New Hi-Fi Reluctance Phono Cartridge

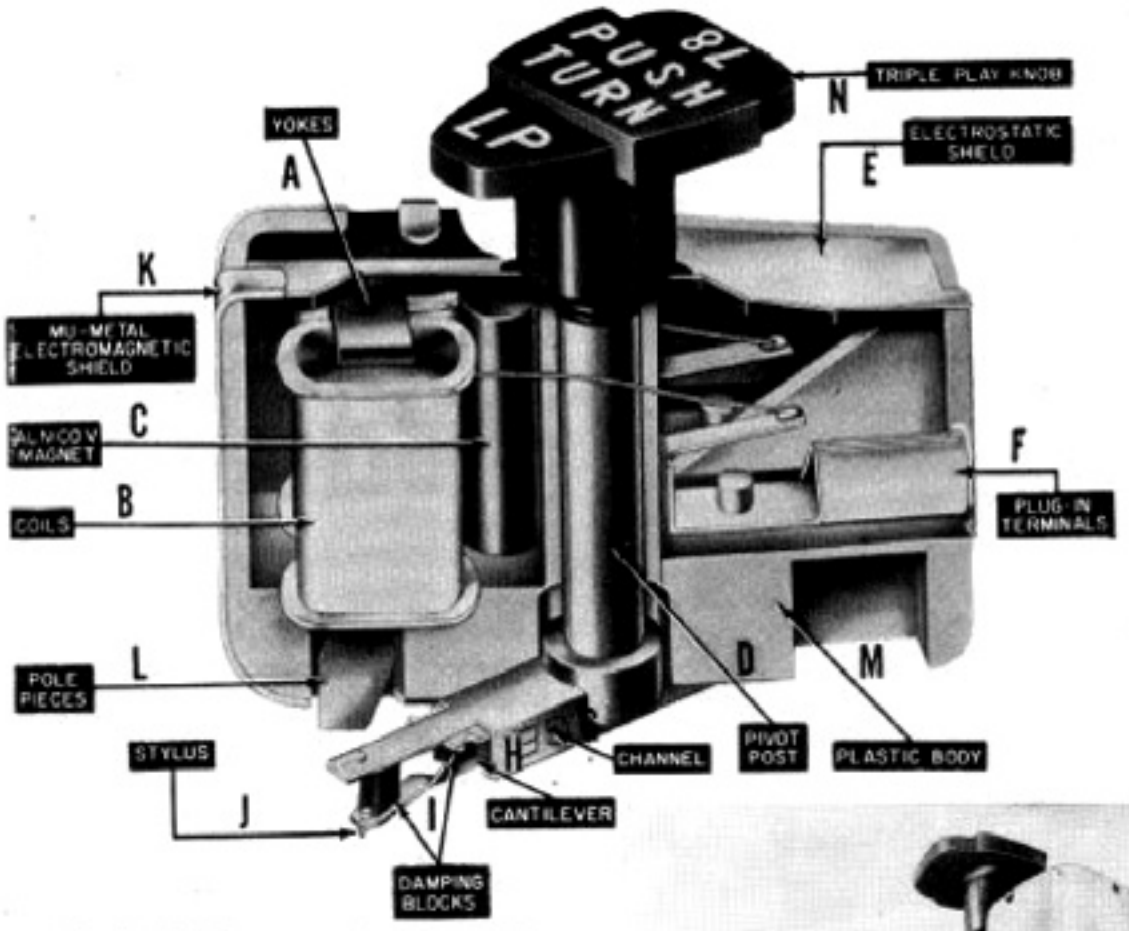

Fig. 1. Cut-away view of cartridge with important parts identified here.

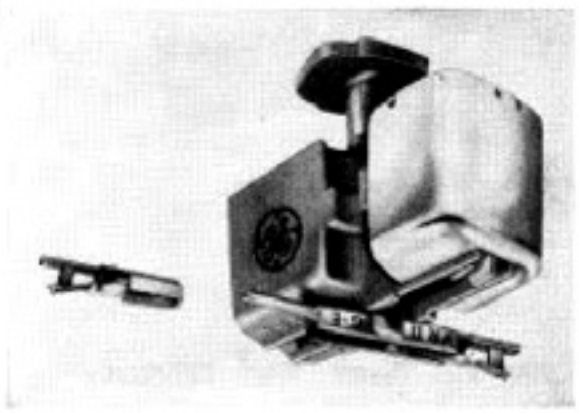

Fig. 2. The dual-stylus type of the VR-II cartridge with its clip-in tips.

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Better high-frequency response, less tracking pressure with new replacement for G-E's RPX reluctance cartridge.

CERTAIN objectives are common to all pickup designs, tempered where necessary to meet practical operational requirements. The objectives include adequate compliance, minimum dynamic mass, smooth extended frequency response, minimum IM distortion, and good transient response.

The VR-II cartridge (Fig. 2) has been designed about these objectives, keeping in mind the essential requirements that it must function properly with presently available changers and tone-arms. It was specifically designed to be compatible, both mechanically and electrically, with the original RPX cartridge and it does replace the original cartridge without changes of any kind. The difference in weight between the two cartridges, approximately two and one-half grams, automatically fixes the vertical needle force of a six to seven gram system to the suggested four gram force suggested for the new VR-II.

Fig. 1 is a cut-away of the cartridge. In playing position (not illustrated) the stylus assembly and its associated channel *G* lie secured in double "V" detents in the body *M*, causing the cantilever *H* to be in the air gap formed by two pole pieces *L-L*.

Assembled on the pole pieces are two coils *B-B*, with the alternating current magnetic path completed by two yokes *A-A*. The cantilever *H* is made of ferrous material and it acts as a flexible extension of the magnet. When the pickup is not in use, the direct current flux divides in the air gap, combines again in yokes *A-A*, with the circuit being completed by air to the magnet. The coils are connected in series opposing for the steady-state magnet flux and stray hum fields, resulting in substantial cancellation of stray fields induced by turntable motors. In operation, the stylus end of the cantilever is driven by the record groove, alternately approaching and departing from each pole piece. The alternating current flux which now appears in the iron path *L-A* causes an equivalent current to be generated in the coils. This current adds in the two coils since the cantilever reduces the flux in one coil as it increases the flux in the other. *(Editor's Note: Although the wire used in the coils is very fine—#44 gauge—no trouble has been experienced in the field with coil burn-out due to the connection of an ordinary ohmmeter across the windings. Such a connection might be made if it is desired to check the cartridge for a possible open winding.)*

We are now ready to consider our design objectives. One of these is the requirement of high compliance. Compliance, expressed in centimeters per dyne (cm./dyne), is essentially a low frequency phenomenon, as ordinarily measured. One common method makes use of tone-arm resonance, wherein the cartridge to be measured is mounted in an arm and driven either with frequency records or a driver. The fundamental resonance of the system is used in the following formula:

$$K = \frac{1}{4\pi^2 f^2 M}$$

where K is compliance in cm./dyne, M is effective mass of cartridge and arm in grams, and f is tone arm resonance in cps.

This method, not used by all manufacturers, results in a better compliance figure because of the low resonant frequencies involved, often as low as ten cycles. Substitution of a calibrated mass for the tone arm permits measurements at a number of frequencies. Disregarding spurious resonances, the higher the frequency used by a given manufacturer, the lower (poorer) the compliance factor will be. This is attributable to increasing internal resistance of any adequate damping material with frequency increase.

It must be emphasized that compliance measurements are essentially low frequency measurements, and are indicative primarily of tone arm tracking ability at low frequencies. A moderate compliance is adequate for this purpose; in fact excessive compliance can be detrimental to changer operation when inadequate tone arm and trip mechanism are involved.

High compliance in itself is not a criterion for minimum record wear. The most destructive record wear occurs at high frequencies and involves other factors, including dynamic or effective mass of the moving system and damping and mechanical resonances. The VR-II moving system consists of a cantilever equipped with a stylus and damping blocks. Since a cantilever is essentially a tuned reed, quite capable of breaking up into any number of mechanical resonances, it becomes obvious that the design of the moving system is of utmost importance. Choice of material, proper cross-section ratio, length and conformation must all be carefully balanced to achieve smooth, wide-range reproduction.

A cantilever, when properly controlled, has certain advantages with respect to effective mass. At low frequencies, it acts as a beam, rigidly supported at one end. When force is applied at the free end, displacement occurs throughout its length to a diminishing degree, disappearing at the secured end. Under these conditions of operation, the effective mass of the VR-II system encountered at low frequencies is not a significant cause of record wear. As frequency is increased, the flexing point of the cantilever moves toward the stylus end. By careful location of the cantilever twist and damping material near the twist, only the front flat section of the cantilever moves laterally, from approximately 9 kc. through 20 kc. Thus the effective mass is greatly diminished at high frequencies, resulting in low record wear in this critical region. Application of controlled damping to this section by means of the front damping block produces a smooth high-frequency response. This results in excellent transient response.

The fundamental compliance of the unit is determined by the length and cross-section ratio of the cantilever in conjunction with the damping system. The necessary degree of restoring force essential to drawing the tone arm across the record is determined by the same factors.

Methods of measuring IM distortion in pickups involves the use of records which, unfortunately, are high in inherent distortion, varying from one to two and one-half per-cent. Such measurements therefore are inconclusive when the per-cent of distortion being indicated by the meter is within this range. Most good pickup designs fall within this category, including the VR-II, and for all practical purposes may be considered to be satisfactory. It is significant, however, that the VR-II reaches this area of fixed distortion at a low vertical needle force.

Fig. 6 shows the VR-II response from 30 cps to 20 kc. An *RCA* 12-5-49 record having an RIAA recording characteristic is utilized for measurements from 30 cps to 1 kc. The curve is corrected in accordance with the corrections included with the record. An *RCA* 12-5-67 pressing is used to measure the response from 1 kc. to 20 kc. This has a constant velocity characteristic and for magnetic pickups has no corrections. Both pressings are in commercial vinyl and present an accurate picture of factual performance.

A word of warning about frequency records. Fig. 3 shows the results of using five different types of records with the same pickup. All pressings are in vinyl and measurement conditions identical. There are other records available that have not been tested. All response claims made for the VR-II are based exclusively on *RCA Victor's* 12-5-49 and 12-5-67 pressings, with nominal manufacturing tolerances applied.

Fig. 4 shows responses with various loads. *Where interstage record compensation is used, the minimum load across the cartridge should be 100,000 ohms.* Larger values may be used. Note that if load resistors in the order of 25,000 or 50,000 ohms are used, these produce undesired treble roll-offs at 15 kc. of 5.5 and 3 db respectively. Since these resistance values are found in a good many preamplifiers that are designed for the variable reluctance cartridge, such units should be checked before installing the new cartridge.

Where it is desired to have an RIAA characteristic directly out of the cartridge from 1 to 20 kc., a 6200-ohm load should be used. This is the same value of cartridge load recommended for the early *G-E* cartridge. Fig. 5 shows the response with such a load, using the 12-5-49 record. Note that under this condition the cartridge may be shunted with as much as 1000 $\mu\mu$fd., without detrimental high-frequency attenuation or resonance effects. For any application that requires a long lead involving high capacitance, record compensation applied directly to the cartridge is recommended.

An electrostatic shield (*E* in Fig. 1) grounds the electromagnetic shield *K* and the moving system to one terminal. This eliminates body capacity effects, if the shield is touched, and effectively dissipates any electrostatic field built up about the stylus by vinyl records. An ungrounded moving system operating under dry atmospheric conditions can result in periodic static discharges, resembling and often confused with severe background noise.

The performance of the VR-II cartridge is readily apparent to the average listener by direct comparison; it is distinguished by peak-free, clean, high-frequency response. Mechanical reproduction, noise emanating directly from the moving system, is effectively reduced by means of a special damping medium. —30—

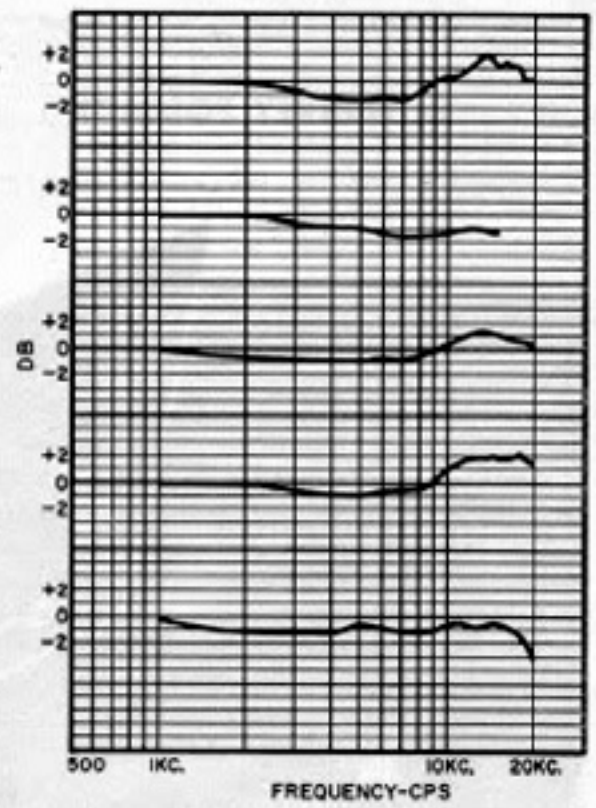

Fig. 3. Response of new cartridge taken under identical conditions with 5 different test records. Had the top 4 of these curves not been obtained from test records produced by the same company, even greater differences would have been apparent.

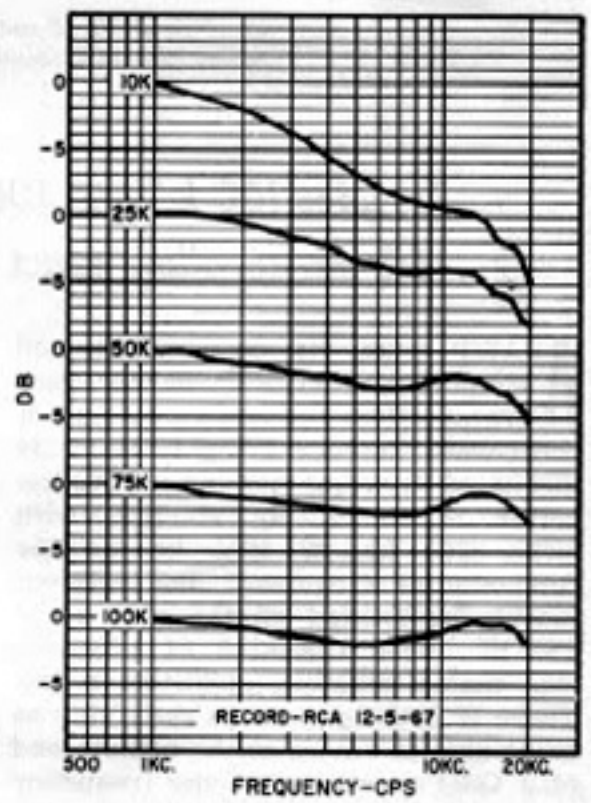

Fig. 4. Note how the output of the cartridge rolls off at the high end when small values of cartridge loading resistors are used. Therefore, when interstage record equalization is employed, the value of the cartridge loading resistor that is used ought to be at least 100,000 ohms.

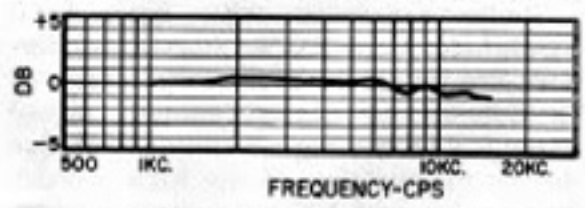

Fig. 5. Response of the cartridge above 1 kc. with a 6200-ohm load resistor. The RCA 12-5-49 RIAA test record was used.

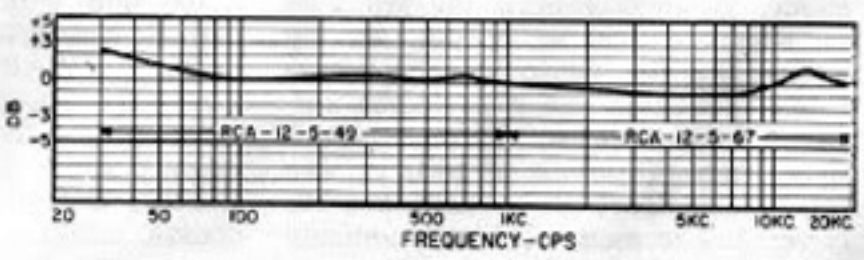

Fig. 6. This is the VR-II response from 30 cps to 20 kc. employing the two test records indicated.

GENERAL ELECTRIC

VARIABLE RELUCTANCE CARTRIDGES FOR STANDARD OR MICROGROOVE RECORDINGS

CAT. NOS. RPX-040, RPX-041, RPX-042, RPX-061 AND RPX-063

SPECIFICATIONS

Cartridge Cat. No.	Stylus Radius	Recommended Use	Equipped with Stylus Cat. No.
RPX-040	.003 in.	Standard (78 rpm)	RPJ-001
RPX-041	.001 in.	Microgroove (33⅓–45 rpm)	RPJ-005
RPX-042	Select Stylus from Service Chart		Less Stylus
RPX-061	.001 in.	Microgroove (33–45 rpm)	RPJ-004
RPX-063	.003 in.	Standard (78 rpm)	RPJ-003

Resistance (D-C).....approximately 340 ohms
Inductance.....approximately 520 millihenries
Output @ 1000 cycles (minimum)
RPX-040 (Columbia 10003M test record).....approximately 10 millivolts
RPX-041 (Columbia RD90 test record).....approximately 10 millivolts
Stylus Pressure.....6 to 8 grams

GENERAL

These cartridges are identical except for the stylus as described in the specification chart above. The stylus assembly may be readily replaced when necessary. All the replacement "Baton" stylus assemblies given in the catalogue listing at the end of this instruction may be used interchangeably with any of these cartridges. The stylus selection should be made in accordance with its recommended use and choice of sapphire or diamond stylus tip. Each stylus assembly is identified by a code color located on the stud pin at point "C" shown in the cartridge illustration.

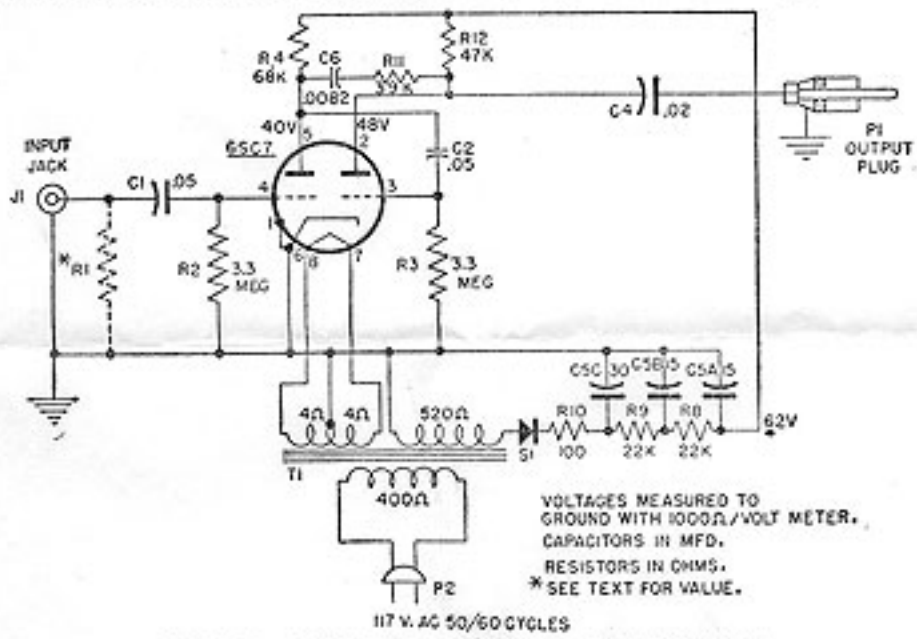

FIG. 1. UPX-003A PREAMPLIFIER CIRCUIT

AMPLIFIER DESIGN

For optimum performance, the amplifier should be designed for full output with 10 millivolt input. Circuit equalization must be employed to compensate for recording characteristics of the various record manufacturers to obtain the desired frequency response. Actual design will vary according to the requirements of the individual installation, but for applications involving music amplifiers and radio receivers, the General Electric Cat. No. UPX-003A Phono Preamplifier is recommended to provide the necessary preamplification of the reproducer's low level output and the previously mentioned circuit equalization. The equalization is provided by C6 and R11 shown in the accompanying schematic diagram of Figure 1. The low frequency cross-over of this combination is approximately 700 cycles. Total equalization is 18 db. In the receiver or sound apparatus to be used with these units, *previously employed circuit compensation for phonograph cartridge frequency response must be removed.*

NOTE: R1 may be seected in the range of 3900 to 50,000 ohms and added as shown in the schematic diagram. The higher values provide increased high frequency response but the surface noise will also be increased. For maximum high frequency response, R1 may be omitted entirely. The recommended value for general application is 6800 ohms.

A1-900 RECORD COMPENSATOR—An adjustable record compensator, such as the General Electric model A1-900, is a convenient means of obtaining the most widely used response curves. This unit also has two scratch filter positions for 78 RPM records. The Variable Reluctance cartridge connects directly into the compensator which plugs into a UPX-003A preamplifier, or equivalent input circuit. When using the A1-900 compensator, the cartridge preamplifier loading resistor, R1, is omitted.

TONE ARM REQUIREMENTS

Choice of the tone arm should be carefully considered. The mass weight of the arm should be low, and the lateral and vertical bearings of the low friction type. If the tone arm has excessive mass, and friction in its bearings, the record groove will be overloaded, causing immediate or early breakdown of the record surface material and consequent destruction of the recording. The force required to move the pickup and arm in a lateral direction should not exceed 2 grams. The difference in stylus pressure measured when moving the arm very slowly upward should not exceed the pressure measured moving the arm downward by more than 2 grams. When making measurements the stylus must rest on the weight measuring device as the device is moved, first upward approximately ⅛ inch, and then downward approximately ⅛ inch.

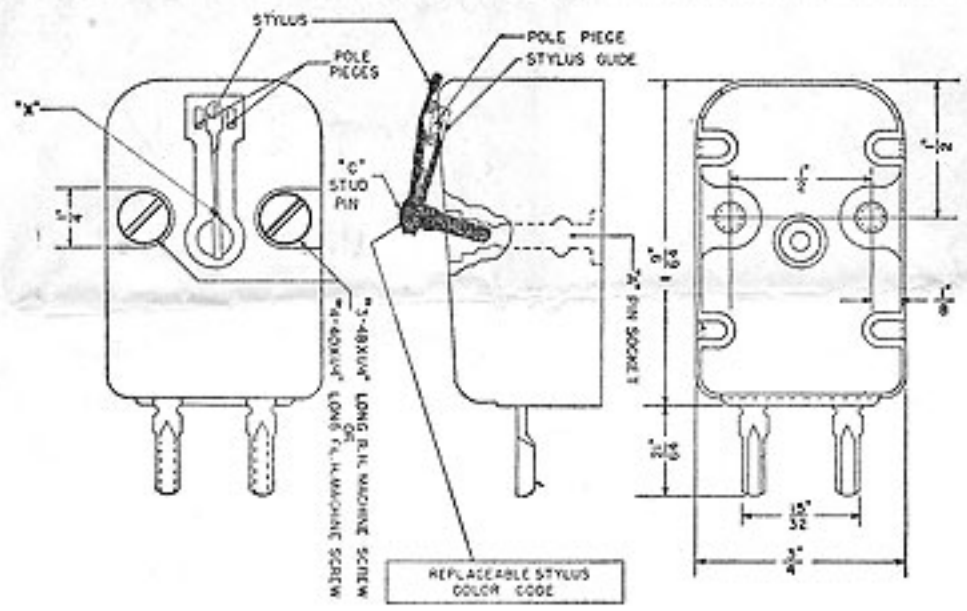

FIG. 2. CARTRIDGE OUTLINE

FA-21-A TONE ARM—The General Electric model FA-21-A tone arm is recommended to meet the above specifications for use with variable reluctance cartridges. An adapter weight (RWP-001) is available to make it operate at the 6 to 8 gram pressure required for these cartridges.

ADDITIONAL REQUIREMENTS

Additional considerations are required in the choice of the preamplifier and phonograph motor. Due to the lower output of the pickup cartridge playing narrow groove recordings (caused by less groove displacement) the hum-to-signal ratio is increased. For this reason the four-pole phonograph motor is preferred to the two-pole type. In addition, adequate filtering of the sound system power supply is necessary to keep the hum-to-signal ratio at a minimum.

MOUNTING

Most tone arms of current manufacture will accommodate the General Electric Variable Reluctance Cartridges readily, mounting being done by means of the two No. 3-48 x ¼-inch long Round Head machine screws. Two No. 4-40 x ¼-inch Fillister Head machine screws are also supplied for use with pickup arms requiring this size screw. In cases where fitting is necessary, pickup arm mounting bosses may be trimmed to accommodate the reproducer. Detailed dimensions are given in the cartridge outline drawing. Any modifications required should be made in the tone arm, never in the cartridge or cartridge case.

For use in automatic record changers, to insure clearance between the topmost of a full stack of records and the cartridge case, the cartridge should be mounted with its top surface parallel to the tone arm.

STYLUS ASSEMBLY REMOVAL AND INSTALLATION

The replaceable stylus assembly is shown in the darker cartridge outline of Figure 2. Unless a hole is provided in the top of the tone arm for the purpose, the cartridge must be removed from the tone arm for access to point "A" in the procedure for stylus removal.

REMOVAL—Insert a straightened paper clip or equivalent tool into the stylus stud pin socket at point "A". Press the stylus assembly out with the tool as shown by the arrow.

INSTALLATION—Lay the stylus assembly into the position shown so that the stylus guide lies within the recess between the magnet pole pieces. Press assembly in firmly by applying pressure only at point "C," making certain that the stylus guide remains centered between the pole pieces to avoid damage to the assembly. The space between the stylus spring and each of the two pole pieces should be approximately equal. If it is not, adjust by carefully bending the stylus arm laterally at the point marked "X." Bend only slightly.

SERVICE

To insure optimum performance from the General Electric Variable Reluctance Cartridge its stylus, magnetic pole pieces, and gaps should be cleaned periodically of foreign particles which accumulate from the record surfaces. A soft bristle brush similar to Cat. No. RQB-001 should be used to clean these parts.

The gap clearance between stylus and each of its pole pieces has been adjusted to be not less than .010 inch. To obtain optimum performance from your cartridge, be careful not to disturb this adjustment during assembly or when cleaning the unit.

The following stylus assemblies are available as catalogued below. These assemblies can be interchanged to mount into the pickup cartridges listed in these instructions.

REPLACEMENT "BATON" STYLI

Tip Radius	Recommended Use	*Sapphire Stylus	Color Code	Diamond Stylus	Color Code
1 mil	Microgroove (33⅓–45 rpm)	RPJ-005	Red	RPJ-004	Black
2.5 mil	N.A.B. Transcriptions	RPJ-006	White	RPJ-002	Yellow
3 mil	Standard (78 rpm)	RPJ-001	Natural	RPJ-003	Violet

*Synthetic sapphire.

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