Motion Picture Film Sound

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Broadcast engineers contemplating the installation and operation of television facilities are introduced to a newcomer. This article deals with the measurement and maintenance of its sound head mechanism and associated audio equipment.

A GOODLY PERCENTAGE of the broadcast time of television stations presently consists of transmitting motion picture film program material. It is both convenient and economical to record short commercials, news-events, playlets, etc., on film to be broadcast at any time that it is desirable to do so. The television broadcaster has also found that full length feature "movies" add interest and variety to his program schedule, and current trends seem to indicate that film will be put to more extensive use in future television program planning.

As transcription facilities are to audio programming, so may be the role of film projection equipment to television programming.

For the technical staffs of audio stations currently installing, or planning to install television equipment, it is worth while to become acquainted with motion picture sound reproducing equipment.

Current Audio Practices

The broadcast engineer has realized for a long time the importance of maintenance routines aimed at preventing equipment failures and inferior performance due to improper adjustment. In audio work this preventive maintenance usually takes the form of

1. Performance measurements.
2. Repair and adjustment.

The first may be poriodic comparison of his equipment, unit by unit, with manufacturer's specifications by audio-frequency performance tests. Or the engineer may prefer to check his equipment over-all from microphone amplifier input terminals to line amplifier output terminals in accordance with approved conditions and techniques.[1] The second phase consists of tube and part replacement, cleaning and adjusting as a result of irregularities discovered by these tests.

Similar procedures may be used in the maintenance of television film projectors, more particularly with the sound-head, with which this article is concerned.

Sound-Head Mechanism

An optical sound-head is shown on *Fig.* 1, which consists of an exciter lamp, optical system, a rotary-stabilized drum over which the film passes as the sound track is scanned, a photo-tube and coupling circuit to the first stage in the audio amplifier. The optical system is usually enclosed in a tube which contains lenses that focus the image of the exciter lamp filament on the plane of a slit. Following the slit, other lenses focus the image of the slit upon the sound track of the film as it passes by the scanning point. There are two types of photographic sound records in general use known as variable area and variable density. These are shown in *Fig.* 2. In both cases the light passing through the film is modulated by the sound track and the resulting change in photo-tube current is amplified. Most motion picture sound reproducing equipments permit adjustments in the sound optical system in the following ways:

1. Movement of some of the elements in the optical system to permit the focusing of the light beam on a plane of film.
2. Movement of the optical system in a lateral, or left to right, direction in order to center the light beam properly on the sound track.
3. Adjustment of the optical system so that the image of the slit is perpendicular to the path of film travel. This is called the azimuth adjustment.
4. Adjustment of the exciter lamp position in order to obtain a uniform distribution of light over the entire slit width. This adjustment is usually required each time an exciter lamp is replaced and involves rotating it about its vertical axis.

Any one, or a combination of these adjustments, if improperly done, will produce frequency and amplitude distortion as well as reduce the output of the system.

There are, of course, other sources of degradation of audio quality, such as dirt collecting on lenses and mirrors and mechanical disturbances in the sound drum stabilizer. Cleanliness of equipment is of great importance and routine cleaning and inspection of the sound reproducer should be observed with regularity.

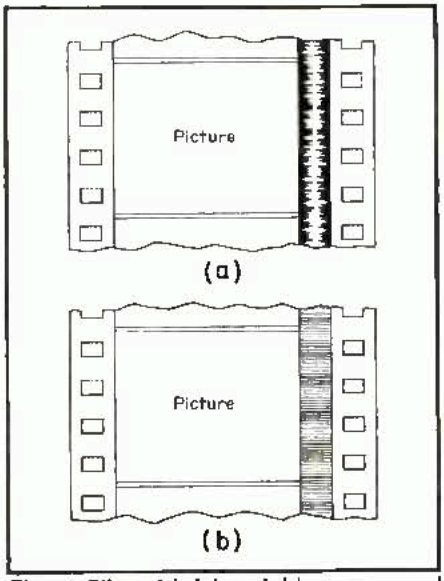

Fig. 2. Film with (a) variable area sound track and (b) variable density sound track. Both are in general theatre use.

Test Films

Adjustments of the sound optical system are usually accomplished by the use of test films. These test films are readily available from several suppliers, one of which is the *Society of Motion Picture Engineers.* A catalog of these test films is available from the SMPE.[2]

Most television studios have 16 and 35-mm motion picture projectors. Test films are available in both 16 and 35-mm. sizes.

For the determination of uniformity of illumination across the slit, two types of test films are available for 35-mm sound reproducers. They are known as Type A 17-Position Track Test Film, and Type B Snake Track

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serious consideration as they are continual. Here again it is at a minimum without any sacrifice in operational requirements. This installation has been operating for the past ten months. Other than tube replacements, and these have occurred within the maintenance schedule, no electrical or operational difficulties have occurred.

After this extended, continual experience with the facilities described herein, we feel that this is an answer to the constantly increasing demand for an efficient, low-cost, flexible studio control room design where the demand is to feed one or more programs to one or more channels. The compactness of the design makes it obvious in a quick glance that operating costs, both in the technical and announcing departments, are cut to a minimum. Aside from the purely technical standpoint, this design is very attractive, giving the impression of spaciousness without waste space.

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staff is called upon to reproduce are satisfactory.

Suggested Maintenance Technique

Figure 3 shows a simplified block schematic diagram of the audio portion of a television studio. In most cases the projection equipment will be set up in a separate room away from the audio control console. It will be necessary to use a portable volume indicator and high impedance headset at the projector while adjustments to that projector are in progress. A bridge of the audio line amplifier output as indicated on the diagram may be run from the control console to the projection room to feed this volume indicator.

Experience has shown that there is a preferred order in which the test films are to be used and adjustments made. It is recommended that adjustments be made in the following order:

1. Azimuth (use Sound Focusing Test Film)
2. Lateral adjustment of slit (use Buzz Track Test Film)
3. Uniformity of slit illumination (use Snake Track Test Film)
4. Focusing Adjustment (use Sound Focusing Test Film)
5. Frequency response (use Multifrequency Test Film)
6. Listening test (use Theatre Sound Test Film).

The location and method of adjustment for each different type of projector is usually found in the manufacturer's instruction booklet.

Noise and Distortion Measurements

Until now we have not mentioned making quantitative measurements of

single frequency distortion, or noise level. None of the projector manufacturers will state that with such and such a test film, his projector will produce so much percent distortion. Such conditions are rarely encountered in practice and have little meaning[3]. There are no accepted standard methods of making such measurements, nor are there any quantitative tolerances. Suffice it to say that recognized 35-mm movie producers follow as closely as possible certain recommended practices made by the Motion Picture Research Council and the Society of Motion Picture Engineers with regard to the recording of sound film. Even so, some variation in characteristics exists in film products.

Because of the many variables involved, it is difficult to make any general statement about film distortion. However, 35-mm film distortion runs in the order of one to two per cent root-sum-square between 400 and 1000 cycles and is in the neighborhood of four per cent root-sum-square at 3000 cycles[4].

If high distortion or intolerable noise is encountered, it may be well to suspect the audio equipment following the photo-tube. Measurements on the equipment following the photo-tube may be made employing the currently standard procedures and tolerances.

Incidentally, the motion picture industry has recognized the necessity of using low-pass filters for reproducing their film products in theatres. Such filters reduce noise and distortion on worn or scratched prints by "rolling-off" the higher frequencies according to certain specifications[4].

Flutter

Broadcast engineers are familiar with "wow" or "flutter", those spurious modulations attending the playing of poorly-made disc recordings or the use of defective turntables. In the motion picture industry, flutter is generally caused by irregularities in film speed due to dirty or worn projector parts involved in passing the film past the scanning point in the sound-head. Measurement of flutter usually requires the use of a rather expensive flutter bridge in conjunction with a flutter test film. The discovery of excessive amounts of flutter generally indicates defective mechanical parts which must be replaced by overhaul. It is recommended that theatre sound test film, which contains musical passages suitable for detecting flutter, be used in a preliminary listening test. If excessive flutter is suspected, quantitative measurements may be undertaken by out-

side service organizations equipped to do so.

As in allied electrical sciences, it is reasonable to expect that minimum performance standards and accepted measurement techniques eventually will be forthcoming in the motion picture field. Until then, however, the logical course for the television station staffs is to maintain their sound-film projectors obtainable through repeated checks, using procedures similar to those outlined.

REFERENCES

1. RMA Standard #TR-105-A Sept. 15, 1947
2. 16-mm & 35-mm Test Films (a publ.) by Motion Picture Research Council and Society of Motion Picture Engineers, 342 Madison Avenue, New York City
3. F. Darsh and E. J. Shortt: "Characteristics of Film Reproducer Systems," J. SMPE (Feb., 1939) p. 169
4. Research Council Basic Sound Committee: "Discussion of Magnetic Recording," J. SMPE (Jan., 1947) pp. 52-53
5. Standard Electrical Characteristics for Theatre Sound Systems, (a technical publ.) by Motion Picture Research Council, April 20, 1948

Reproducers

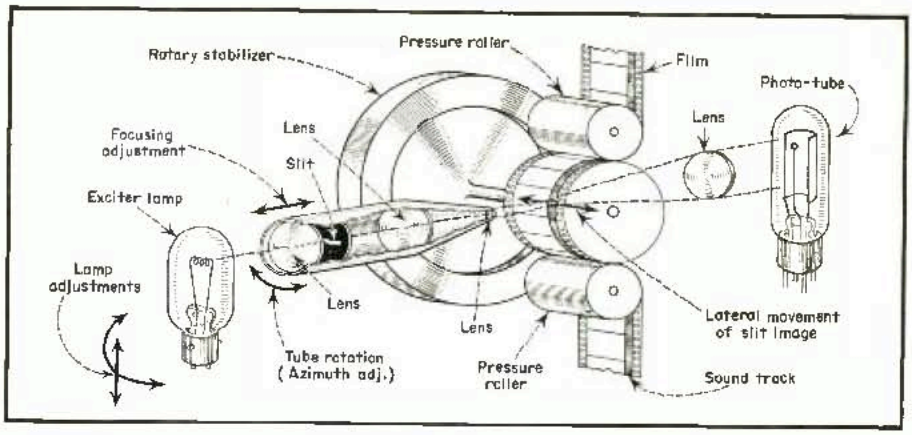

Fig. 1. Functional diagram of a motion picture reproducer sound-head. The essential components are shown. Arrows indicate adjustments necessary to produce optimum quality, and are explained in the text.

Test Film. The Type A is usually used by manufacturers in the production testing of equipment. It contains 17 very narrow tracks uniformly distributed across the sound track width. Each of the 17 tracks appears on the test film for a sufficient time to make a reading of the output of the sound with a volume indicator. With this type of film it is possible to plot a curve of light distribution across the slit width.

Type B is usually used for maintenance of such equipment in the field and is to be preferred for television sound reproducer maintenance. The Type B track is made of a very narrow sound track which, when put in motion in the sound head, moves across the slit at a uniform rate and a measurement of audio output is made. Uniformity of illumination across the slit is indicated by a minimum variation in sound output and can usually be held to within ± 1.5 db. A one-hundred-foot reel of Type B track is sufficient to enable the operator to make the necessary adjustments of the exciter lamp position.

For adjustment of the position of the slit image upon the sound track, a buzz track test film is available. The sound track of this film is completely opaque. However, a 300 cycle square wave track is located immediately to one side of the normal sound track location and a 1000-cycle, square-wave track on the other. The tracks are located so that when the film is run in a sound projector properly maintained, neither tone is heard. If the slit image is out of adjustment laterally, either the 300 cycle or 1000 cycle tone will be heard. Usually one hundred feet of the film will give the operator sufficient time to make this adjustment. Buzz track film is available in both 35-mm and 16-mm stock.

Sound Focusing Test Films, both 16 and 35 mm, are used to adjust the azimuth and focus of the optical system. The SMPE makes available several types. They consist of 5000 or 7000 cycle tones in either variable area or variable density. The variable density is more sensitive to small changes in azimuth and is to be preferred for this test. Correct azimuth and sharp focus are both manifest by maximum output as observed with a volume indicator. Some reproducers have the azimuth pre-adjusted at the factory and should not be tampered with. Usually from 100 to 200 feet of the film is all that is required.

Multi-Frequency Test Film

Multi-frequency Test Film Type B is normally used in routine servicing and includes frequencies from 40-8000 c.p.s., each preceded by a spoken announcement. Enclosed with each individual reel is a chart of the correction factors that must be added to the volume indicator deflections to obtain the correct frequency response of the system. 16-mm Multi-frequency Test Film covers a somewhat more limited frequency range but is handled in the same fashion as 35-mm.

Oftentimes the operating staff of a station plays prints which sound unpleasant. Question arises at once as to whether the equipment is defective or whether the recorded material is faulty. The Theater Sound Test Film, which is also available in 16 mm, is considered by the motion picture industry to be representative of currently available release prints of quality consistent with the state of the art. This film is used for listening tests by the industry and should show, by direct comparison, whether prints which the

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Fig. 3. Most microphone preamplifier inputs do not constitute a proper load for phototube coupling coils, therefor external terminations must be provided as shown.