SUCCESSFUL SERVICING

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the crystal phonograph cartridge

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(The author acknowledges the cooperation of the Astatic Corporation whose illustrations are used in this article.)

It has been said that Tom Edison was inspired to invent the phonograph while watching a rotating cylinder which clacked every time another moving part struck a worn irregular spot on its surface. Tom then decided that he could impress certain irregularities upon the face of the cylinder, using a defacing instrument operated by vocal speech funneled through a megaphone. Once impressed, the irregularities moved a needle through the "clacks" at the same impressed rate, in turn reproducing the sound at will.

If that is the whole of the story then little change has taken place in the basic process. The cylinder (now more popularly a disc) permits the needle (stylus) to move (generally in lateral motion) in turn transmitting this movement to a reproducing device (see Fig. 1).

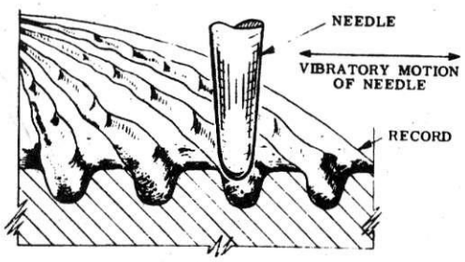

Fig. 1. Greatly enlarged view of record and needle, showing needle following record grooves. The needle is vibrated in proportion to the amplitude of the record sound.

It is the reproducing device used to change the mechanical movement to electrical impulses that concerns us here. While several systems are in use, the most common and economical utilize the crystal cartridge. This is a device capable of converting instantly without additional equipment, torsional mechanical energy into electrical energy within itself (piezoelectric effect). The crystal cartridge is one of the simplest effective phonograph pickups yet contrived.

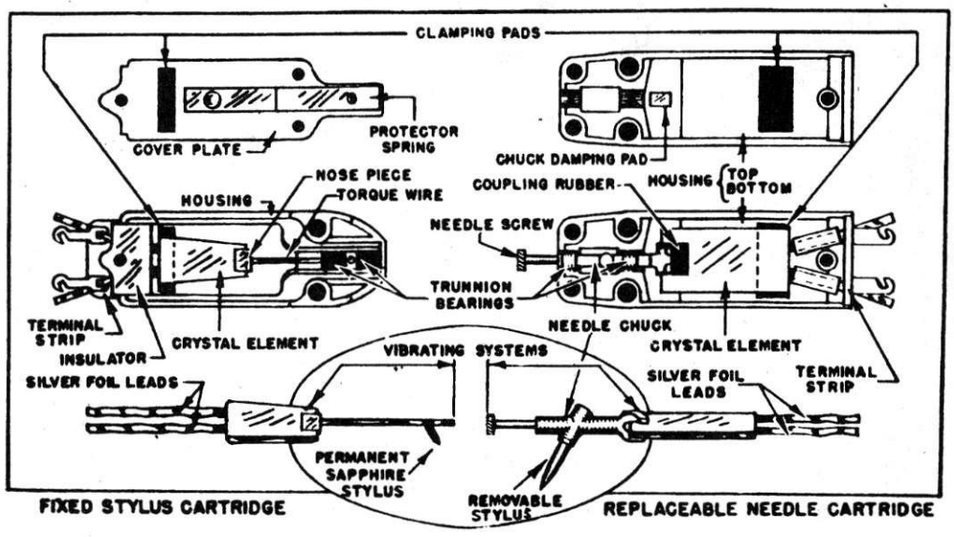

Fig. 2. Fixed and removable stylus crystal cartridges.

Consider Fig. 2. Here are shown various views of both the fixed-stylus cartridge and also the replaceable-stylus type. Note the simplicity. A glance at Fig. 3 will show (somewhat irreverently) exactly what happens. Mechanical vibration comes in at one end—electrical impulses go out the other.

Temperature Effects

The phonograph pickup cartridge crystal element is ordinarily made of Rochelle salt (sodium potassium tartrate). Since it is a salt it is hygroscopic, like table salt, and can absorb water—even from the air itself—if the humidity is high enough. It is sensitive to temperature as well, operating best between the temperatures of 70 to 80 degrees (F), at a relative humidity of about 50 per cent. In this respect these crystals are very much like human beings, in that wherever humans can live comfortably the crystal element will function normally and have a long life span.

The crystal elements will continue to operate between temperature extremes of —40 degrees and 120 degrees (F). If exposed to temperatures above 120 degrees (F), the crystal will lose its piezoelectric activity permanently. Since normal usage of phonographs brings the crystal element within the acceptable temperature range, the serviceman need concern himself only with allowing sufficient ventilation around the phonograph or radio cabinet in order that the temperature around the pickup be kept at the proper value. Pickup cartridges and other crystal devices should not be stored near heaters or radiators, nor should they be displayed in store windows or show cases where bright sunlight is apt to shine. (Did you ever return a pickup for credit, explaining that it was taken from a brand new phonograph which had never been taken from the display window?)

Moisture Problems

In extremely dry climates, some crystal pickups have a tendency to become dehydrated (losing much of their natural moisture) when subjected to high temperatures at low humidity. Once a crystal becomes dehydrated, nothing can be done to restore

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it to normalcy. It is too late to merely add moisture then, because the crystal structure itself has warped.

In climates where the temperature and relative humidity are extremely high, crystal cartridges have a tendency to take on excessive moisture. A simple *desiccator,* such as is shown in Fig. 4 may be used as an aid in controlling this hydration. The desiccant may be either calcium chloride or silicagel. If the crystal cartridge, when not in use, is stored in the desiccator, the excess moisture will be removed from the crystal element, thus helping to prolong the useful life of the cartridge.

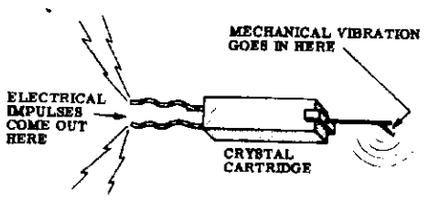

Fig. 3. Operation of the crystal cartridge.

In this case the desiccant must be changed periodically, as it becomes saturated with moisture. To determine whether the desiccant has reached its saturation point, a piece of paper toweling may be moistened and inserted in the desiccator. This should completely dry out within approximately 1½ hours. If it does not dry, it may be assumed that the desiccant has become saturated and should, therefore, be replaced.

Soldering to Cartridge Terminals

When leads are required to be soldered to the cartridge terminals during installation or service, the soldering iron should not be applied for a longer time than necessary to make a solid joint. Terminals are well tinned during manufacture and if leads are also well tinned before connection is made, it is only necessary that the soldering iron be applied to the joint long enough to flow the solder. Remember the metal ribbon leads to the crystal conduct heat very well, and the usual soldering iron temperature is well over 120 degrees F. Give the crystal element a chance, before it is even connected to the phonograph.

Replacement of Cartridge

To an experienced serviceman replacement of a crystal phonograph cartridge is a fairly routine procedure. Charts are available, listing replacement cartridge specifications, identifying the frequency response, output voltage, physical mounting, needle pressure—everything required to show which cartridge may be used to replace which. From stock, or if necessary from the shelves of dealers, the required replacement is obtained, connected, mounted, and the job is done. The serviceman gets his fair labor charge, and he's sold a cartridge. The customer has a speedy repair with an exact replacement.

On the other hand, lest the serviceman consider opening the crystal cartridge and attempting an internal repair of the element itself—remember the eternal soldering caution? It's even worse inside. Consider:

1. A crystal element consists of a chemical salt. (If you get the chance, give one a lick with your tongue. *Salty,* isn't it?) No binder but the normal crystalline structure holds the fragile element into a single piece. In handling and assembly this frail salt is easily broken. You break a crystal in assembly, and there's your profit on the floor in chips.

2. Crystals are especially treated at the factory to protect them from adverse climatic conditions, requiring specially controlled storage facilities. The crystal elements themselves are not stocked. They are assembled as received. The complete cartridge is stocked as a sealed unit. Should the service shop desire to stock crystal elements, without temperature and humidity controls, the loss from deterioration of crystals would prove prohibitive.

3. The crystal pickup cartridge assembly appears to be a simple mechanism. In operation it is truly simple. However, fine tolerances with special instruments and individual company techniques make each cartridge a precise problem in basic construction. Even if you could match the company assembly, would it pay?

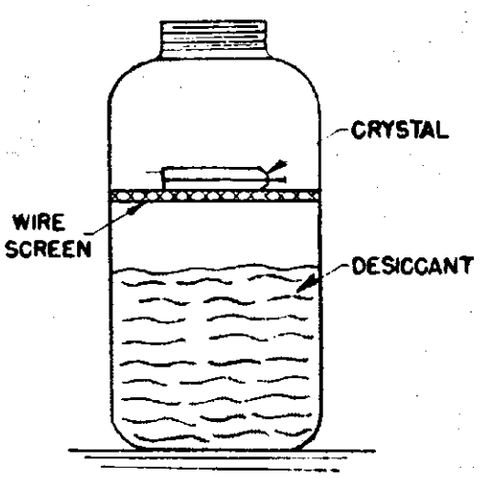

Fig. 4. Using a desiccant to dry out a crystal.

4. Finally, even if you did complete the assembly, could you tell how the repaired unit stacked up against the factory product? Few servicemen have access to the test equipment necessary to properly test pickup cartridges. And there's no dealer return of opened, "repaired" cartridge units.

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"Improving" the Situation

Now, for another service failing. The well-intentioned serviceman, finding it necessary to replace a bad cartridge, decides to win customer approval by improving the performance of the equipment by replacing the original faulty cartridge with a more recently developed model. The output voltage of the original cartridge was approximately 2.5 volts at 1,000 cps. The cut-off frequency of the cartridge then might have been 4,000 cps, with a husky needle pressure of 2¾ ounces. The customer had been satisfied, but now simply requested replacement and return of the apparatus.

Good-hearted-Joe thumbing through the catalogue instead picks out a cartridge with an output voltage of 1 volt, a needle pressure of 1 ounce, and a greatly extended frequency range, cutting off at almost 10,000 cps. The customer, impressed by the description, waits the two weeks for delivery, finally arriving to find the unit installed.

Of course, the pickup arm had to be counterbalanced for one ounce needle pressure. This caused considerable trouble with the record changer trip mechanism, since it was designed to operate at the greater needle pressure required by the original cartridge. A decided loss in output resulted, of course, since the new cartridge was designed with decreased output voltage. The audio amplifier, never designed for extra power or wide response, didn't even notice the highs, and didn't have enough gain to make up the loss of input in the first place, consequently giving very weak output. As if that weren't enough, the maximum volume setting to get even weak output accented needle scratch and increased audio distortion. P.S. The new model also cost more. (Question—how much is Joe's profit?)

Every story should have a moral. Okay, here it is: A serviceman's business is to restore the faulty unit to its original condition.

Carry an Extra-Hi Voltage etc.

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for feedback. There is nothing critical about the placement of parts, but reasonable care should be used to insulate the high-voltage. A stand-by switch is used instead of an on-off switch to facilitate testing without waiting for the filament to heat each time. No pilot light was included because the squeal of the transformer can be heard when the power is on.