June 5, 1934. J. CRABTREE 1,961,338

PHOTOGRAPHIC FILM PROCESSING

Filed May 21, 1931

FIG. 1

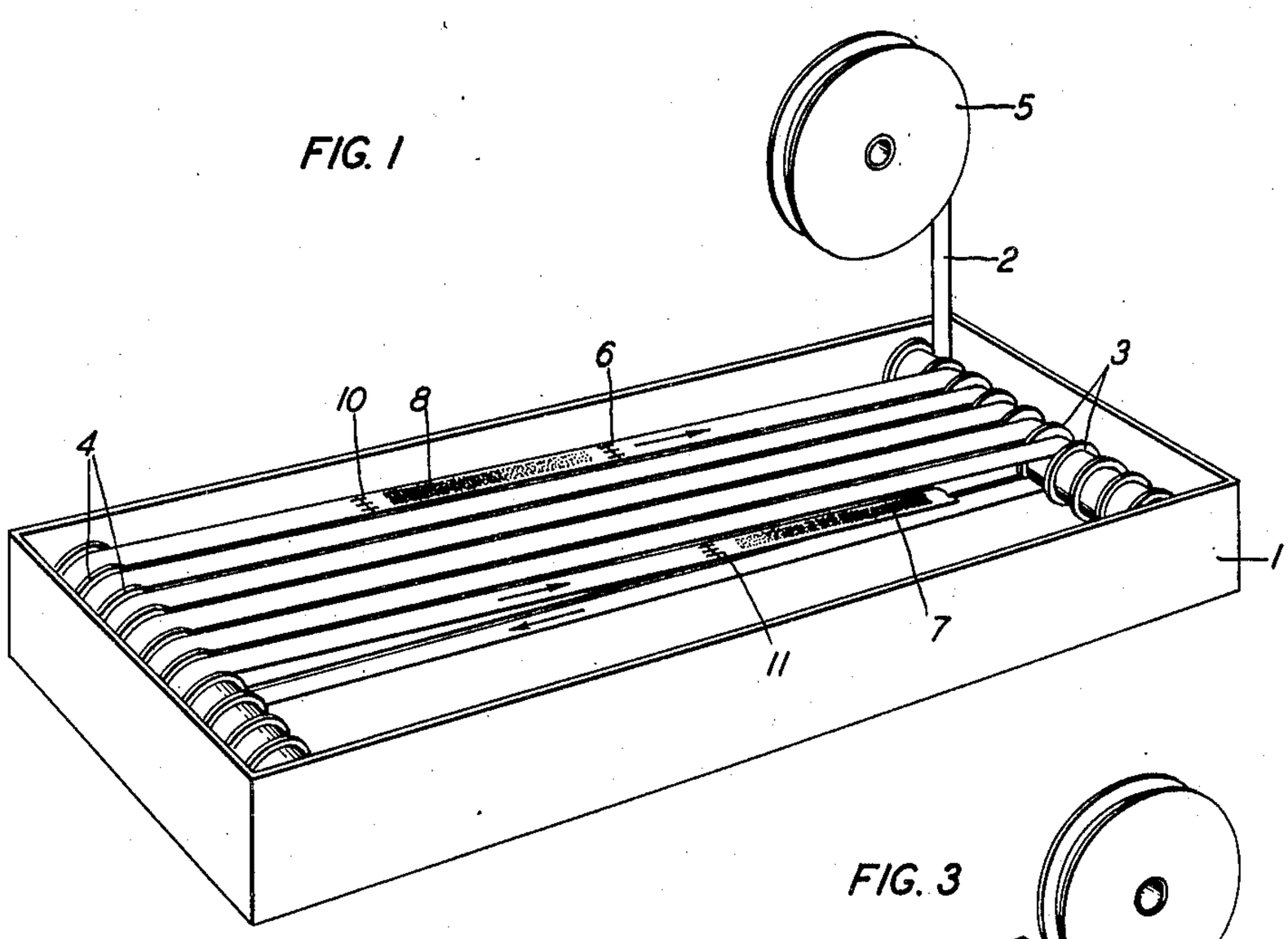


FIG. 3

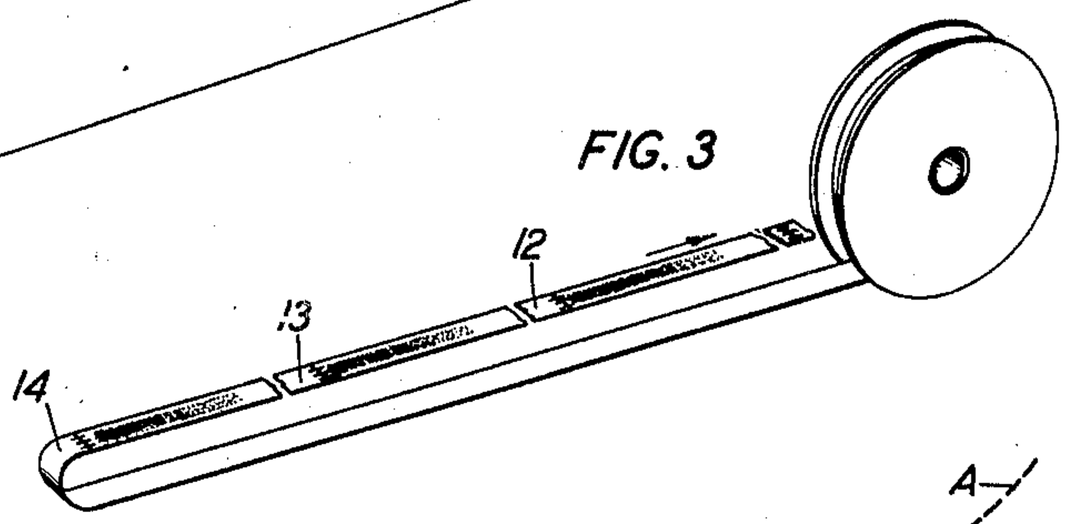
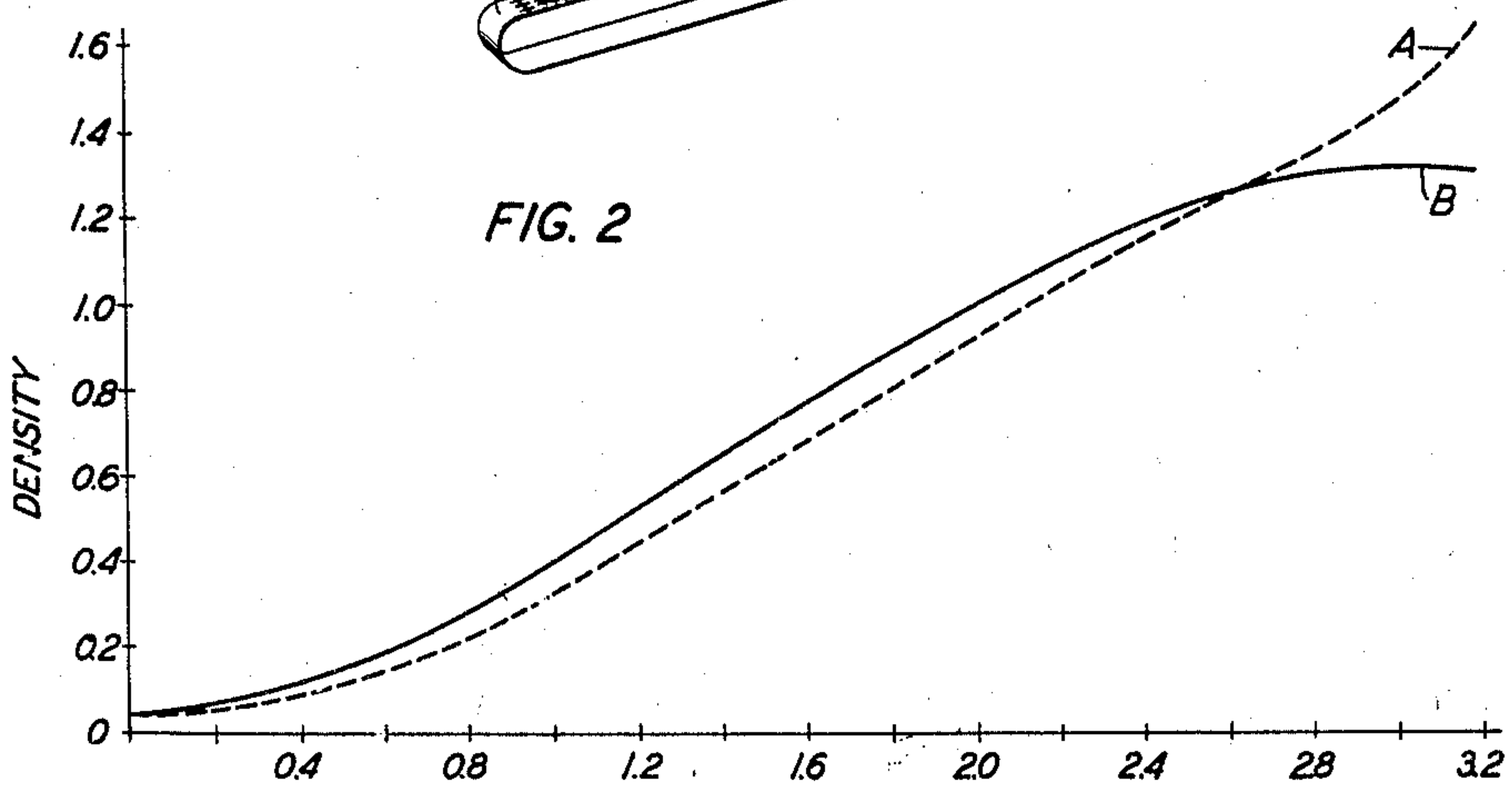


FIG. 2



INVENTOR
J. CRABTREE
BY G. H. Heydt
ATTORNEY

Patented June 5, 1934

1,961,338

UNITED STATES PATENT OFFICE

1,961,338

PHOTOGRAPHIC FILM PROCESSING

James Crabtree, East Orange, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application May 21, 1931, Serial No. 538,961

3 Claims. (Cl. 95—88)

This invention relates to photographic film processing and more particularly to a method and means for producing uniform developing action in machine processing of photographic film.

It is the usual practice in the motion picture art to employ continuous film processing machines for the developing, fixing, washing and drying of exposed photographic film which has been used to record either picture or sound, or both picture and sound. The processing machines referred to are well known in the art and the two types in general use are the vertical tank type and the horizontal tank or tray type machines. In both of these machines, the length of exposed film is continuously drawn through the successive baths constituting the complete process. To provide for precise control of the development operation, it is customary in the development of continuous film to attach to each length of film that passes through the processing machine a short length of film upon which a sensitometer exposure has been impressed. As is well known in the art, this sensitometer exposure consists of a series of exposures in which small areas of film are exposed to different and known quantities of illumination. After exposure and development of the film, the measurement of the different densities produced on these areas enables one to determine the characteristics of the film material employed and also to measure the degree of development that has been given to the film. From this, the printing exposure and development treatment to be given the positive film may be determined. Therefore, the result obtained from the sensitometer strip, which result takes the form of the characteristic curve of the film for the development received, is an important factor in the commercial processing of photographic film.

The object of the invention is to provide a method and means of obtaining accurate and uniform sensitometric control of the development of continuous photographic film in a continuous film processing machine.

A further object of the invention is to provide a method of preparing for development a plurality of sound and picture records on a composite reel or a plurality of separate reels of film for successive development, in such manner that the resulting characteristics determined from the accompanying sensitometer exposures will be uniform throughout the developing process.

Difficulties have been experienced in obtaining close sensitometric control of the development of a continuous film in machines as described above. Characteristic curves obtained from separate sensitometric strips having identical exposures on the same or similar film and which were given identical development were found to vary widely.

Applicant has discovered the effects causing non-uniform development of the film and the sensitometer exposures thereon and consequently the reasons for the inconsistent results evidenced in the characteristic curves obtained from these exposures. As a result of this discovery, applicant has developed a method of preparing for development and developing in a continuous processing machine a plurality of lengths of film, each having a sensitometer exposure thereon, whereby a uniform development results in consequently uniform characteristic curves may be obtained from the several sensitometer exposures.

Applicant has discovered that the non-uniform developing action in processing machines arises from the following facts: The film in its travel through the developing solution in one direction produces a movement or counter current of the developing solution in the opposite direction. The developing solution in developing a small area of the film is exhausted locally in proportion to the density produced. The products of reaction at the developed surface are of such a character that they tend to lower the density produced on the next adjacent area if they are free to make contact with it. Due to that travel of the solution in a direction relatively opposite to that of the film, these products of reaction do make contact with the next adjacent area and exercise a restraining influence upon it which results in the production of a lowered density in this area. It has been found that this restraining action takes place regardless of the agitation of the developer resulting from its circulation through the machine. This action may be cumulative and therefore may cause a greater defect in the development of the next succeeding area.

In the drawing, Fig. 1 is a schematic view in perspective of a developing tank of a continuous film processing machine; and

Fig. 2 is a showing of characteristic curves obtained from the sensitometer exposures impressed on the film as shown in Fig. 1.

Fig. 3 shows a film reel bearing a plurality of sound picture records jointed into a composite reel with the corresponding graduated areas of accompanying strips of sensitometric light images similarly disposed with respect to the direction of film propulsion.

Fig. 1 discloses a developing tank 1 containing a developing solution into which a film 2 is

fed by means of sets of rollers 3 and 4, one or both of which may be driven by suitable means (not shown). The film 2 is fed from a film reel 5 over the rollers 3 and 4 in a direction indicated by the arrows. This reel may carry a film containing a complete sound and picture record or a film composed of various sound and picture records joined together as at 6 to form a composite reel. As shown, each division or section of film has attached thereto, as at 10 and 11, a sensitometer exposure consisting of 16 divisions of graded densities produced by different and known quantities of illumination.

For the sake of explanation of the characteristic curves shown in Fig. 2, the sensitometer exposures 7 and 8 are shown as being directed through the developing solution in the same direction, but with their exposures reversed.

As the result of applicant's study, it has been determined that in machine developed sensitometer exposures the characteristic curves could be divided into two distinct classes, according to the direction in which the sensitometer strip passes through the developer.

In Fig. 2 are shown characteristic curves obtained from two sensitometer strips having identical exposures and developments, but in which the film associated with curve B was passed through the developing machine in such manner that the low density areas of the sensitometer exposure preceded the higher density areas; while the sensitometer strip associated with curve A was passed through the developing solution in a reverse direction. This might be more clearly shown by reference to Fig. 1 in which the sensitometer exposure 7 is directed through the developing solution with the darker areas preceding the lighter areas. Sensitometer exposure 8 is directed through the developing solution with the lighter areas preceding the darker areas. The curve A is representative of a characteristic curve which would be obtained from a reading of the developed sensitometer exposure 7, while curve B is representative of a characteristic curve which would be obtained from a reading of the developed sensitometer exposure 8.

As explained above, the differences in the characteristic curves obtained from the two sensitometer exposures is caused by the fact that in passing from one density area to the next adjacent one on the film, the developer solution is exhausted locally in proportion to the density produced. The density of any given sensitometer area or step, therefore, depends upon whether it is preceded by steps of lower or of higher densities. If a step is preceded by an area of lower density, the density produced will be higher than if this area had been preceded by a step of higher density. In the case as shown by curve A, the areas of higher density precede the areas of lower density and as a result there is a greater quantity of products of reaction set free to produce a restraining influence on the succeeding areas of lower density. This condition results in a series of abnormally low density for the areas of lesser exposure. As can be seen from the curve A, there is a distinct depression of the lower densities, while the areas of higher density have received full development. In the curve B, the areas of lesser density preceded the areas of higher density and as a result, the lower density areas received full development and the higher density areas were subjected to the action of slightly exhausted developer which thus caused a correspondingly lowered shoulder to the characteristic curve. Also in the latter case there is a shortening of the straight line portion of the characteristic curve.

It is thus seen that both curves represent a distorted form of the true characteristics of the photographic material used. However, the curve B, which is the characteristic curve obtained from the sensitometer strip in which the lighter densities preceded the darker densities during development more nearly represents the true characteristics of the material and the true action of the developer upon the material than does the condition represented by curve A in which the dark densities preceded the light densities.

If the curve A were used as representative of the characteristics of the film for the development received, the results would be misleading as the straight line portion of this curve is longer than would be the straight line portion of a true characteristic curve. Therefore, as the straight line portion of the curve is the principal portion used in determining the gamma of the film, the curve having the more correct development for this portion should be chosen as the truer curve.

As a result of applicant's discovery of the effects causing non-uniform results in the characteristics obtained from identical sensitometer exposures developed in a continuous processing machine, the method forming the subject matter of this invention was developed for preparing and developing continuous film in such machines to produce uniformity in the results obtained.

This method comprises propelling all strips of sensitometric latent images attached to a continuous film through the developer in one direction to produce a uniform development of all such strips. The preferred method is to attach all sensitometer exposure strips to the film in such manner that the lighter areas precede the darker areas through the developing solution so that the resulting characteristic curve will more nearly represent the true characteristics of the material and the true action of the developer upon the material.

The method provided for preparing a plurality of sound and picture records for development is shown in Fig. 3, in which the various sound and picture records 12, 13 and 14 are joined into a composite reel with the sensitometric images of the various records similarly disposed with respect to the direction of film propulsion as indicated by the arrow.

It is obvious from the above description that this discovery and the method developed as a result thereof has resulted in the clearing up of a number of inconsistencies found in practice, and has led to many new conceptions relating to the continuous processing of film by machine development.

What is claimed is:

1. The method of preparing a plurality of sound picture records and accompanying strips of sensitometric latent images for subsequent development in a continuous processing machine which comprises joining said records into a composite reel with corresponding graduated areas of all strips of sensitometric latent images similarly disposed with respect to the direction of film propulsion.

2. The method of preparing a plurality of reels of sound picture records and accompanying strips of sensitometric latent images for subsequent successive development in a continuous process-

ing machine which comprises attaching the accompanying strip of sensitometric latent images to each reel of film with corresponding graduated areas similarly disposed with respect to the direction of film propulsion.

3. The method of preparing a plurality of sound picture records and accompanying strips of sensitometric latent images for subsequent development in a continuous processing machine which comprises joining said records into a composite reel with the corresponding graduated areas of all strips of sensitometric latent images similarly disposed with the areas of lesser exposure preceding the areas of higher exposure.

JAMES CRABTREE.