Modern Sound Projection

(PART III)

The third and last of a series of articles on synchronized sound and pictures, from the standpoint of a practical projectionist. The mechanism used and its operation are fully described.

By RICHARD CARMAN

AT the present moment there is still much controversy as to which is superior; sound on film, or sound on disc. There are many arguments, both pro and con, that may be brought forward on either side. Consequently, the industry is still divided on the point; with the result that practically every modern sound-picture booth is equipped for both.

Sound on Film

We will discuss first the sound on film. Perhaps one of its greatest advantages lies in the fact that the sound is recorded on a tiny band about one-eighth inch wide at the side of the film and therefore must run exactly in synchronism with the picture.

Sound on film also presents a greater possibility of high- and low-frequency recording, especially where the new type of wide film is employed; as the speed of the wide film is relatively faster in proportion to its size. The greater the recording surface exposed per second, the wider is the possible band of frequencies.

The life of the film, however, is greatly shortened in comparison with that used with sound on disc; because of the fact that the film becomes scratched, oil-spattered and spotted in not too many trips through the projector. This results in the distortion of the resultant sound; naturally, every scratch or oil spot or bit of dust will vary the light thrown into the photoelectric cell, just as the photographed sound-variation bands do. So, long before the actual picture has been ruined by wear and tear in the projector, the sound track has become totally unfit for further service and the film has to be discarded.

Sound-on-Film Amplifier

Sound on film also presents a problem that is not present in the disc system. The tiny electric current which is produced by the photoelectric cell is so small that it must be amplified, say two hundred times, to bring it up to the value of the current delivered by the electrical magnetic pick-up, used on the disc; the current delivered from the film or disc must be of the same value when it reaches the fader.

This amplifier must be constructed with the greatest of care, and fed with the purest direct current. It is fitted just below and in front of the projector head (see Fig. A) and therefore the greatest of care must be exercised to eliminate any possibility of microphonic noises, audio feed-backs or strays of any kind. Pure current is required; because the slightest variation would be magnified many times in the sound reproducers back of the screen, with an obvious result.

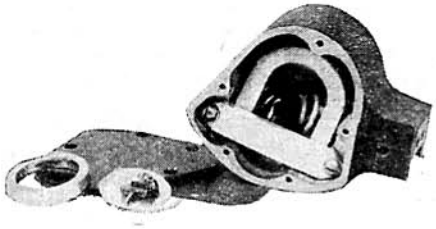

Fig. E

The parts of the disc reproducer; compare Fig. 3.

Sound Optical Trains

Fig. 1 shows the "heart" of the sound on film; the component parts so placed are called an optical train. At the extreme left is shown the exciter lamp, a bulb containing a straight "line" filament, which is operated usually on a voltage of from six to twelve, and draws a current of three to eight amperes.

This filament lights to an exceptional brilliancy; and a photographic image of this lighted filament is focused on the moving film by the lens assembly just to the right of the exciter lamp. This assembly, in the Western Electric equipment, consists of two small high-powered condenser lenses, followed by an aperture or slit 3/16-inch long and from .0012- to .0015-inch wide. Beyond these are placed two of the finest type "objective" lenses, which complete the assembly. At the extreme right is a line representing the film, moving past the "sound aperture." This moving film, passing at a constant rate of speed, varies the light in a degree corresponding exactly to the photographic sound variations which are recorded on the film. This varying light now falls into the photoelectric cell, which correspondingly varies the current passing into the small amplifier beside it, and thus the current to the fader and the main amplifiers. The photoelectric cell is a "light-sensitive" device (see Fig. 2) comprising

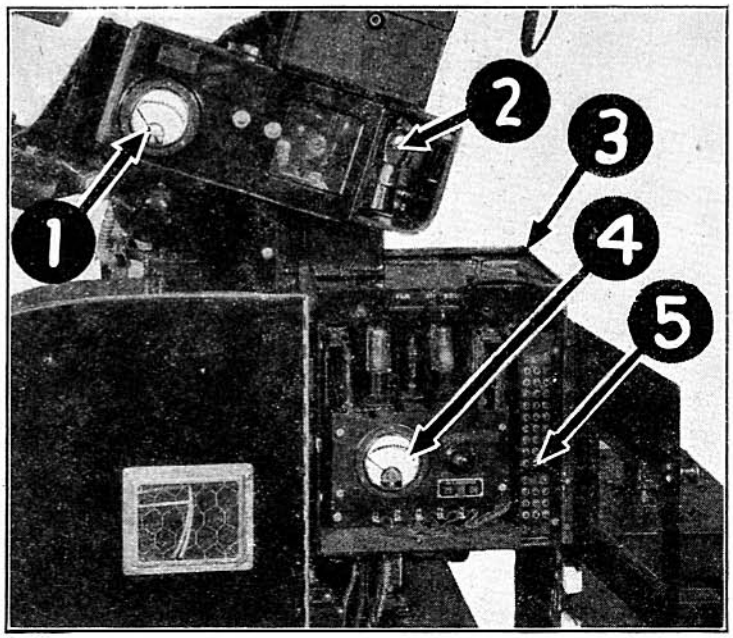

Fig. A

At the left, a film pick-up head and film sound amplifier. The parts are: 1, current meter, for the exciter lamp, which is mounted on the lamp's housing; 2, the photoelectric cell, the construction of which is diagrammed in Fig. 2; 3, the housing of the film sound amplifier; 4, filament current meter for amplifier; 5, "attenuator panel," used to equalize current from the film pick-ups of both machines.

At the right, the arrangement of the essential parts of the film driving mechanism in its relation to the film sound pick-up, shown in Fig. 1.

All illustrations by courtesy of Bell Telephone Laboratories.

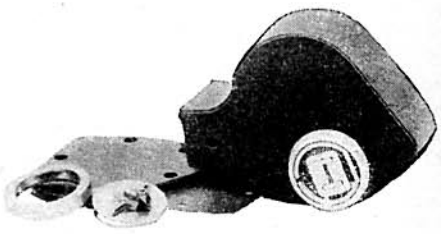

Fig. D

A W. E. Type "4-A" disc reproducer. The needle receptacle has been removed from the armature.

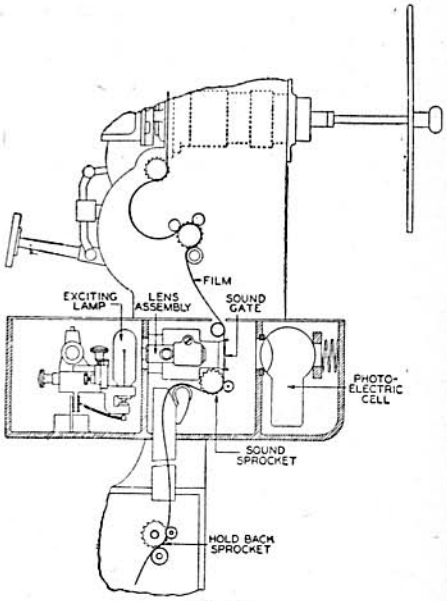

Fig. 4

a glass bulb from which run two leads or connections; one, connected to a ring-shaped electrode in the center of the bulb, called the anode, is always connected to the positive side of the circuit. The other lead makes contact with the inner surface of the bulb which has been silver-plated, to form an electrical connection with the light-sensitive material which is coated over the silver. This light-sensitive surface, called the cathode or negative electrode, is always connected to the negative side of the circuit. A small portion of the bulb, on one side, is left clear to serve as an opening or "window" through which the light enters the cell.

The light-sensitive material is made of a special compound of potassium. Besides this, the bulb contains a small amount of "noble" gas, such as argon. When the light-sensitive surface is not illuminated, this gas is an effective non-conductor and no current will pass in the circuit through the cell. The instant that light enters the cell, however, these conditions change instantly; and electrons then flow from the sensitive surface to the anode, attracted by the positive voltage on the latter. The flow of electrons, in itself, constitutes a very minute electric current; but by the action of the electrons on the gas in the tube the flow of current is considerably increased. The gas becomes "ionized" (that is it breaks down electrically) and is then a fairly good conductor instead of an insulator. A current therefore flows in the circuit.

The light entering the photoelectric cell increases the current flowing through it, in direct proportion to the amount and variations of the light itself.

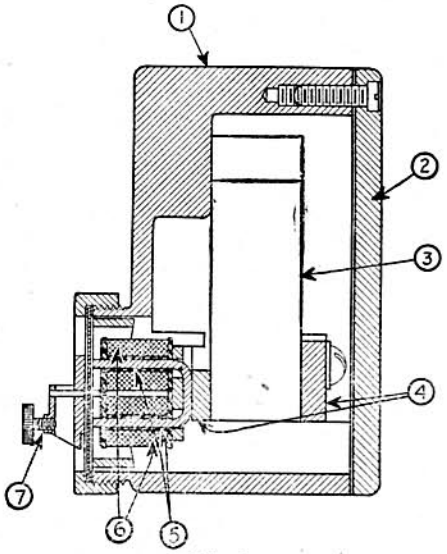

Fig. 3

Sound on Disc

The principal advantage of sound on disc is that, so long as the print of film holds together, it may still be used; while the quality of the sound will remain perfect, because, as often as necessary, the record may be replaced with a new one. The separate record, nevertheless entails much trouble that we do not have to contend with in sound on film. In case of a break or damage to the film, the exact amount of film must be replaced, either by the picture, or by black or opaque film; so that the exact number of squares or pictures shall remain unchanged from the original length and the film continue to match the record and retain its synchronism. This method also entails all the necessary handling of the discs, both in projection and in shipment. Records will also "single-track" and jump grooves, in case of defects in the record or, sometimes, in case of extreme or harsh sound. This necessitates a high degree of skill and efficiency on the part of the projectionist to restore synchronism—a fact which is seldom, if ever, appreciated by the public.

Of course we must realize that synchronization of sound with motion pictures is actually in its infancy and, therefore, we should not condemn any one system of recording or reproduction until time and actual experience has proven conclusively the superiority of one over the others.

The Electro-Magnetic Disc Pick-Up

The equipment necessary for sound on disc, so far as the pick-up is concerned, is very simple in comparison with the film method. The only equipment between the electromagnetic pick-up and the fader is the selector switch. The electromagnetic pick-up (see Fig. 3) consists fundamentally of a permanent magnet the ends of which are placed against two field-pieces, around which are wound field coils. The coils are placed in series, and the remaining leads furnish the output of the reproducer. A steel armature is so placed between these field-pieces, so that when the needle, to which it is connected by a needle receptacle, is vibrated by the record groove variations it will vary the voltage in the tiny field coils. This arrangement may be varied in design and construction, the parts hermetically sealed and damped with oil, and other refinements of various kinds may be introduced; but the electrical pick-up is basically the same as in any radio-phonograph.

THE "talkies" and their kindred developments, all originating from the application of radio engineering methods to the moving-picture and the phonograph industries, present a wonderful opening to the radio technician. The ambitious radio Service Man and experimenter should not fail to read every one of this series of articles on Sound Projection which began in the February issue of RADIO-CRAFT.

—Editor.

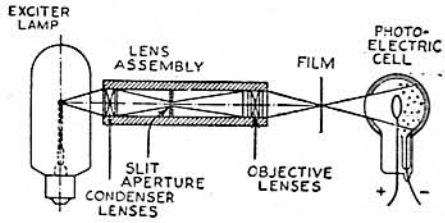

Fig. 1

The optical train of the film sound pick-up; compare also Fig. 1 on page 520.

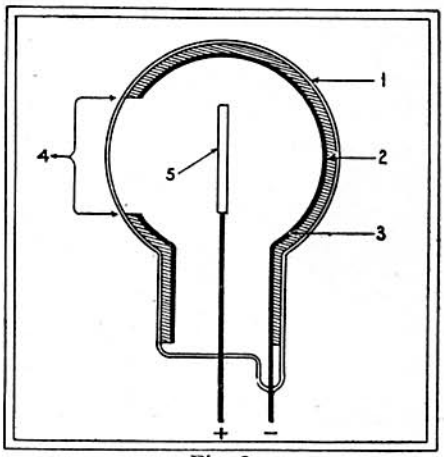

Fig. 2

The photoelectric cell or "electric eye": 1, bulb; 2, silver; 3, potassium; 4, window, 5, anode ring.

The Mechanical Filter

The purpose of the mechanical filter is to overcome any fluctuations or irregularities

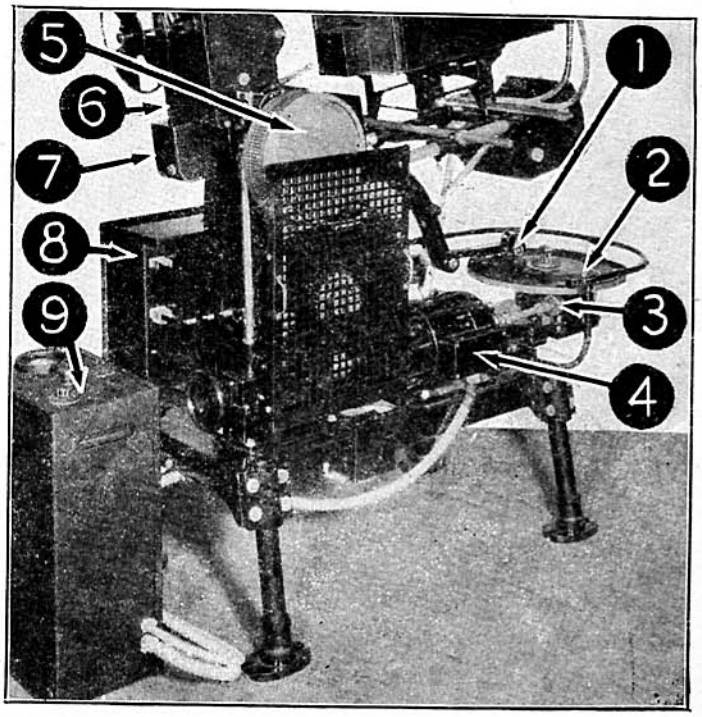

Fig. C

At the right, the Western Electric "Universal" base, equipped for both film and disc. The figures indicate: 1, electromagnetic pick-up (see Figs. D and E); 2, disc on its turntable; 3, mechanical filter (see Fig. B); 4, speed-control motor; 5, film-sprocket mechanical filter; 6, projector head; 7, photoelectric cell compartment; 8, photoelectric cell amplifier; 9, motor-control box and tuned circuit described in Part 2 of this series. At the left, mechanism of the disc pick-up; 1, sealed housing containing "damping" oil; 2, cover; 3, permanent magnet; 4, magnet-retaining bars; 5, field-pieces of magnets; 6, field coils; 7, needle receptacle, attached to armature.

in the motion of the disc turntable or the film-drive sound-sprocket. A separate filter is used for each purpose; but both are built upon the same principle. No matter how much care has been exercised in the design and manufacture of the machinery, there is a certain amount of fluttering or irregular motion, due to the meshing of the gears, etc. The mechanical filter is designed to overcome this and deliver an absolutely even flow of motion, taking up all the shocks, fluttering and irregularities. Fig. B is a picture of a Western Electric mechanical filter for the disc. At one side is the housing, containing the driving shaft which connects the motor with the worm gear, part of which is shown engaging the circular gear. On the latter are mounted six springs at three different points. The other ends of these springs are connected to the turntable drive shaft by means of the triangular part mounted in the center of these springs. The turntable is mounted directly on this shaft and the only connection to the driving unit is through these springs. The difference between this filter and the film-sprocket filter is that the triangular part is connected, not to the turntable shaft, but to a heavy flywheel firmly fixed to the driving-film sound-sprocket.

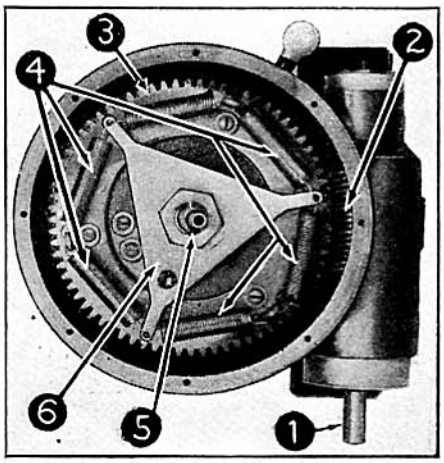

Fig. B

Disc-type mechanical filter: 1, motor drive shaft; 2, worm gear; 3, ring gear; 4, springs; 5, turntable drive shaft; 6, triangular connecting link.

In Figure C is shown the Western Electric universal base, upon which is mounted everything necessary for one machine to project sound pictures. This machine, when assembled, may be moved as one complete unit; thus doing away with the alignment of various parts, so common with many installations and with the earlier models of Western Electric sound apparatus.

The positions of the mechanical filters for film and disc is easily discerned; turntable, reproducer unit and arm, and mechanical filter are mounted in a suspension arrangement of rubber which absorbs any mechanical vibration of the machine. The shaft which connects the motor to the mechanical filter is in two sections coupled by a rubber hose as an additional buffer.

The Methods of Sound Picture Recording

By JOSEPH RILEY

THE electrical recording of sound requires a method of transforming sound vibrations into electric currents; then the transmission, control and amplification of these currents, and finally, a method of changing the electrical energy into mechanical energy, so that a permanent record may be impressed on the recording medium—either by modulated light on a sensitized film, or by the movement of a cutting stylus in soft wax.

In a recording studio, the essential apparatus consists of the microphone pick-ups on the stage, a mixer and volume control, amplifiers, recording machines, and a synchronous motor system for synchronizing the recorders with the cameras.

The stage on which recording is done is constructed purposely to exclude external noises by covering the walls and ceiling with sound-absorbing materials.

As in the broadcast studio, particular care must be taken in placing the microphones, to record successfully the speech or music occurring on the set. However, it often happens that the problem of locating the microphones is complicated by the construction of the set, and by the necessity of keeping them out of view of the camera. In such a case the "mike" then may be hung from the ceiling (as in Fig. B) or suspended from the end of a long boom (as in Fig. A). The microphones used are generally of the condenser transmitting type; this is, briefly, a condenser in which one of the plates is a very thin, stretched sheet of duralumin, which may be set in motion by the vibration of the sound waves. The capacity of the microphone is thus varied, and a modulation is caused in the electrical circuit to which the microphone is connected.

Camera booths are constructed of sound-proof materials to eliminate camera and motor noises, but have a clear glass window in front for the camera to "shoot" through. In Fig. B a sound-proof camera booth is shown in an actual studio scene.

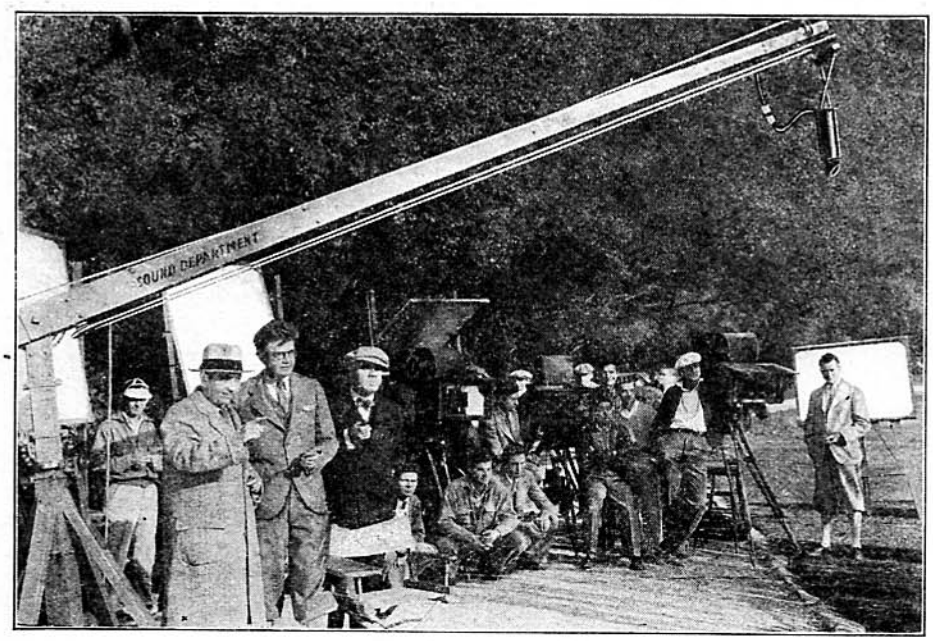

Fig. A

A sound-picture staff on the lot; the microphone hangs below the amplifier at the end of the boom. The cameras used are larger and more complicated than the hand-operated type used for silent pictures.

Courtesy United Artists.

The Man Who Hears

The person responsible for the balance, quality and volume of the recording is called the "monitor man." His duty, is first, to place the microphones properly after determining the acoustic conditions of the set; and he must be, therefore, very familiar with the action being photographed. He then sits in a bay window in the "monitor room" with a clear view of the stage and, by means of special horns only, since his room is insulated from the stage by sound-proof walls, hears all sounds picked up from the stage.

The centralized control for the whole system is the "mixer table." Here controls are located for fading microphones in and out, maintaining volume balance between several microphones, and regulating total volume; also for operating communicating systems, signal lights and relay-control switches. The monitor man in his room has a visual volume indicator, to help him keep the sound