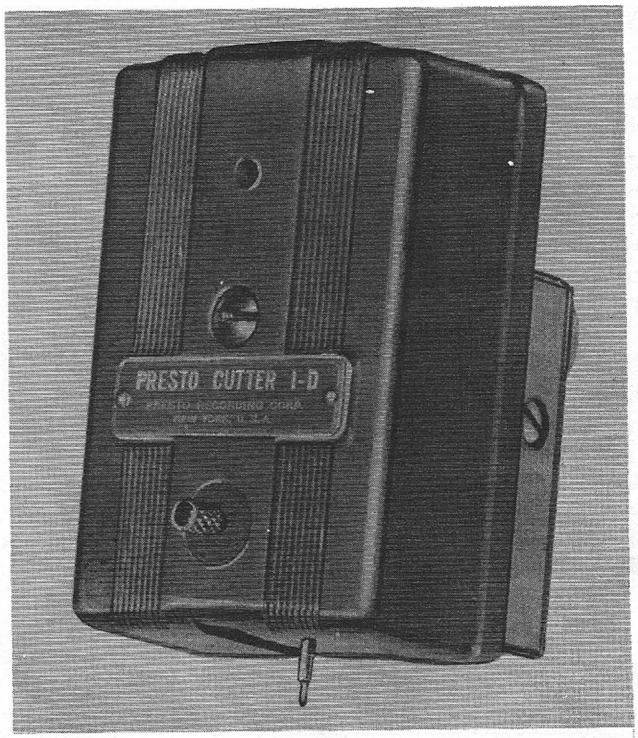
INSTRUCTIONS

PRESTO RECORDING CORP.



1-D Recording Head

GENERAL DESCRIPTION

The 1-D recording head represents essentially a multisection mechanical band pass filter which is terminated with the aid of **Prestoflex**, a new damping material with a very low temperature coefficient. Prestoflex was developed and manufactured exclusively by the Presto Recording Corporation.

Because of a carefully balanced armature in the construction of the 1-D head, cancellation of the even harmonic components is achieved, while proper choice of the magnetic characteristic of the armature material helps to reduce odd harmonics to a very low value. Eddy current losses, which are unavoidable at higher audio frequencies, are kept to a minimum through the use of laminated pole pieces. The permanent magnet was selected for its stability and long life. The armature moves against an accurately machined and hardened knife edge and is centered between the pole pieces with the aid of three tempered steel springs.

FREQUENCY RESPONSE

The normal response range of the 1-D head extends from 50 to 10,000 cycles per second. Recordings made with this head are of constant amplitude below the cross-over frequency of approximately 500 cps, and of constant velocity above 500 cps for constant input at all frequencies into the recording amplifier.

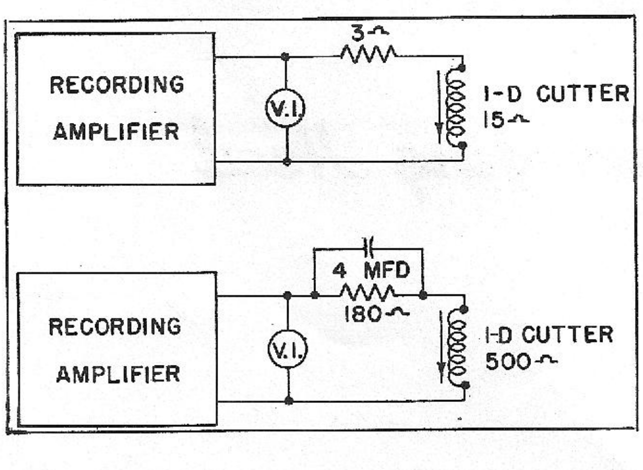


FIGURE 2. DETAILS OF CUTTER COMPENSATOR NETWORK

To obtain a 6 db per octave slope of the velocity versus frequency characteristic below the crossover point requires the use of a 1-D head in series with a simple network across the amplifier output (figure 2). For a 15-ohm head this network is a three-ohm series resistor, whereas a parallel combination of a 180-ohm resistor and a 4-mfd capacitor is used in series with the 500-ohm head. The average frequency response obtained with these values for the elements of the compensating network is shown in figures 3 and 4. Variations in the low frequency response are indicated for a number of different values of the series resistor. To realize the full possibilities in recording with the 1-D cutting head, the playback characteristic chosen should be complementary to the cutter frequency response.

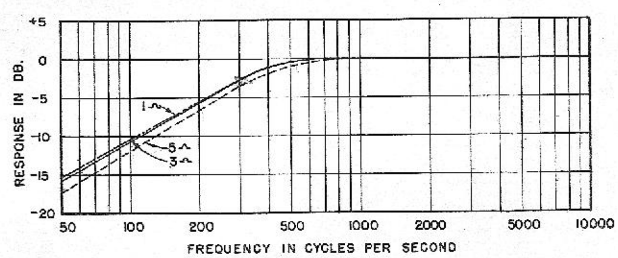


FIGURE 3. AVERAGE RESPONSE OF 15 OHM 1-D RECORDING HEAD. (Tolerance ±2 db)

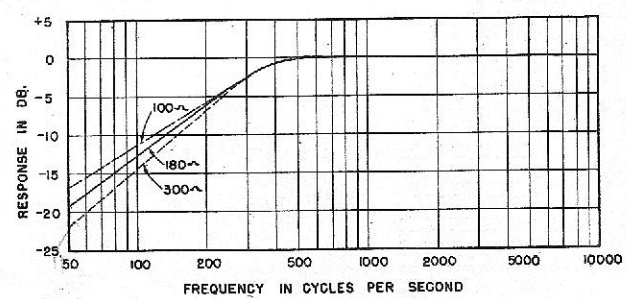


FIGURE 4. AVERAGE RESPONSE OF 500 OHM 1-D RECORDING HEAD. (Tolerance ±2 db)

DISTORTION

The distortion of recordings made with the 1-D recording head is very low because of the special construction features mentioned in the general description. With full groove modulation at 112 lines-per-inch the maximum overall distortion, including pickup and amplifier non-linearity, is approximately 3% (r.m.s.).

SENSITIVITY AND INFLUENCE OF RECORDING STYLUS

The audio power required for approximately 5.5 cm per sec. stylus velocity at 1000 cps is 0.6 watt. This sensitivity is obtained with a sapphire stylus 47/64″ ±1/64″ long, and having a shank diameter of 0.065″. This is also the correct stylus size for obtaining a uniform frequency characteristic up to 10,000 cps. A longer stylus, though giving slightly higher recorded amplitude for the same power output, will not give such a uniform high frequency response. The use of a sapphire with a short shank is not recommended.

TEMPERATURE INFLUENCE

Temperature variations have very little influence on the response and sensitivity of the 1-D cutter. Tests covering the temperature range from 60° Fahrenheit to 95° Fahrenheit show no more than a ±2.5 db variation in the frequency response. At low temperatures, the loss in sensitivity is on the average less than 2 db. The use of Prestoflex makes the 1-D recording head much more stable with temperature than the viscoloid or oil damped unit.

The heating effect of the signal currents flowing through the coils is negligible, and at normal recording levels a sinusoidal steady state signal, even if applied for several minutes, does not cause any changes in the characteristics of the 1-D cutter.

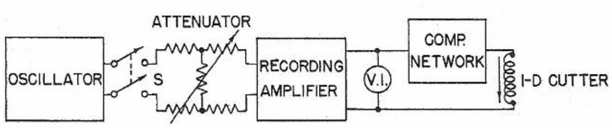


FIGURE 5. SETUP FOR RESPONSE MEASUREMENTS

RESPONSE MEASUREMENTS

The response of the cutter is usually checked at 78 rpm. The setup is shown in figure 5. The 78-rpm speed is chosen because the pattern obtained is very sharp and well defined and because of the relatively high needle velocity. The amplifier used with the cutter should have uniform response from 30 to 10,000 cycles. The recording level is adjusted to +23 db* (approximately +31 dbm**) at 1000 cycles. A constant input voltage to the amplifier from a good audio oscillator at all frequencies will result in a frequency pattern similar to the one shown in figure 6.

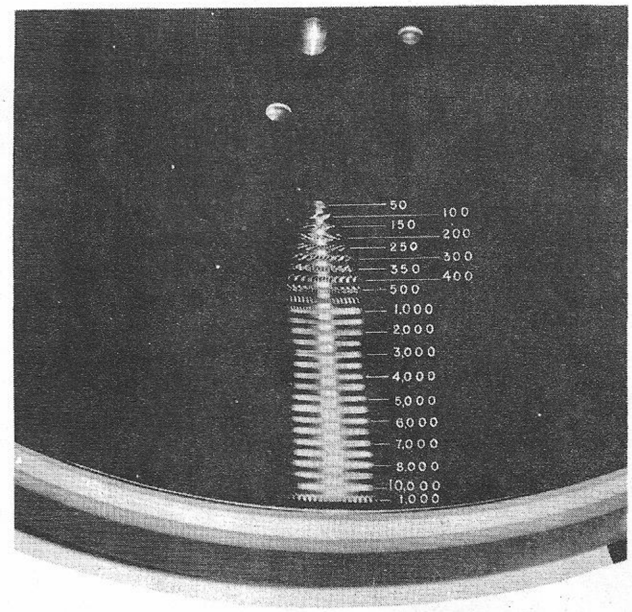


FIGURE 6. UNRETOUCHED PHOTOGRAPH SHOWING LIGHT PATTERN

Checking the 1-D cutter at the factory follows this procedure: The pattern is started on a 12″ disc at the inside at approximately 2-3/4″ radius, and the following frequencies in cycles per second are cut in bands about 1/16″ wide and spaced 1/16″ apart: 1000, 50, 100, 150, 200, 250, 300, 350, 400, 500, 750, 1000, 1500, 2000, 2500, 3000, 3500, 4000, 4500, 5000, 5500, 6000, 6500, 7000, 7500, 8000, 9000, 10000, 1000.

The spacing between recorded frequency bands is obtained by opening the key "S." The 1000 cycle signal is recorded at both the inside and outside of the record to obtain a reference level at both ends of the frequency band. Observation in sunlight or any other artificial parallel beam light source should show a substantially flat pattern above the cross-over frequency.

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*db - single frequency level (6 milliwatts)
**dbm - single frequency level (1 milliwatt)

33-1/3 R.P.M. NARTB CHARACTERISTIC RESPONSE MEASUREMENT

A check on the equalized recording characteristic (NARTB) should never be made with the input to the amplifier kept constant. This would lead to an output rise of about 16 db above the 1000-cycle level at 10,000 cps and damage to the cutting head may result. Such an overload cannot occur during recording of any actual sound program, since peak energy levels at higher frequencies are about 20 db below peak energy in the middle audio-frequency range. In making this equalized run, the attenuator between the oscillator and the recording amplifier should be of the variable type with fixed known loss between points. The amount of attenuation between the oscillator and the recording amplifier should be reduced by an amount equal to the rise in the equalizer characteristic for any particular frequency. For example, if the equalizer characteristic shows an increase of 4 db at 2000 cps above the 500-cps level, the attenuation should be increased by 4 db at 2000 cps. The result of this decrease in amplifier input and the complementary rise in the amplifier frequency characteristic, because of equalization, will be a flat recorded pattern. Any deviation from a uniform characteristic (above the cross-over point) indicates an incorrect equalizer curve if the previous frequency run with the amplifier in the flat position shows the cutting head itself to have the correct frequency response.

OPERATION

CHARACTERISTICS OF THE RECORDING CHANNEL

The recording amplifier to be used with a 1-D head should have an output impedance of 15 or 500 ohms, depending on the cutter used. When operating into its nominal load impedance, the amplifier should have a uniform response between 50 and 10,000 cps. It should be possible to equalize this response at higher audio-frequencies if desired. Such a high frequency pre-emphasis is useful in improving the signal-to-noise ratio during playback. This is achieved by accentuation of the higher frequencies while recording and their attenuation when playing back since most of the noise components resulting from the granular structure of the recording blank lie in the upper part of the audio spectrum. Equalization of these frequencies during recording is permissible since this frequency range contains only a small amount of the total sound energy.

The 1-D recording head is normally operated at a power input of 1.2 watts or +23 db. The average current and voltage corresponding to this power level are exceeded considerably at very low and very high frequencies respectively. This necessitates the use of a power amplifier capable of delivering at least 10 times (corresponding to a level of +33 db) this power with low harmonic distortion. Such a power reserve is also very important to record the instantaneous peaks of orchestral music without excessive distortion.

To improve the transient response of the recording head, it is advisable to keep the internal impedance of the recording amplifier as low as possible by using either triodes or pentodes with voltage feedback in the final stage. High frequency equalizer circuits used with this cutter should not cause any changes in the internal output impedance of the amplifier because a very poor transient response would result.

RECORDING AT 78 RPM

A recording amplifier as described above, together with the 1-D cutter, the compensating network and the proper recording stylus will then represent a recording channel flat up to 10,000 cps and provide the characteristic normally used for recordings at 78 rpm. The connections of the recording head, the network and the volume indicator are shown in figure 2. The volume level indicator should have the electrical and dynamic characteristics necessary to meet the requirements of monitoring broadcast programs. A VU-meter (type 30) will be most satisfactory.

RECORDING AT 33-1/3 RPM

In 33-1/3-rpm work it is standard practice to use the NARTB rising high frequency characteristic for recording and its complement for playback to improve the signal-to-noise ratio. The standard NARTB recording characteristic for lateral transcriptions is shown in figure 7 with the shaded area indicating the ±2 db tolerance limits. The 6 db slope of this characteristic below the cross-over frequency requires a recording at constant amplitude. This is obtained by the decrease in cutter impedance with decreasing frequency. Thus less and less voltage is developed across the cutter as compared to the voltage drop across the internal impedance of the amplifier.

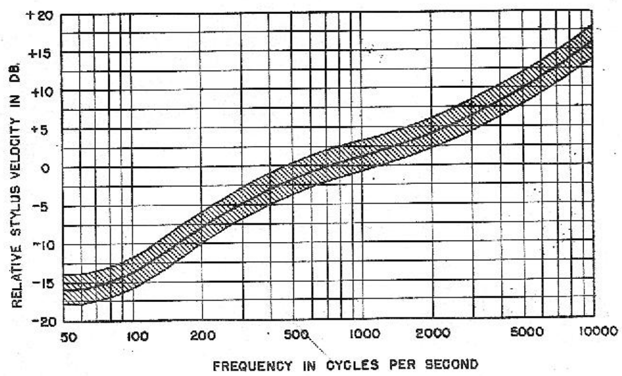


FIGURE 7. RECORDING CHARACTERISTIC FOR LATERAL TRANSCRIPTIONS

This decrease in voltage coupled with the simultaneous decrease in cutting head impedance tends to keep the current through the cutter constant.

MAINTENANCE

The 1-D cutter is carefully calibrated and adjusted when it leaves the factory. It is protected by a closely fitting cover. The cutting stylus is inserted through a hole in a rubber washer which keeps any magnetic dust from entering the narrow gaps between armature and pole pieces. The cutter will stay calibrated indefinitely unless exposed to extremely high temperature or overloaded electrically for a considerable length of time.

The armature has a V bearing milled out along its longitudinal length as shown in figure 8. In manufacturing, this operation is very carefully carried out so that a perfect V is made, the apex of which is a fine line. The armature is mounted with the V resting against a knife edge which is carefully hardened and ground. The armature saddle, on one side of the armature, has two springs mounted thereon. The center spring (the retaining spring) is fastened to screw B. Screw B pushes the armature up against the knife edge. Inspection of the contact area between the knife edge and the V of the armature is then made under a microscope. When the proper contact is made, screw B is locked with setscrew B-1. This adjustment is permanent and should never be disturbed. The two balance springs are used to center the armature between pole pieces. Each spring is controlled by its own screw A. When the position of the armature is definitely set, screw A is locked by setscrew A-1.

If the armature collapses, follow this procedure to center it: Remove cover screw, needle screw, and front cover. Next, remove back cover plate by removing the small flathead screw. With a small screw driver, loosen lockscrews A-1. The adjusting screws A can now be turned by means of a small screwdriver. By holding the cutter to the light and adjusting screws A, the armature of the cutter can be brought back to the magnetic center. When this adjustment is made, tighten lockscrews A-1. Be careful not to exert too much pressure with the screwdriver, because the heads of these small screws will break easily.

CAUTION: *Under no condition should lockscrew B-1 be loosened or the retaining spring screw be moved. Failure to heed this warning will throw the armature off the knife edge.*

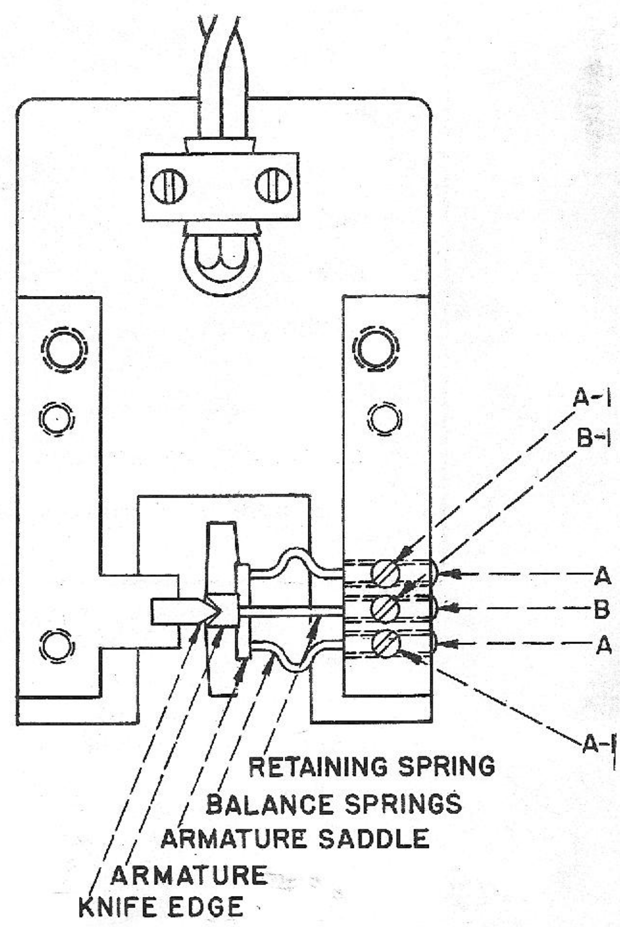


FIGURE 8. REAR VIEW OF 1-D RECORDING HEAD

GUARANTEE

The Presto Recording Corporation guarantees to repair or replace, without charge, any equipment or part thereof which shows a defect due to workmanship or materials within ninety days after date of sale. To obtain free service or replacements under this guarantee, the equipment or part must be returned, transportation prepaid, either to the Presto factory or to the distributor from whom it was purchased. Before returning equipment to the factory, kindly write to our service department for shipping instructions and return authorization forms. We cannot assume responsibility for any charges incurred in returning equipment without our authorization.

A guarantee card is enclosed with each unit. This card must be returned to the factory within seven days of the date of purchase to obtain service under the guarantee.

AN INSTANTANEOUS RECORDING HEAD

COMMUNICATION & BROADCAST ENGINEERING MARCH, 1937

By GEORGE J. SALIBA

Chief Engineer

PRESTO RECORDING CORPORATION

INSTANTANEOUS RECORDING has progressed so rapidly in the last two years and its field of application has been so widened that now the hue and cry is for recordings that are equal in every respect to commercially pressed electrical transcriptions. The amplifiers, record materials, and recording machines have been so highly developed that instantaneous records are now equal to commercial transcriptions in every respect except one—and that one exception is high-frequency response. The fault has been in the type of cutting head used, and it is the purpose of this article to discuss a late development in recording heads.

In designing the cutting head herein described the following specifications were laid down:

(1) It must be driven with comparatively little power

(2) It must have a good frequency response from 50 to 7,000 cycles

(3) It must work from a low-impedance source not exceeding 500 or 600 ohms

(4) It must not be susceptible to weather conditions and high temperatures

(5) It must maintain its calibration with very little service.

A good recording head operates in a linear fashion over the range of amplitudes involved in speech and music. It is essentially a constant-velocity device. This means that for a given input voltage to the speech coils of the cutter, the amplitude of the wave on the disc at a frequency of 500 cycles will be twice as much as the amplitude for 1,000 cycles and four times as much as the amplitude for 2,000 cycles. Since the energy of speech and the timbre and depth of good music lie principally in the lower frequencies, it is obvious therefore that the greatest tendency for two adjacent grooves to cut into each other will occur at the lower frequencies. Therefore, below 400 cycles the cutter should have constant amplitude. This means that for a given input the amplitude at any frequency below 400 cycles will be the same. The frequency characteristic of the cutting head in Fig. 1 is shown in Fig. 3.

The upper limit of high-frequency response is seen to be 7,000 cycles. This is about the practical limit in lateral disc recording. The sharpness of the angle of cut becomes of great importance in the reproduction of frequencies higher than this. At any given distance from the center of the disc the wavelength of the groove will be inversely proportional to the frequency. Therefore, with increase of frequency the distance between successive points at which the groove crosses the mean will become less and less. If a record is cut with maximum lateral amplitude for a number of single frequencies proceeding from low to high, a frequency will presently be reached for which the wavelength is so small as compared with the amplitude that the groove crosses the mean very nearly at right angles. It is impossible for a needle to follow so steep a wave front, and therefore it will be necessary to reduce the amplitude in order that the needle may track at such frequencies. As soon as the amplitude is reduced, the surface noise will become quite noticeable, with the result that little is gained. (A study of amplitudes and wavelengths appeared in the January, 1936, issue of COMMUNICATION AND BROADCAST ENGINEERING.) Since the linear velocity of the needle in the groove is at all times proportional to the distance from the center of the disc to the groove where the needle rests, it follows that the angle of cut is of less importance as a limiting factor toward the outside of the disc than it is toward the inside. For example, a frequency of 7,000 cycles might be easily reproduced at the outside of the disc and not reproduced at the inside.

ARMATURE MOUNTING

The electrical principle involved in the operation of recording heads is the same as that involved in the operation of electric motors. The recording head performs the same function as an electric motor; both take electrical energy and convert it to mechanical energy. The principle involved in either case is the same; namely, that of a wire carrying current in a magnetic field. In recording, alternating current is fed to the coils of the head and the armature

FIG. 1. THE WIDE-RANGE INSTANTANEOUS RECORDING HEAD.

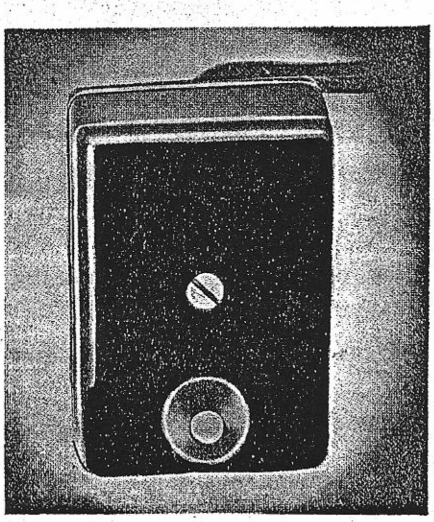


FIG. 2. ANOTHER VIEW OF THE RECORDING HEAD OF FIG. 1.

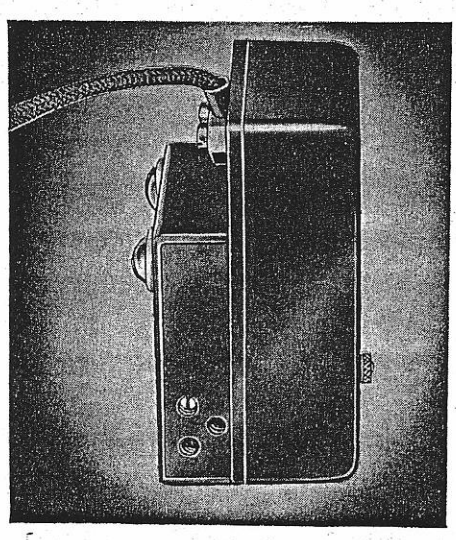
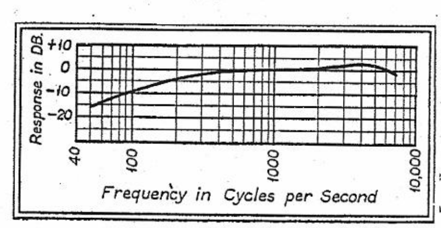


FIG. 3. FREQUENCY CHARACTERISTIC OF THE CUTTER.



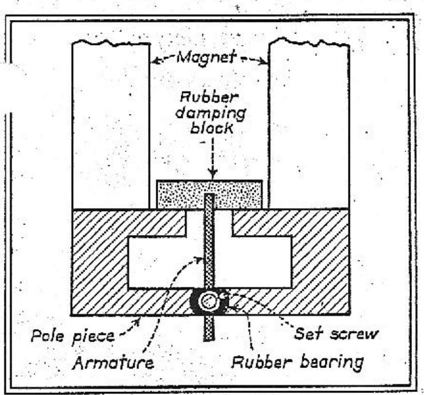


FIG. 4. AN OLDER TYPE CUTTING HEAD.

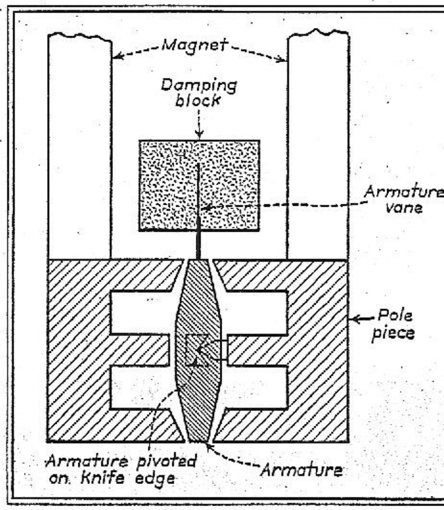


FIG. 5. A CUTTER HAVING THE ARMATURE PIVOTED AT THE CENTER.

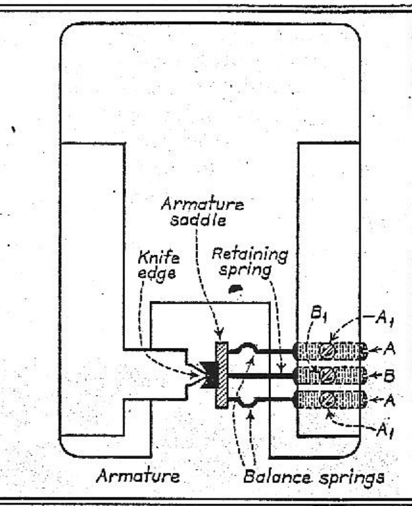


FIG. 6. REAR VIEW OF THE NEW CUTTER SHOWING ARMATURE MOUNTING.

vibrates from side to side in direct proportion to the current being fed. In the converted pickup type of cutter the armature is held in place by a rubber block which also acts as a damping block (Fig. 4). The armature is free to vibrate between the polepieces, but all the magnetic action takes place at the top of the polepieces. In the cutter shown in Fig. 5, the armature is pivoted in the center and action takes place between both the top and the bottom of the polepieces. In the cutter of Fig. 4, in, the armature is held in place by pressure of the polepieces which are milled out in semi-circular form to fit the armature. Between the polepieces and the armature is the rubber washer, and, as mentioned previously, it is this rubber washer with its lost motion that plays the biggest part in limiting the high-frequency response.

In designing the cutter of Fig. 1, a great deal of thought was devoted to finding a method of mounting the armature which would eliminate all possibility of lost motion. The method finally found to be the most satisfactory is shown in Fig. 6. This shows a detailed rear view of the armature looking at the back of the cutter. The armature has a V bearing milled out along its longitudinal length. In manufacturing, this operation is very carefully carried out so that a perfect V is made, the apex of which is a fine line. The armature is mounted with this V resting against a knife edge which is also carefully ground and hardened.

The method of keeping the armature tight against the knife edge is unique and at the same time practical. On the right side of the armature is mounted armature saddle on which are unted three springs. The center spring is known as the retaining spring and is fastened to screw B. Turning screw B pushes the armature up against the knife edge. Inspection of the contact area between the knife edge and the V of the armature is then made under a powerful microscope. When the proper contact is made B is locked with set-screw B-1 and sealed. Once this adjustment is made, it need never be tampered with.

The two balance springs are used to center the armature between the polepieces. Each spring is controlled by its own screw A and when the position of the armature is definitely set, the screws are locked by set-screw A-1. These three screws comprise the entire adjustments on the cutter and, since they are set and adjusted at the factory, the cutter should require very little service and very little adjustment in the field.

DAMPING

In any transmission system a correct terminating impedance is desired and since the cutting head is a transmission system in itself, converting electrical energy to mechanical energy, it also requires a proper terminating impedance.

In commercial wax recording the load imposed by the wax is very small and therefore it is necessary to create a mechanical impedance in the cutter that is relatively large. The mechanical load used as a terminating impedance is a rod of rubber about 10 inches long. Loss of energy along this rubber rod is such that a vibration is substantially dissipated by the time it has travelled down the line and back. Thus the rod constitutes a substantially pure mechanical resistance. In acetate recording the material which is being cut offers a much higher resistance to the cutter than wax does, and, therefore, a built-in large mechanical terminating impedance, such as a long rubber rod, is not required. Hence, the problem of damping is quite different, and the damping block consists of a small piece of absorbent material which successfully dissipates the vibrations without causing them to react again on the armature.

OPERATING LEVEL

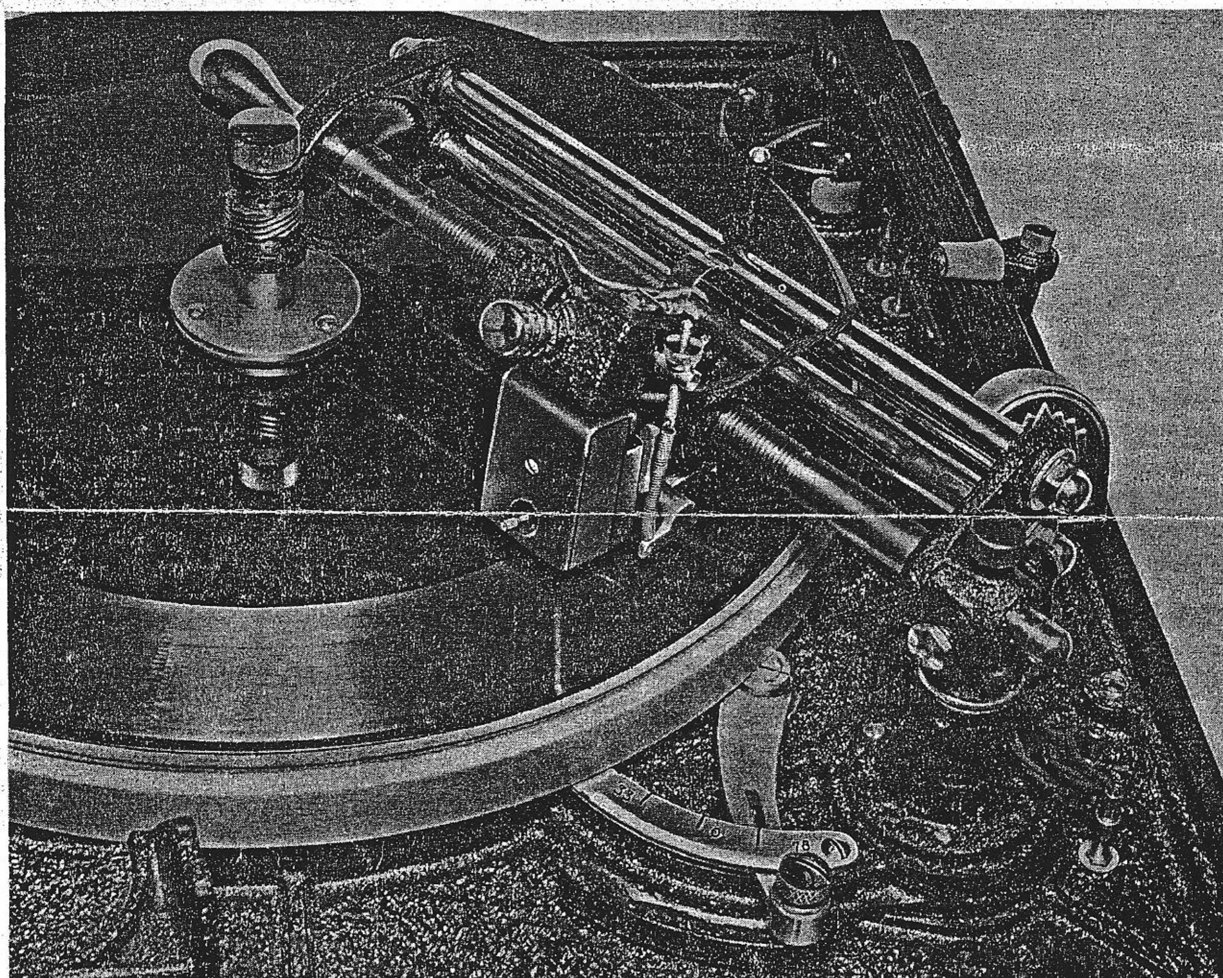
This cutter operates at a level of + 16 db which is the equivalent of 0.242 watt referred to .006 watt as zero level on a 500-ohm line. At this level the groove in the disc is fully utilized at a pitch of 112 lines per inch and the surface noise is 40 db below the level of the recorded sound. This is 10 db better than the surface noise on a shellac pressing, and about equal to the surface noise on the best acetate transcription disc. A level of + 16 db is comparatively low, and any well-designed recording amplifier having clean power output of at least 2 watts will handle the head very easily.

MEASUREMENT OF FREQUENCY RESPONSE

In obtaining a frequency characteristic of a cutting head three methods are commonly used. In the deflection method the cutting head with a recording stylus set in it is clamped tightly in a vise and frequencies are fed to it. Then a polarized beam of light is focused on the needle and by means of calibrated microscope the amount of deflection of the needle point is measured for each frequency. The frequency characteristic of the head is then plotted. This is the true frequency response of the head and the readings give the air velocity of the needle point. This method is satisfactory for measuring wax cutters where the terminating impedance is built in as part of the head as discussed previously. With acetate, the major portion of the terminating impedance is the disc material itself, and any true frequency response of the head should include the recording material.

One method of utilizing the disc material is to record the different frequencies and then measure their amplitudes on the record by means of a calibrated microscope. This method is an excellent one but tedious and long drawn out. An easier way is to record the different frequencies and then reproduce them using a calibrated pickup, amplifier and vacuum-tube voltmeter. Then by taking into consideration the discrepancies in the pickup and amplifier the true response of the cutter is found. This is the method used in obtaining the characteristic shown in Fig. 3.

The development of this high-fidelity cutting head makes possible much wider range instantaneous recordings—but it should be remembered that recording high frequencies requires extreme care besides using the finest equipment. It does not require much to lose the "highs" above 4,000 cycles. A loose sapphire in its holder—although not easily detected—is one cause; a needle screw that is not very tight is another reason; and if the needle is too far out of the head the flex in the shank will lose more "highs."



The Presto wide range instantaneous recording head in operation on a standard Presto 16″ portable recording turntable. Note the spring counterbalance on the cutting head mounting for accurately adjusting the depth of cut. The angle of the cutting head with respect to the disc is adjustable both vertically and laterally over a range of 10 deg. to compensate for slight differences in cutting needles. This feature, exclusive with Presto, is of major importance in obtaining a quiet cut and brilliant high frequency response. Note in foreground new Presto speed shift. Change from 78 RPM to 33 1/3 RPM is accomplished by simply moving the lever.

PRESTO RECORDING CORPORATION

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