

A Three-Element Glow Lamp for Sound Recording

By VERNE T. BRAMAN*

THE ordinary two-element glow lamp (gas discharge tube) consists of a glass, Pyrex, or quartz tube which contains rarified gases,

and into which are sealed two electrodes, an anode and a cathode. If sufficient voltage be applied to the two electrodes, the gas will ionize and carry current, at the same time becoming luminous.

If now the voltage be varied up or down, the current will also vary, causing a variation in illumination proportionate to the variation in current. Thus, if the lamp voltage is modulated, its illumination is modulated proportionately.

This lamp may be modulated at sound frequencies and photographed

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through a slit onto film to make a sound track, such as is done in a number of recording systems.

Objections to the use of the glow lamp for sound recording have been given as lack of sufficient illumination for use with positive stock, short duration of life, lack of uniformity, and "blasting" when modulated at high volume levels. This last will be gone

into more fully later.

Intense illumination can be gotten only by the proper combination of certain gases and vapors, which must be extremely pure and at the proper pressure. If all impurities and gases are not completely eliminated from all parts of the tube and tube elements, they are almost certain to manifest themselves

later and cause early deterioration of the lamp. Likewise the nature of the gas and its pressure, as well as the material and purity of the electrodes determine the amount of sputter and the useful life of the lamp. Only by careful control of all of these factors can lamps be made with illumination sufficiently intense to expose positive stock, and with reasonably long life and uniformity.

Blasting at Full Modulation

If the voltage applied to the tube terminals be decreased, the current will gradually decrease until a

voltage is reached where the current drops from a certain value (say I_1) to zero. Let us call this the extinguishing voltage. If, after extinguishing, the lamp voltage be increased, it will not ignite until a voltage somewhat higher than the extinguishing voltage is reached, which we will call the ignition voltage. At this point ionization of the gas is affected and the current suddenly rises from zero to a value (say I_2), which is greater than I_1 .

Thus, when the voltage is modulated down to the extinguishing voltage and back again, the current will not exactly follow the voltage modulation, but will remain at zero until the ignition voltage is reached. Thus a hysteresis loop is introduced into our modulation curve. Fig. 1A shows how this can affect the current waveform at maximum modulation. I_1 is the minimum current before extinguishing and I_2 the current at ignition. The current remains at zero over a portion of the cycle, introducing a waveform which, due to the extremely sharp wave front or rise in current, is very productive of undesirable harmonics and distortion, causing harsh, raspy quality.

The Three-Element Tube

Obviously the only way to prevent this form of distortion is to make the ignition voltage equal to the extinguishing voltage. This is done by introducing a third element into the tube which allows an unmodulated ionizing current to flow at all times, independent of the modulated current flowing between the two normal electrodes. This unmodulated current from the third electrode keeps the gas ionized at all times, so that for the two normal electrodes the extinguishing voltage and ignition voltage are equal, and the hysteresis loop is eliminated. The resultant undistorted waveform is shown in Fig. 1B.

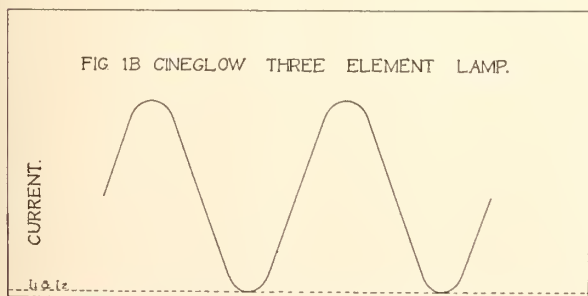
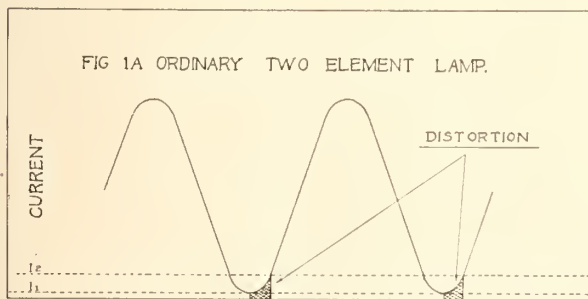
The distortion shown in Fig. 1A is mild compared with that of some tubes the author has measured. Certain impurities in the gas and improper spacing of the electrodes causes I_1 and I_2 to be much more widely separated.

Besides the "lag" in ionization because of the time required for the voltage to reach the ionizing voltage, there is also a time lag in the ionizing of the gas even after the ionizing voltage is reached. This effect tends to accentuate

The Employment of a Third Element in Glow Lamps Overcomes Certain Difficulties Heretofore Experienced in Sound Recording



Fig. 2. Three-element glow lamp.



Current curves of two types of glow lamps.

the distortion previously described. By causing continuous ionization, the third element eliminates this effect also, and certain otherwise desirable gases and vapors which are sluggish in ionization can be utilized to advantage.

Fig. 2 shows the appearance and mechanical construction of a Cineglow three-element recording lamp.

The construction of this lamp is simple and rugged, and it is made entirely by machinery, thus eliminating the human equation which is not only costly but subject to non-uniformity.

The circuit for the three-element recording lamp is extremely simple. The two modulated electrodes are connected as in the standard two-element lamp circuit; i.e., the cathode is connected to the negative voltage supply, and the anode to the positive voltage supply through a transformer or inductance and a stabilizing resistance, the modulating voltage being introduced by the transformer or inductance in the usual manner. The third electrode is connected directly to the positive voltage supply through a very high resistance, say one or two megohms, which allows an unmodulated ionizing current on the order of 0.3 milliamperes to flow. This simple addition is enough to accomplish the desired purpose and eliminates all

of the undesirable effects previously described.

Effect of Overload

Since the hysteresis loop has been eliminated and the ignition voltage made equal to the extinguishing voltage, obviously any over-modulation of the three-element lamp will result in only a flattening of the lower peaks of the waves, similar to the overloading of a vacuum tube, light valve, etc. It has been found that a certain amount of distortion of this nature is not noticeable in most forms of sound work, as practically all natural sounds are already very rich in the harmonics which are introduced, and a slight increase changes neither the character nor the quality of the tones. In addition to this, most complex waveforms consist of high frequencies "riding" on the waveforms of lower frequencies, so that the peaks of these higher frequencies are the first to become flattened, and the higher harmonics introduced are soon lost by being above the audible range as well as the transmission characteristic of the sound system.

Reason for High Modulation Level

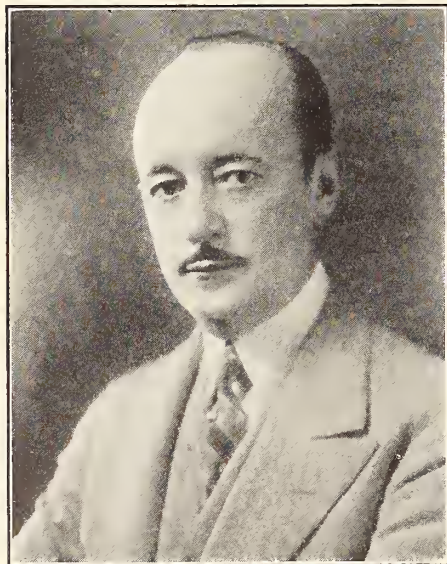
In sound systems our modulation level is limited at the lower end by ground

noise and at the upper end by over-modulation. Since these limits are narrower than the volume range of sounds in nature, we must keep the average modulation reasonably high so that the weaker sounds are not lost in the ground noise. To take full advantage of volume range we must record with peaks on the verge of over-modulation. With the ordinary two-element tube this cannot always be done with good results, since full modulation results in the introduction of the previously described harsh and raspy quality, the distortion introduced bearing no harmonic relationship to the original sound. Thus the two-element tube must be modulated at a lower level, with corresponding loss in volume level and range.

With the three-element tube, however, full advantage may be taken of the volume range of the system with the knowledge that full modulation may be utilized, a slight amount of over-modulation on the extreme peaks being permissible. The use of a lamp capable of exposing positive stock also makes possible increased volume range and a reduction of ground noise. The net result is high quality sound recording with a greatly increased volume range and volume level.

RCA PHOTOPHONE GAINS

WITH more than 3,000 installations of sound reproducing equipment contracted for during 1930, as against slightly more than 900 to its credit at the beginning of the year, RCA Photo-



CHARLES J. ROSS
Executive Vice-President
RCA Photophone, Inc.

phone, Inc., has registered more than a 300 per cent increase in business in its domestic and foreign commercial departments during the last twelve months. In addition thereto, RCA Pho-

tophone recording division in both domestic and foreign fields showed by far the greatest number of new installations of recording apparatus of any company engaged in the manufacture and distribution of sound equipment. In spite of the financial depression that affected all lines of business, RCA Photophone, Inc., under the leadership of Charles J. Ross, executive vice-president, has established a record that has been the subject of much favorable comment in all branches of the motion picture industry.

In commenting upon the outlook for 1931, Mr. Ross made the following statement:

"Continued refinements in recording and reproducing apparatus, the simplification of operation and the standardization of installations to reduce expenses, will receive primary attention during the coming year. Prices of equipment will not materially change, due to the high cost involved in the manufacture of standard equipment. Improvements will be made, however, and the number of models will be reduced.

"There are at least 10,000 unwired theatres of the smaller type in the United States and at least 5,000 of these will install sound reproducing equipment, in addition to several thousand others that will replace unsatisfactory apparatus with dependable equipment."

S. M. P. E. TO HOLD SPRING MEETING IN HOLLYWOOD

THE Spring meeting of the Society of Motion Picture Engineers will be held in Hollywood May 25 to 28, 1931, according to announcement by W. C. Kunzmann following a recent meeting of the Board of Governors.

O. M. Glunt, chairman of the Papers Committee, has already begun work in securing representative speakers and papers for the meeting.

The last meeting to be held in Hollywood was in the Spring of 1928 and with so many new developments brought about by sound in the studios since then, the coming convention is expected to be of great interest and value to the members of the Society.

THEATRE ACOUSTICS

Kendell & Dasseville, of New York have opened a branch office at 1734 Ridge Avenue, Philadelphia. It is staffed with a complete sales, service and engineering unit and covers Eastern Pennsylvania, New Jersey and Delaware. Five houses, The Ridge, Grand, Jackson, Diamond and Ritz have already been acoustically corrected via The Kendell Method. Lewen Pizor, chain operator, is having eleven of his houses gone over; George Kline of National-Kline Poster fame, nine of his, and Comorford tops the list with twenty.