NOISE REDUCTION IN DISC RECORDING

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IN the interests of maintaining transcriptions at a high degree of excellence, it is necessary that not only the program content be of high quality, but also that the surface noise or scratch of the transcription be of a low order of magnitude. The lower the level of scratch, the higher is the permissible dynamic range of the program.

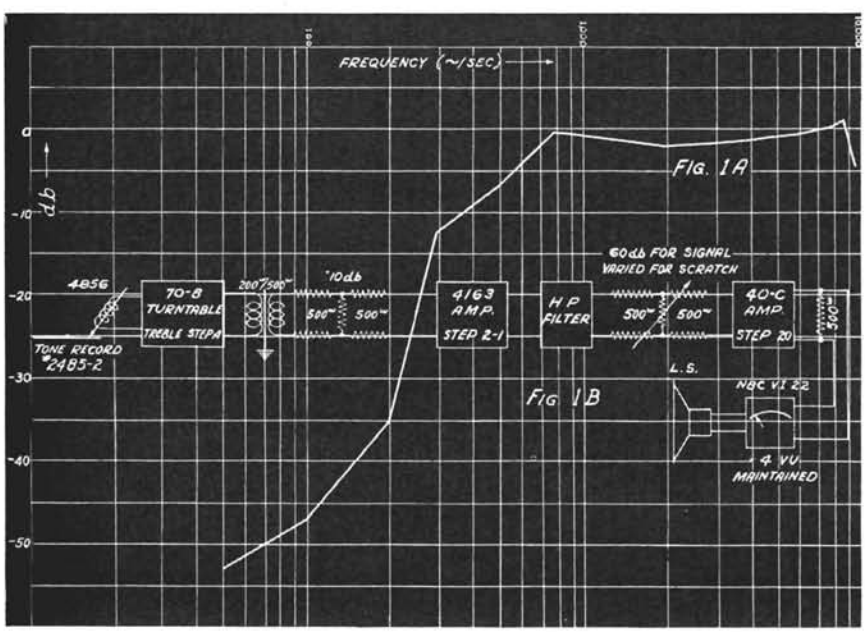
Basically, the measurement of scratch is relatively simple. All that is necessary is to reproduce unmodulated grooves of the transcription through an amplifier with sufficient gain to obtain a convenient output reading. A few practical considerations must, however, be observed. Low frequency disturbances, originating from building vibration or from turntable rumble, is normally of sufficient intensity to cause errors in the scratch measurement. For this reason a 500 cps high-pass filter must be used in the reproducing circuit.

The location of the H P filter is important. If placed after the amplifier it is very probable that the rumble levels will overload the amplifier. If placed ahead of the amplifier there is a possibility that hum picked up by induction will be amplified through the high gain system and give erroneous readings. Careful shielding will minimize this condition. However, since the high gain amplifier system normally consists of two units, the easiest expedient is to place the H P filter between the two. In this manner the rumble disturbances have not attained sufficiently high amplification to cause overloading before they are attenuated in the filter and at the same time the inductive hum is not excessively amplified in the final amplifier unit.

The only requirement pertaining to the frequency characteristic is that the circuit be essentially flat from 1,000 cps up to 10 kc and, of course, the lower frequencies must be attenuated below 500 cps by the H P filter. The tone run taken by reproducing the RCA tone record No. 2485-2 is shown in Fig. 1A.

The amount of bass compensation used in the reproducer circuit is relatively unimportant since the 500 cps H P filter attenuate these bass frequencies in any event.

The equipment diagram used by the author is shown in Fig. 1-B. The turntable used is the RCA 70-B with the treble compensation switch set to step "Out" which gives a flat high frequency response.



A 60 db variable pad is inserted in the circuit, as shown, to permit the tone run. For purposes of calibration the gain is so established that a convenient reading is obtained from the tone record. The 1,000 cps reading is especially noted. The scratch sample is then reproduced and sufficient pad is removed from the circuit to permit the scratch reading to duplicate the previously obtained 1,000 cps reading. The 1,000 cps band of the tone represents the nominal value of a fully modulated transcription. Therefore, the value of the pad removed to make the scratch read the same as the tone represents the signal to scratch ratio and is expressed in db.

The results of the measurements show some interesting effects. It is readily apparent that the discs most commonly used today are easily divided into three general categories. Shellac discs display the highest noise, vinyl discs come next with lacquer displaying the least amount of scratch.

Figs. 2A and 2B show readings of —23 db for a shellac pressing and —47 db for a V-257 pressing, both pressed from the same master.

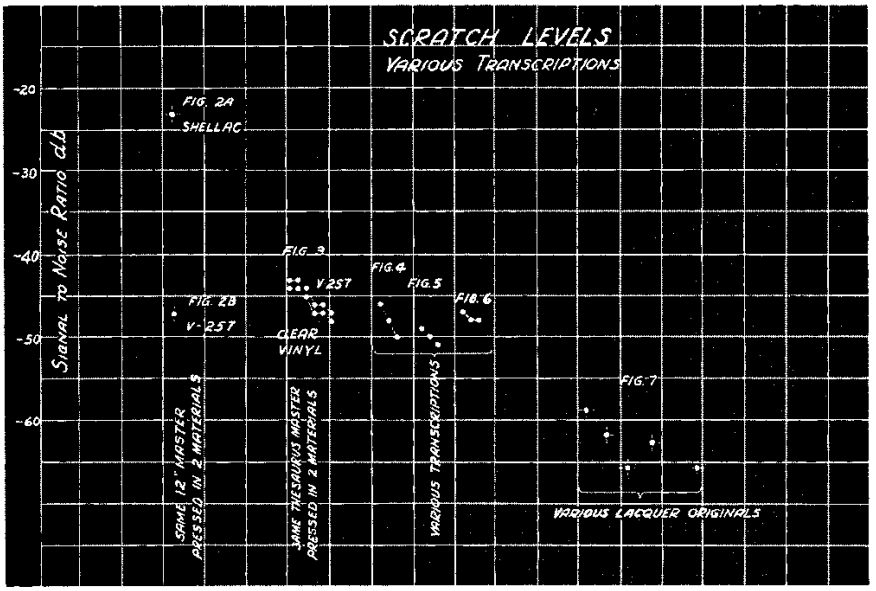
It is to be noted that shellac is not intended for transcription work even though it is quite often used for this purpose. It is of rather coarse texture and so designed to withstand the serious abuse given it on home reproducers and "Juke-Boxes." The reproducing heads are generally found to be heavy (3 oz. or more) with massive styli consisting of the typical steel phonograph needle or equivalent. Under such conditions it is desirable to have the coarse textured disc to cause the stylus to wear down rather than have the stylus wear out the

disc upon a few playings. Even so, a certain amount of wear is incurred on the disc.

An improvement can be obtained, however, when using shellac discs by incorporating a high fidelity type of reproducer which exerts a weight on the disc that is not in excess of approximately ¾ ounce. It is assumed that the stylus compliance is compatible with this figure, that is, no advantage is gained by counterbalancing the tone arm to this reduced stylus pressure if the reproducer contains a stiff moving stylus-armature assembly. In this case disc wear of unmodulated grooves is reduced but the wear of the modulation passages would still be severe. If shellac discs are to be used for transcription work with a high fidelity reproducer, care must be exercised to prevent even a single playing of the disc with an older type of reproducer which will mar the surface.

The various vinyl compounds have been designed specifically for transcription work. They are softer than shellac and will not hold up under conditions of home use. Light weight reproducers with permanent jewel joints of low mass and a very flexible armature movement are demanded for the most satisfactory results.

At the present day it can be shown that there is a negligible difference in the scratch content of the various vinyl materials used to make transcriptions. This has not always been the case. For instance, several years ago it was found advisable to use a certain amount of filler in the compound to give optimum results with the reproducers available as of that date. The principle was analogous to but not as severe as that described under the action of shellac and a steel stylus. As improvements have been made in reproducers it has permitted a modification of the filler used in the transcription disc. For the past year the NBC Thesaurus has been pressed in a material known as V-257. This is primarily a vinyl compound with a filler which is microscopic in size. Comparisons made to clear vinyl compounds show negligible differences in reproduced scratch. Fig. 3 shows such a comparison. Additional measurements of vinyl transcriptions are shown in Figs. 4, 5 and 6.



An inspection of the various measurements shows the scratch to be higher for the outside program bands than for the inner program bands. This effect is effected by one or more of several causes. The starting cut of a recording stylus is sometimes noisy which either clears itself or which is readjusted for optimum depth by the operator as the recording progresses. Also in the plating process of the record manufacturing, the deposition of metal is slightly irregular toward the outer diameters of the disc. A third contributing effect is that the flow of the compound, as the record is pressed, is somewhat irregular at the outer edge of the disc. These various factors should be so under control that the spread between the outer and inner diameters of the transcription should be not in excess of 6 db.

Fig. 7 shows that lacquer gives rise to the least amount of scratch upon reproduction. This material is very soft and is intended for transcription work where only relatively few playings are desired.

The scratch measurements as herein described are made with a flat high frequency response. With Orthacoustic, where high frequency attenuation is applied upon playback, a still further improvement is obtained in regard to the signal to noise ratio. The additional improvement amounts to from 6 to 12 db depending upon the distribution of the scratch noise throughout the high frequency spectrum. 8 db is taken as the average figure for this improvement.

Although as has been pointed out, negligible scratch difference is encountered between V-257 and clear vinyl, V-257 has a definite advantage due to its lower susceptibility to accumulating an electrostatic charge. Electrostatic charges are detrimental since dirt particles, which eventually scratch the grooves under the wiping action of the playback, are attracted to the disc. Furthermore, any attempt at brushing off the particles builds up the charge to higher values causing the particles to adhere more persistently to the disc.

Some idea of the severity of this condition is indicated in the results obtained on an elementary laboratory set-up which included an electrostatic voltmeter with a working range from 3,000 volts to 15,000 volts. The mere withdrawal of a clear vinyl disc from the paper envelope created charge in the range of 3,000 to 5,000 volts, the value depending on such factors as the room humidity and the rapidity of withdrawal of the disc. Rubbing the disc with felt created potentials as high as 12,000 volts. Atmospheric

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switching facilities, gain controls and communication circuits are located in the master control room. The selection of the incoming lines made with patch cords and switches or, if the number of lines is large and the personnel is limited, automatic dial selector systems may be employed.

Monitoring Systems

The monitoring facilities present a minor problem in the smaller installations. In the larger systems, however, special precautions must be taken to provide adequate monitoring facilities with protection against program interference. Such installations usually require monitoring speakers in the offices as well as the studios and control rooms. Also, it is generally necessary to provide a means of selecting the source of the program to be monitored. A typical monitoring circuit is shown in Fig. 15A. Monitoring circuits are provded for the outputs of each studio, the outgoing channels, the incoming network and the output of a receiver. Single or double-stage isolation amplifiers are used between the program lines and the monitoring buses. These amplifiers prevent impedance variations and monitoring bus circuit noises from feeding back into the program lines. The outputs of the isolation amplifiers are loaded with resistors and the monitoring stations are bridged across the low impedance buses.

Two methods of distributing the monitoring circuits are used. A multiple pair telephone cable may be run to every monitoring station where a simple rotary switch can be used as the selector as shown in Fig. 15B. Another method utilizes an automatic dial selector system which requires only two two-wire lines to each station.

(To be concluded in the next issue.)

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conditions caused varying rates of decay of this charge. On one particular day a clear vinyl disc dropped from 11,600 volts to 6,000 in a two-hour period, while the same disc on another day dropped from 11,400 volts to 3,000 volts in the same time period. It was found that V-257, subjected to the same tests, could not be made to exceed a maximum potential estimated at 1,000 volts. The sensitivity of the meter was such that no further data can be presented at this time on the rate of decay of V-257. Sufficient evidence is displayed, however, to show the appreciable superiority of V-257 over clear vinyl from the standpoint of the susceptibility to electrostatic charge.

In the foregoing paragraphs mention has been made of "clear vinyl." To avoid confusion it is perhaps advisable to point out that the terminology "clear vinyl" is used for all vinyl compounds free from filler. However, various dyes are used to attain any desired color of disc, which dyes have no effect on the electrostatic characteristics. In some instances heavy concentrations of dark colored dyes are used which make the discs opaque and consequently similar in appearance to V-257 which is opaque due to the filler used. The susceptibility to electrostatic charging is a reliable test to differentiate the two classes of vinyl discs.

In concluding it is pointed out that the signal to scratch ratio of present day transcriptions is in the vicinity of 45 db to 50 db. With the applicaton of Orthacoustic a further reduction to the vicinity of 55 db is realized. Present day developments in the recording and processing techniques gives promise of attaining, within the very near future, transcription reproduction with a signal to scratch ratio in the order of 60 db or better. Experience has demonstrated that this figure is entirely satisfactory for all broadcast requirements.

S.S. AMERICA

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just as readily to determine the position of other ships at sea.

Lifeboats Radio-Equipped

The direction finder uses a highly sensitive and selective superheterodyne receiver, and is designed with an automatic compensator so that deviations in the radio bearings are automatically corrected. The unit is also used in conjunction with the ship's gyro repeater system, thereby enabling radio bearings to be taken with reference to true North at all times.

Permanently installed in each of two motor-driven lifeboats of the *America* are complete radiotelegraph transmitters and receivers. Designed to withstand the weather conditions encountered by a lifeboat, this equipment permits communication on the distress frequency of 500 kilocycles. Power is derived from storage batteries.

Thirteen antennas are used in the *America's* radio communication system. Including the two life boat antennas, they are the radio direction finder loop antenna, the direction finder sense antenna, the harbor telephone antenna, the five doublet receiving antennas, the main flat-top, the horizontal V and the forward inverted L antennas.

Power Generators

Power for operating the ship's radio equipment is derived from four motor generators located in a room just forward of the radio quarters. Unit No. 1 supplies 2500 volts for operation of either the intermediate or low frequency transmitters. Unit No. 2 is similar to No. 1 and powers the high frequency transmitter. A switching panel is provided so that, in event of failure of one unit, either of the other units may be quickly connected to the desired transmitter.