HOW TO CONDUCT A SOUND-ON-FILM RECORDING STUDIO

The studio described by Mr. Queen enables you to make (1) synchronized lectures, (2) theatre trailers, (3) news events reels, (4) screen tests, (5) recordings of scientific experiments, (6) home movies (reduced to 16 mm. size), (7) commercial or advertising pictures, (8) short featurettes, and (9) non-synchronized recordings.

THE STUDIO

I. QUEEN PART II

PART I OF this article described in detail the principles of the various methods of sound recording. Now, in this Part, we are ready to discuss the problems of setting up and maintaining the studio and the operation of a typical modern sound-recording outfit. This apparatus has been in continuous use for the past year in the production of talking trailers, screen tests, talkie news shots, etc. A double 35mm. recording system is used. The results have been excellent and compare favorably with regular feature productions.

ACOUSTICS

A knowledge of the principles of acoustics is of great importance for proper operation of a studio. In the case of talking pictures, sound-proofing is of even greater importance than in broadcasting. This is due to the fact that the microphone will usually be placed at a relatively greater distance from the subject, so that it will not be in the camera field. The ratio of original sound to reflected sound is thus greater. Also, the reverberation period of the theatre in which the film is projected is added to that of the recording studio, when the film is reproduced.

It is known that sound waves are reflected from most smooth surfaces. In the case of a closed room the sound is reflected from the several walls, ceiling and floor until the sound energy is dissipated. If the length of time between the start of the sound until it is inaudible is comparatively long, either a bad *reverberation* or an *echo* will result, that is, syllables will be superimposed over each other. Also, most rooms have a period at which they will resonate more freely than others. This also causes distortion of the sound input.

The remedy for this lies in sound-proofing. If the walls, ceiling and floor are covered with sound absorbent material, the energy will be quickly damped (transformed into heat energy). It is possible, however, to sound-proof a room to an excessive degree so that the room will sound "dead" and unnatural. Experiment usually determines how far sound-proofing can be carried.

Among the more commonly used materials, with their absorption co-efficients are the following (An open window is taken as 1. since it will absorb [that is, transmit] all the energy striking it and return [that is, reflect] none to the room.):

Acousti-celotex	.46
Rock wool	.80
Felt	.66
Velour	.45

An audience in the studio will greatly contribute to the absorption of sound, also. A carpet usually covers the floor where it will not lie in the camera field.

STUDIO TECHNIQUE

A typical studio would have approximately the following dimensions: 25 ft. wide, 45 ft. long and 15 ft. high. A larger

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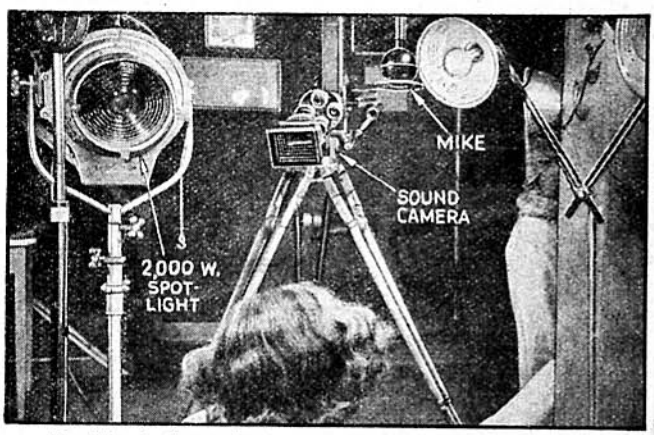
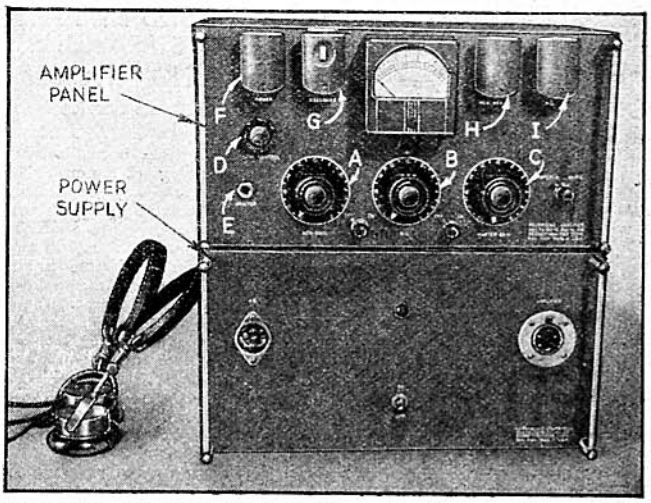
The author is shown monitoring a sound-on-film recording.



Everything in the studio is set to begin "shooting" the "talkie."



The amplifier and power supply of the sound-on-film recording apparatus. See text for details.

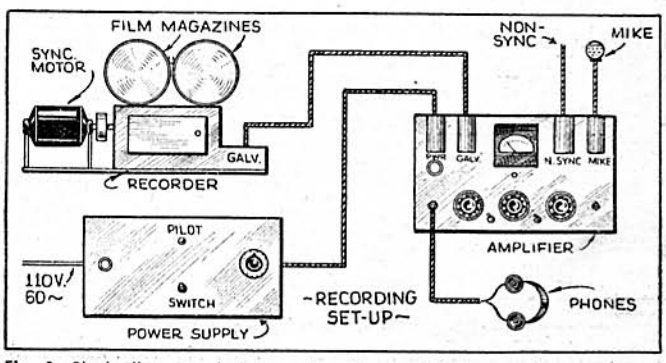


Fig. 3. Block diagram of the sound-on-film recording apparatus comprising recorder, amplifier and power supply.

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room will bring complications due to excessive reverberation unless adequate precautions were taken and would be unnecessary for most purposes. At one end of the room are built 2 booths, each about 4 by 7 ft. These booths are covered with sound-absorbent material with the exception that in the doors (facing the studio) each has a glass window 2 ft. square at eye-level.

One booth is for the *camera-man* and his camera, while the other houses the *recordist* and the recording apparatus. Both technicians can thus watch the scene as it takes place and no noise from the motors in the booth can be heard outside.

REHEARSALS

Many rehearsals are often necessary before the scene begins. Unlike in radio broadcasting, the actors must not only be thoroughly familiar with their actions but must read the lines from memory. During the rehearsals, the monitor at the recording equipment listens-in and may direct a change in microphone placement or a slight change in the position of the various props (properties—tables, chairs, etc.) to obtain the clearest sound.

The recording engineer has under his control a switch for turning on red lights in the studio and the booths. When the scene is about to begin these lights are turned on as a warning for silence. The recordist then presses the switch which turns on both his recorder and the camera simultaneously.

The Clap-Stick. An assistant now steps into the camera field holding up a *clap-stick*. This consists of 2 metal plates hinged together with room on the faces for the number of the scene and any other information needed later in cutting. This information is photographed by the camera. The assistant now closes the clap-stick sharply causing a loud noise, and as soon as he has stepped out of the camera field the shooting of the scene begins. The above procedure is necessary to synchronize the film. The frame on the picture negative showing the 2 metal plates just closing took place at the instant that the loud noise caused a heavy overmodulation on the track. Since synchronous motors are used and since the start of the films is known, the sound and picture films will now match throughout their length.

MONITORING

There are 3 main pieces of equipment: (1) the *power supply*, (2) the *amplifier*, and (3) the *recorder* (see the photographs on pg. 415). On the amplifier panel are 3 major controls. The left-hand one (A) is the volume control for the non-sync. input (phonograph pickup); the center one (B) is the volume control for the microphone; the third (C) is master control for the other two. All controls are of the constant-impedance type. At the left side of the panel is an uncalibrated dial (D) to adjust the recording bulb intensity. This bulb is located in the galvanometer unit. Below this control is the head-set jack (E).

The meter in the center is used both as a *level indicator* and as a *current meter* for the recording bulb. When the button below it is depressed it reads on *ampere* scale, otherwise it reads in *decibels* to measure the modulation. Full modulation is indicated when the needle swings to 3 decibels on the peaks. A switch at the right side of the panel can be used to change-over from voice to music recordings.

There are 4 special type sockets at the top of the panel. Left to right, the 1st (F) is marked "power" and connects to the power supply. The 2nd (G) is connected to the galvanometer socket in the recorder. It supplies the modulated output, the D.C. for the recording lamp and the field current for the electromagnets. The 3rd socket (H) is used for non-sync. input (phono). The last socket (I) is for microphone. Hum pick-up is minimized by the separation of power supply and amplifier into 2 units.

It is the duty of the monitor to watch the decibel meter to keep the average modulation at high level. This is similar to radio broadcasting. Also it is necessary that he note as often as possible that the bulb has not burned out, otherwise many scenes may have to be done over.

PROCESSING

When the recording is completed, the 2 films are taken from their respective magazines in a dark room and sent to the laboratory for processing. A different developer is used for each. The films are then ready for the "cutting" room where scenes may be shortened, eliminated or a change made in their continuity. Each change made in the picture negative calls for an exact and corresponding change in the negative of the sound, otherwise the synchronization will be lost.

In splicing film the ordinary splice will not do since it causes a sharp break in the light beam falling on the photoelectric cell and a loud noise. Therefore, a special punch called a "blooper" is used. This punches out a section of the track where the splice is made. The punched-out section is in the shape of a triangle so that the beam of light in the projector will now be interrupted gradually and no sound will result.

The picture is now ready for printing, that is the finished *positive* is to be made. The picture is printed first, the track section being *masked off* in the printer; and then the sound is put on, the picture part being masked off. The start of the sound, however, is printed 19½ frames or 14.4 ins. AHEAD of the start of the picture. The reason for this is that in projecting it is naturally impossible for the 2 apertures to be in the same place on the projector. It is necessary for the print to be run through one aperture and then pass through the other. The standard adopted has been to place the sound aperture 14.4 ins. *ahead* (in the direction of the film travel) of the picture aperture. The sound film is now ready for run-off.

MAINTENANCE OF EQUIPMENT

It is essential that the equipment be kept in first-class condition at all times. The apparatus is subject to use at a few minutes' notice so that tubes, motors, etc., must be kept inspected frequently.

This particular outfit is sometimes used in a D.C. district in the heart of Boston so that a motor-generator set for supplying A.C. 60-cycle current must be used. A 4-terminal starter is used for the motor. The total A.C. used by both synchronous motors, amplifier, etc., is about 8 A. An essential part of the equipment is a *frequency meter* to measure the line input frequency. A reed type is used for the purpose. For possible servicing and repair work on the amplifier, power supply and general equipment, an analyzer is always kept in the booth.

A complete diagram covering both amplifier and power supply is shown in Fig. 4. Only the highest grade parts can be used in such a system due to the exceptionally low powers dealt with. Four tubes are used in the amplifying system; and 2 rectifiers are a part of the power supply. The 84 supplies high voltage for the various tubes, while the EL-22, a high-current rectifier, supplies 6 V. for the recording bulb, field magnets and also the filament voltage for the first 76 tube. Very low hum output results from the D.C. power on its filament.

The 2 input sockets are shown at the left. The microphone input is applied at the control-grid

The "clap-stick" which the assistant is holding in the camera field is a device which is mighty useful in the subsequent editing, cutting, and synchronization of the "talkie".

of the first tube through a transformer, while the non-sync. input is sent only through the last 3 tubes.

The microphone used is a W.E.-630-A type dynamic. The output is exceedingly low, having an average of only 10^{-11} watts. Because of this the connecting cables must be shielded from all possible sources of induction and the shielding grounded. Also the impedance, approximately 30 ohms, should be matched for best quality and to prevent loss of energy. Lately, W.E. developed a non-directional baffle to be used with this microphone.

To keep the high-frequency response up, so necessary with sound-on-film, *equalizers* are inserted in the circuit. The last tube is a 6E6, composed of 2 triodes. They are connected in push-pull to eliminate 2nd-harmonics. The output is transformer-coupled, the impedance of the secondary being approximately 50 ohms to match the galvanometer winding. The master volume control is indicated in the input circuit to the 2nd type 76 tube, while the other 2 are connected just ahead of the transformer, coupled to the 6C6 input.

The diagram of the mixer circuit and the equalizer circuit indicated in Fig. 4 are shown in Fig. 5. The words "note (x)" and "note (φ)", code words used by the manufacturer, denote (respectively) an *equalizer* and a *high-pass filter.*

The Equalizer. The equalizer placed after the 76 is used for the purpose of emphasizing the high frequencies at the expense of the lower ones. It is the usual communications type of equalizer. (See Fig. 5A.) The assembly, L/C, is tuned to approximately 6,000 cycles and offers high impedance to frequencies at about this range. The resistance, R, in series with this circuit is for the purpose of flattening out the curve of frequencies passed on. Systems for aiding the high frequencies are necessary with sound-on-film installations since in reproducing there is always a tendency to lose them. In other words, since frequencies in the neighborhood of 7,500 cycles and up result in extremely thin lines on the film it becomes difficult to record them. Also, for the same volume, a high note means that the galvanometer must move back and forth faster than for a low note. If it were possible to move the film past the slit faster in recording and reproducing then, of course, a still greater range of high frequencies would be available, and so on. For instance, *in 16 mm. recording*, since the film travels 2/5 of the 35 mm. speed, *the high frequencies suffer even more and still greater precautions must be taken if good quality is wanted.* It is necessary, then, that an amplifier for sound-on-film use must always overemphasize the high frequencies to result in a straight-line characteristic in the final film reproduction.

It will be noticed that although a switch (marked "in" and "out") is available with the equalizer, it is always kept in the circuit. The equalizer is placed in the circuit so that it is effective both on *non-sync.* (phono. disc) and *sync.* recording, that is just before the 2nd stage.

The Mixer. The diagram of the mixer circuit, also, is shown in Fig. 5A. These are constant-impedance pads of 30 ohms resistance and are connected in series, their output going to the equalizer and the next transformer. For example, an *increase* in one control (say, the *sync.*) and a *decrease* in the *non-sync.* control will, of course, fade-in the sync. input and fade-out on the non-sync. as in usual sound procedure. The master control for increasing or decreasing the combined inputs of the mixer, is placed just before the 2nd 76.

The Low-Pass Filter. The low-pass filter is shown in Fig. 5B. This is the unit shown in Fig. 4 as Note (φ).

The box marked UC-35, etc., is the decibel-ammeter which is shown in the center of the amplifier panel in the photos. Note from the connections that depressing the button results in the meter being an ammeter while release causes it to be a db. meter. The current meter is used, of course, to measure current to the 6-V. bulb in the galvanometer assembly and the decibel meter is used to measure the level of the output (A.F.) (Characteristic data concerning the EL-type heavy-current rectifiers appear in the article "Uses of Low-Voltage Thermionic Rectifiers" in the April 1936 issue of *Radio-Craft. —Editor*)

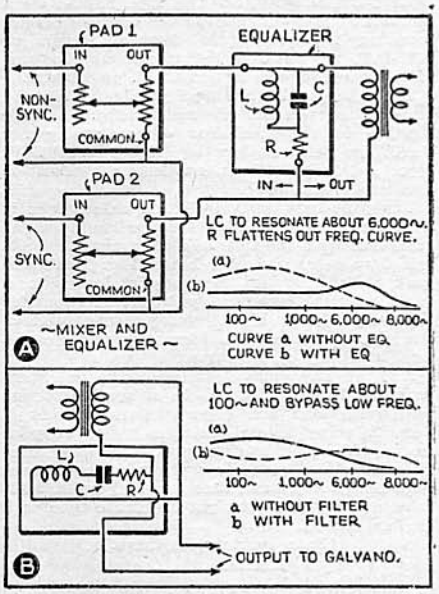

Fig. 5. Circuit details of (A) "mixer" and "note (x)" (high-pass filter), and (B) "note (φ)" (low-pass filter), in Fig. 4.

CONCLUSION

It is hoped that this article has given to the readers of *Radio-Craft* a better understanding of talking picture procedure. Many new developments in this field are being worked out in research laboratories and will in time be in common use, but the foregoing principles are *basic* and a knowledge of them will still be necessary. (The reader may also wish to study the 3-Part article, "Servicing Theatre Sound Systems," which started in the December, 1935 issue of *Radio-Craft*, for additional information on the subject of talkies.—*Editor*)

This article was prepared in 2 parts, Chapter I, "Principles of Recording" was so long as to require 2 issues of *Radio-Craft* and therefore appeared in the November and December issues. Chapter II, "The Studio," appears in this issue of *Radio-Craft*. The editors—and the author, too!—will be very much interested to receive reader comments pro and con concerning articles on this subject.

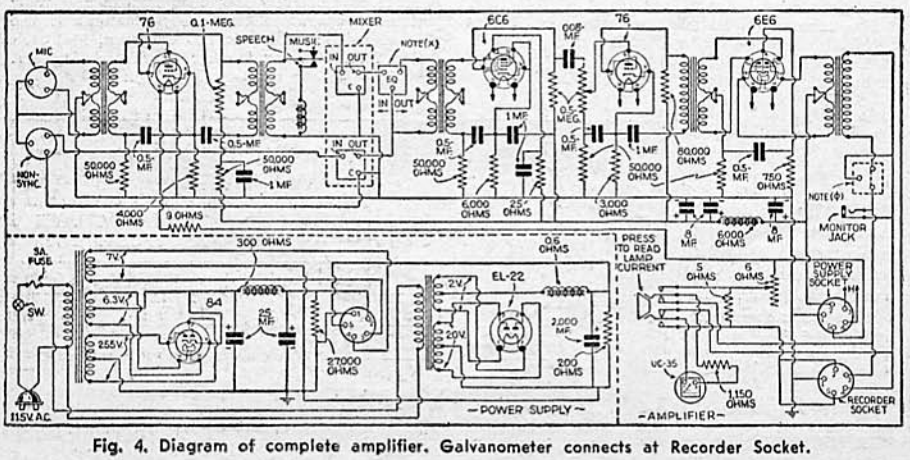

Fig. 4. Diagram of complete amplifier. Galvanometer connects at Recorder Socket.