Silent Recording Methods

New Developments Will Reduce Noise on Both Disc and Film

By I. QUEEN

JUST prior to the war, sound recording for commercial and home use was rapidly increasing. Many of the larger radio receivers were being sold as combined raido-recorders and reproducers (disc) so that not only could a direct home recording be made, but incoming radio selections could be taken off the air and recorded for future playback. It is natural to wish to repeat the performance of a famous comedian, favorite orchestra or world leader, just as it is for us to photograph faraway places, scenic wonders, friends or important events. The recording of sound or picture enables us to bring forth at will events of the past.

It is confidently expected that the postwar period will bring widespread use of electronic equipment. This will be especially true of television, which is expected to follow within a few years of our conversion to peaceful endeavors. Just as the development of radio brought with it a wide interest in recording on disc, we may expect the advent of television to make us more sound-plus-picture conscious.

We may wish to record our favorite actress, football game or political leader. Possibly the television program may call for a particularly interesting experiment in chemistry, a "how to make it" stunt or the exhibit of a rare document. By means of a sound-on-film camera and recorder we may make a permanent record of the scene as it appears on the television screen and are then at liberty to repeat it for friends who may have missed it or to file it away for future reference.

SOUND RECORDING METHODS

The principles involved in recording sounds are not particularly complicated or different from those with which the radio technician is acquainted. Disc recording is the simpler of the two methods in common use, but film recording is not much more difficult to understand. Many articles have appeared in *Radio-Craft* magazine during the past few years on both subjects. The writer, for instance, covered "Sound on Film" in three parts beginning November, 1937, and "Sound on Disc" in the March, 1941, issue. The former method is used where an accompanying moving picture exists, while the latter is the simpler and less expensive of the two.

The technician and serviceman may well consider recording and reproducing of sound as an extension of radio. He should accordingly be prepared to handle work in these lines. Judging by requests for articles on sound recording it is apparent that high interest exists among *Radio-Craft* readers. Accordingly, this article will describe several new developments pertaining to this field.

SOUND ON FILM

Sound on film utilizes the principle of a narrow light-sensitive track which travels uniformly before a varying light source. Fig. 1-a shows a piece of variable density recording wherein the beam of light extends through the entire width of the track and is varied in intensity either by a mechanical valve or a varying light source. Fig. 1-b is a variable-area recording wherein the light source is constant, but the film area exposed is changed. These changes correspond to changes of acoustic energy at the microphone. During the recording the film is everywhere masked off except for the small slit on which exposure is desired. For reproduction the film travels uniformly in front of a similar slit. A constant light

(Continued on following page)

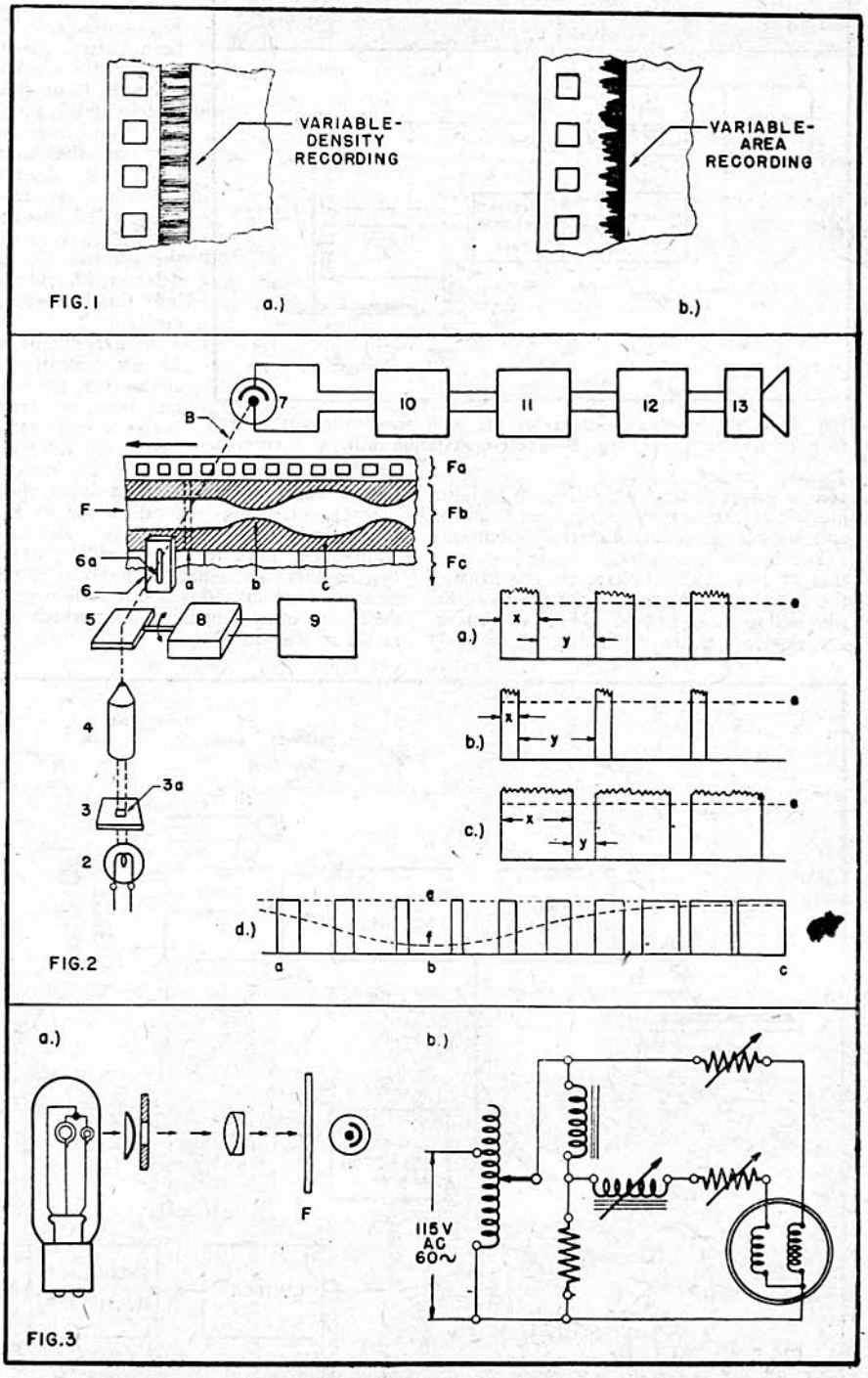


Fig. 1—The two common types of sound-on-film. Fig. 2—An improved system of noiseless sound-on-film reproduction. Fig. 3—A special circuit for eliminating the exciter-lamp hum.

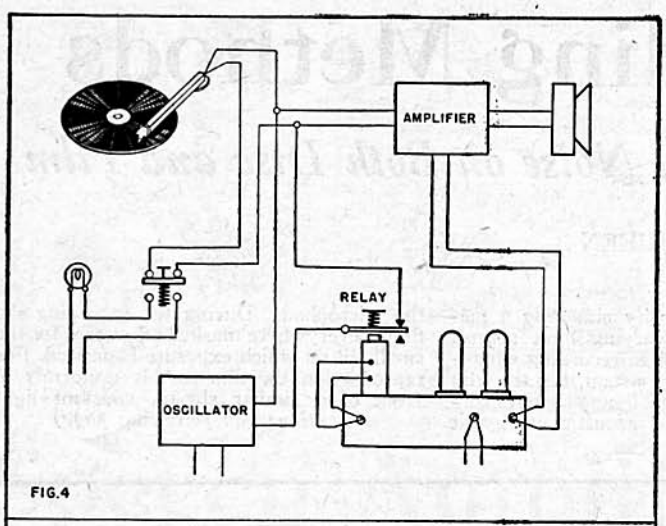


FIG.4

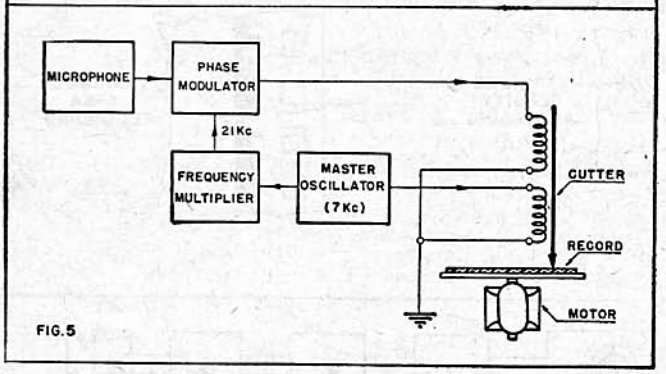


FIG.5

Fig. 4—A synchronizing system for use with non-continuous matter such as lantern slides. Fig. 5—Phase-modulation with disc records.

source shines through this slit onto a photoelectric cell so that the modulated beam results in corresponding electrical vibrations.

For less noisy reproduction it is desired that at low modulation levels the area of the slit be reduced so that the grains of the film will cause less noise. Therefore a masking device (in the variable-area method) follows the envelope of the sound so that the exposed area is only that necessary for sound reproduction.

A very recent invention by a Maine man, John R. Cooney, will result in the complete elimination of noise due to film grain, etc. Fig. 2 shows a constant light source, 2, passing through an aperture, 3, and an optical system, 4. A vibrating mirror, 5, is connected to a piezo crystal unit, 8, which is actuated by a 25 Kc. oscillator, 9. The beam after passing through the masking plate, 6, is approximately .001" square and scans from one side of the sound track to the other on the film, on to a photocell, 7. An amplifier, 10, feeds into the limiter, 11, and detector, 12, and then into the loud-speaker, 13.

As a result of the 25 Kc. vibration of the mirror, the scanning beam will travel back and forth across the track. Referring to Fig. 2a, we plot light intensity (vertical) against time (horizontal). The time interval shown as x is that in which the beam travels along the transparent part, y corresponding to the opaque part. Note that the intensity during x is not constant. This is due to film grain, dust and other imperfections, which will result in noise.

Fig. 2b shows what happens when the film has moved so that section b is now in front of the beam. Evidently, the opaque sections are now greater than the transparent. Fig. 2c corresponds to film portion c. We therefore have pulses of light which the photocell sees as almost constant, but are really modulated by feeble changes in amplitude.

The limiter, 11, is set to a pre-determined level to slice off these irregularities as in Fig. 2d, resulting in noise-free reproduction from the speaker.

Another recent improvement in sound reproduction is shown in Fig. 3. One source of difficulty has always been in connection with the exciter bulb. This requires a heavy current for intense illumination, and an A.C. source provides a loud hum in reproduction. One solution has been to use a source of super-sonic power; which, however, results in a complex arrangement. In the present case we make use of a bulb containing two filaments, a thin one and a massive one.

As illustrated, a 60-cycle source connects to an auto transformer, the output going to the heavy filament (at the right in Fig. 3a). Due to a phase-changing arrangement consisting of choke and resistor, the lighter filament is supplied with a voltage 90° out of phase. The maximum brilliancy of one filament is reached at the instant when minimum brilliancy of the other is attained. With both filaments focussed for the same spot, one overlaps the other, resulting in a minimum of hum. This new type of bulb is due to Robert L. Haynes of Indianapolis.

SOUND-ON-DISC

The utility of disc recording is limited to cases where synchronized moving pictures are not desired. However, this method is well adapted to accompany non-synchronized pictures or single frame pictures. For instance, until the start of the war, great interest was shown by the public in the single-frame cameras exemplified by the Leica. This type takes only one still picture at a time, and because of the compact-

(Continued on page 121)

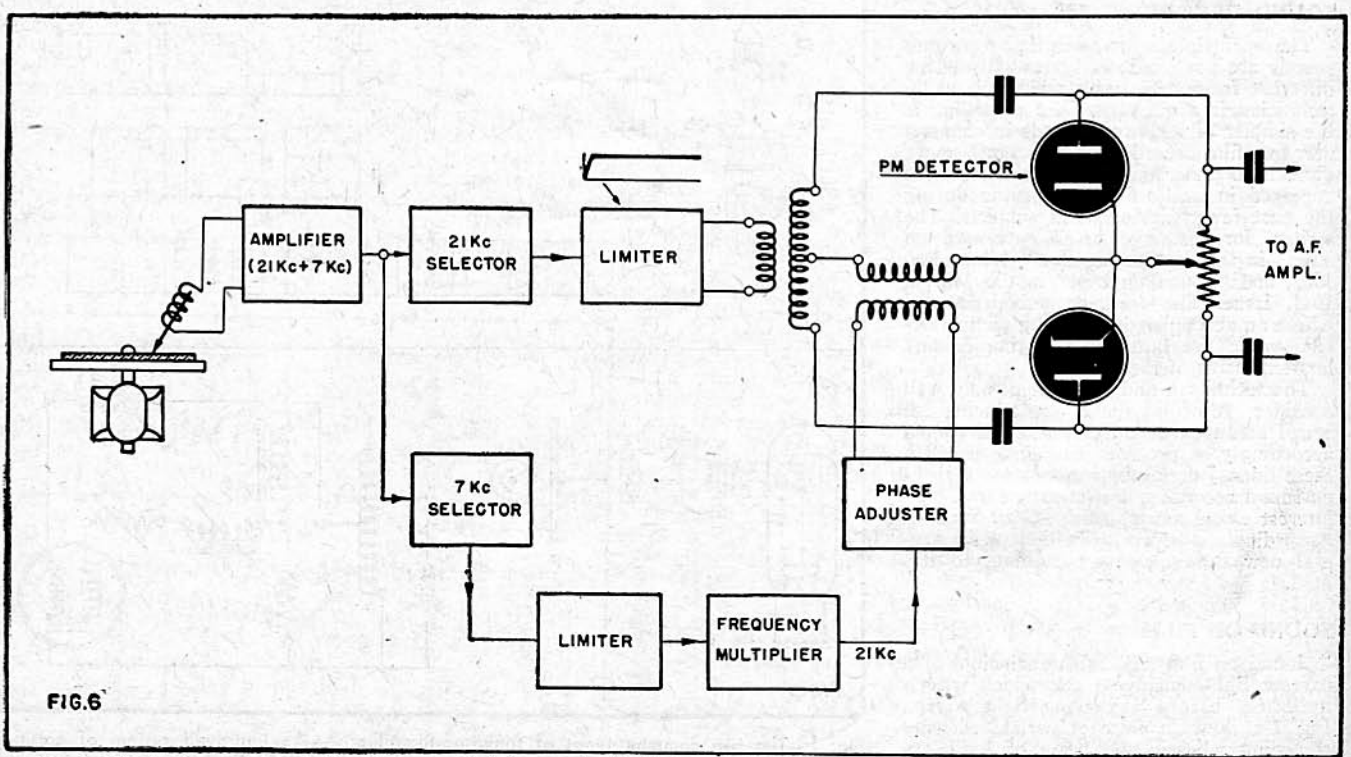


FIG.6

Fig. 6—Playback arrangement for phase-modulated records. Limiters and discriminators cut off noise, give high-quality reproduction.

SILENT RECORDING METHODS

(Continued from page 90)

ness, convenience and low cost, this type of photography was most popular.

A method of sound recording which would automatically accompany slide-film strips, such as an explanation of the scene, pointing out certain persons involved or date and time of exposure would naturally be of great interest and add to its usefulness. This method also would have great advertising and commercial possibilities, besides home use.

Such a recording method has been recently patented by Conkling Chedister of Livingston, N. J. Since the speed of the phonograph is uniform, the strip of film must be advanced one frame at a time automatically in step with the talk. Use is made of a super-audible frequency as the control, (above 10 Kc.).

The sound sequence is recorded through the microphone and amplifier on the disc (Fig. 4). While the microphone is energized, power will be supplied through a second amplifier to actuate the relay which closes and cuts off the source of super-audible oscillations. During periods of silence, however, the relay opens as shown and these oscillations are recorded instead. Normally then, either audible or inaudible frequencies are recorded. Now, when it is desired that the next frame be moved into place, the double-pole switch is thrown so that a completely silent portion exists on the disc. A pilot light acts as monitor.

In playing back use is made of a motor which will move the film strip one frame every time a silent piece is encountered. If either audible or inaudible recording is on the disc, the motor remains stationary. A relay in series with the motor opens while any frequency is recorded. The picture will then be synchronized with comment.

PHASE MODULATED RECORDING

The great advantages of phase modulation are now available for sound recording. An invention by Walter van B. Roberts of Princeton, N. J., makes possible noise elimination and a high fidelity system. Referring to Fig. 5, incoming sounds at the microphone phase modulate a carrier of 21 Kc. The latter frequency is first generated by a master oscillator at 7 Kc., which passes through a tripler. Both the original 7 Kc. and the phase modulated 21 Kc. actuate the cutter as shown.

Fig. 6 shows the set-up for playback. The reproduced frequencies are amplified. They are separated, each passing through its own limiter which slices off any irregularities which in other systems cause noise. The two channels (both now 21 Kc., one modulated) are combined in the phase modulation detector, which converts changes of phase to changes of amplitude. A conventional A.F. amplifier follows. Even though the cutter may discriminate between frequencies, the action of the limiter will eliminate this amplitude modulation and result in high fidelity and wide range without distortion.

COMPRESSION-EXPANSION

It is well known that in all types of recording and even in broadcasting, it is necessary that the dynamic range be compressed at the source. In other words, the softer passages must be brought up so that they will not be lost in the noise level while the louder passages must be toned down so that they will not overload the system. This is a necessary procedure due to the limitations of all recorders and, of course, results in destroying to some extent the wide range of the original.

(Continued on following page)

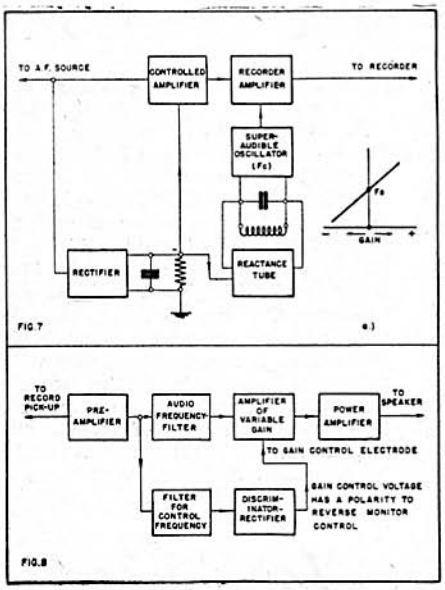
Broadcasting, according to FCC chairman James Lawrence Fly, can contribute materially to full post-war production and employment.

"At the very moment when returning soldiers are coming back for jobs and manufacturers are turning from war to peace production, broadcasting will be launching vast new projects for public service," Mr. Fly said.

"Frequency modulation and television, the two great ventures which lie ahead, insure that broadcasting will do its share to see that the post-war era is one of expansion and prosperity, rather than contraction and depression."

(Continued from previous page)

In order to restore the reproduction range, an automatic system has been invented by Chester M. Sinnett, Westmont, N. J. In Fig. 7 we show that the A.F. source connects to a controlled amplifier whose gain



depends upon the bias across the rectifier output. This bias in turn depends upon the strength of sounds to be recorded. Therefore, the louder the sound the less the gain.

This bias simultaneously acts upon a reactance tube to vary the frequency of a super-audible oscillator. As the incoming sound becomes louder it raises the oscillator frequency and vice versa (Fig. 7a). Two frequencies are thus recorded on the disc, the actual sound and a super-audible modulated frequency.

When being played back the recorded frequencies are passed through an amplifier (Fig. 8) and separated. The super-audible control frequency goes to a discriminator-rectifier which serves to vary the amplifier gain in a reverse sense (to expand the range). Therefore, the range which has been automatically compressed in recording is now automatically expanded so that the original dynamic range is available at the speaker.

The above-described developments are all very recent and it should be kept in mind that the basic ideas involved are protected by patents.

●

TWO NEW PREDICTIONS

POST-WAR predictions are entering the quantitative stage, to judge by two recent reports. In Chicago H. A. Crossland, General Electric sales manager, assured the National Association of Music Merchants that within 18 months after the war no less than five million FM receivers will be on the market. Prices, he said, would average about $60.00, and receivers would be capable of receiving AM as well as FM programs.

This prediction follows that made by T. F. Joyce, manager of RCA's radio, phonograph and television department, who stated that within 18 months after television receivers become available, 741,000 homes will be equipped. He believes that this would mean more than four million spectators, as an average of nearly six persons per machine may reasonably be expected. Television receiver prices would be about $200.