in the corresponding direction.

Since the inward force depends on the friction between the stylus and the disc, this test is only approximate, for the friction of the stylus on the plane surface may be different from that experienced when riding properly in the groove. If the stylus has been used, it may also have developed a shape causing it to "skate" in the preferred direction.

The most certain test is to examine a used stylus (not diamond) under a microscope and compare the wear on the two sides. This gives information as to the average state of affairs under the actual working conditions. (As a caution, remember that when turning points upside down and looking at them under a microscope, one's ideas of direction can play funny tricks.) With an offset head, it is usually the inside surface of the stylus which shows most wear. If so, the inward-acting resultant of *A* and *B* has not been countered sufficiently. The reader will now know what to do.