Dec. 7, 1965 M. WRIGHT 3,221,755

DATA PROCESSING APPARATUS

Original Filed Aug. 22, 1961

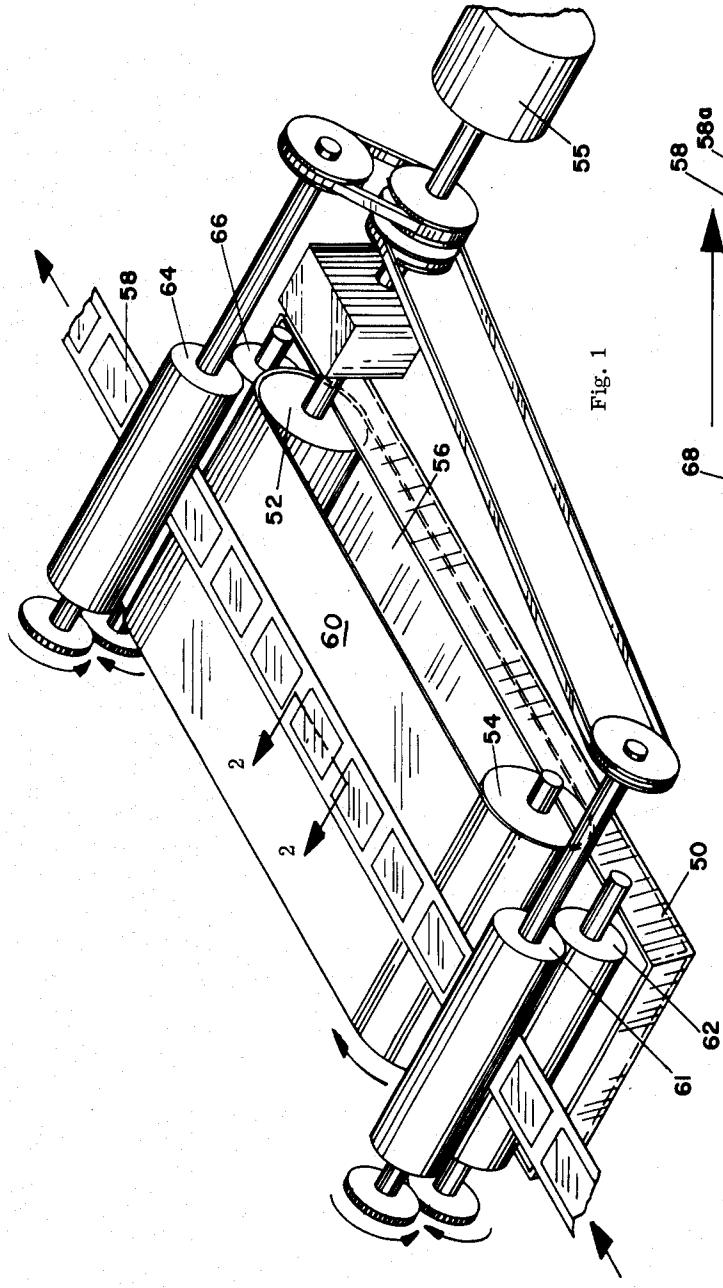


Fig. 1

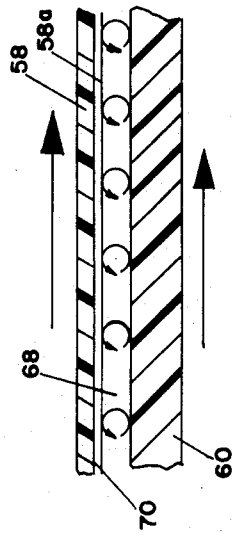


Fig. 2

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DATA PROCESSING APPARATUS

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Original application Aug. 22, 1961, Ser. No. 133,268. Divided and this application June 15, 1964, Ser. No. 387,252

4 Claims. (Cl. 134—122)

This application is a division of the copending application Serial No. 133,268, filed August 22, 1961.

This invention relates to apparatus for the fluid treatment of strip material, and more particularly to apparatus for rapidly processing photographic film in which a layer of uniformly and vigorously agitated processing fluid contacts the gel surface to process the film and simultaneously acts as a scratch-free bearing support for the film during processing.

The rapid and accurate processing of photographic film poses a number of problems. In automatic film processing equipment, the requirements are even more critical, especially in applications such as data storage on film, microfilming and aerial photography. In such data storage techniques, there may be as many as one hundred lines of information per millimeter of film. Any uneven development of the film can result in a serious error when the stored data is recovered and printed out. For example, in processing of aerial photographs, development must be as even as possible, for subtleties of light and shade play a very important part in subsequent interpretation of these printed photographs.

The amount of displacement of the emulsion gel on the film is also quite crucial. Displacement may produce uneven refraction of light passing through the gel, with consequent distortion of the recorded images. Serious errors when the information on the film is printed out can thus occur. It is imperative that the emulsion gel be undisturbed during processing, not only in the illustrative examples given above, but in many other applications where a high degree of accuracy is required.

Another problem of prior art film processing equipment involves passage of the film over a plate, a roller or other surface. It is possible for dirt, grit, or imperfections in the plate or roller to scratch the film. Again even a minor scratch or burr may be critical where high accuracy of recorded information is required.

Prior art processes have also been found to be lacking in speed of processing. Usually microfilm and other data storage applications require speedy recovery of information thereon for efficient functioning of the system. Attempts have been made to step-up processing times by increasing the temperature of the developing bath. Unfortunately, however, such increased temperature frequently degrades the appearance and photographic response of the film. Increased fog is a typical example of such degradation.

It has been found that one of the principal causes of uneven development of photographic film in conventional processing systems is the lack of agitation of the fluid at the surface of the film in motion, or an uneven agitation. Uneven exposure to the processing fluid results in inaccurate development of the film, which is a great cause of error in recovering photographically recorded information.

Accordingly, it is an object of the present invention to provide film processing apparatus which provides for effective agitation of the processing fluid at the film surface.

Another object of the invention is to provide a film processing apparatus of the above character which applies processing fluid to a film with a minimum of displacement of the film emulsion.

A further object of the invention is to provide a film processing apparatus of the above character in which the dangers of damage to the film during processing are minimized.

A further object of the invention is to provide a film processing apparatus of the above character in which the film is supported by a fluid bearing layer of processing fluid as the film goes through the processing stage.

A further object of the invention is to provide apparatus for the processing of film in which relative movement between the film and a thin layer of processing fluid creates turbulence in the field adjacent the film.

A further objection of the invention is to provide apparatus for the fluid treatment of film in which the film is developed with a high degree of uniformity and accuracy.

Another object of the invention is to provide apparatus of the above character which are inexpensive and reliable in operation.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the several steps and the relation of one or more of such steps with respect to each of the others, and the apparatus embodying features of construction, combinations of elements and arrangement of parts which are adapted to effect such steps, all as exemplified in the following detailed disclosure, and the scope of the invention will be indicated in the claims.

For a better understanding of the nature and objects of the invention, reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a perspective schematic view of another embodiment of the invention; and

FIG. 2 is an enlarged fragmentary cross-sectional view taken along lines 2—2 of FIG. 1.

As stated above, it is essential for rapid and accurate film processing that the processing fluid be uniformly agitated as it contacts the film surface. In this invention, effective agitation of the processing fluid is achieved by relative movement between a thin layer of fluid and the film strip. This relative movement produces a "shear" effect in the fluid and provides a uniform and vigorous fluid turbulence over the surface of the film. This "shear" effect is enhanced because of the thinness of the fluid layer, and the resulting turbulence has been found to reduce processing time considerably.

The desired uniform agitation of the processing fluid is achieved in the various embodiments of the invention by moving the fluid over the film surface under pressure or by means of a fluid carrier means such as a moving belt. The fluid acts as a top and bottom bearing for the film. Both the fluid and the film are passed between stationary plates, with the film being moved at a slower rate than the fluid. Transverse movement of the film within the fluid body is easily controlled by application of the fluid flow principle. Any tendency of the film to collapse will cause creation of uneven fluid pressure between the bottom and top layers of fluid. This will tend to return the film to its center position and therefore no scuffing of the film surface will occur.

In the embodiment of the invention shown in FIGS. 1 and 2, the processing fluid is moved as a thin layer by a belt, upon which the film rides with its emulsion face in contact with the layer of fluid. Thus, in all of the above embodiments, the moving film is supported by a thin layer of uniformly agitated processing fluid as the fluid moves relative to the film.

It has been found that very satisfactory results are obtainable in developing microfilm when a layer of fluid approximately 1/32 of an inch thick is moved past each side of the film at a rate approximately one hundred times the rate of movement of the film through the chamber. A velocity of one-half to 2 feet per minute is the customary speed of the film. It should be understood, however, that the properties of the particular processing fluid being used and the properties of the film to be processed may necessitate variations in film speed and fluid pressures for the achievement of optimum results. As a specific example, the apparatus herein has been used to process microfilm at a rate of 30 pictures per minute.

The embodiment shown in FIGS. 1 and 2 utilizes a thin layer of fluid in the processing chamber. The film is supported on one side by a fluid layer which in turn is carried by a belt. The rotation of the belt and the passage of the film through the chamber provide the relative movement between the fluid layer and the film, which creates the vigorous agitation necessary for good processing.

As shown in FIG. 1, the processor is provided with an open-topped tray **50** with a pair of rollers **52, 54** positioned to move a continuous belt **56** through the processing fluid in the tray and then to convey an adhering layer of processing fluid into juxtaposition with the film **58**. The belt may be made of a number of materials including cloth, neoprene, silicone rubber or even stainless steel. A pair of feed rollers **61, 62** and a pair of delivery rollers **64, 66** are synchronously driven by drive means **55** to move the film strip **58** over the top run **60** of the belt **56**.

In operation, the belt **56** is continuously driven by the drive means **55** through at least one of the rollers **52, 54** and preferably by the roller **52** so as to provide a flat run **60** under the film strip which is being passed thereover. The feed and delivery rollers are precisely made and accurately positioned with respect to their mates. They are preferably covered with soft rubber about 0.2 inch thick to prevent scratching of film or displacement of the emulsion gel. Polished metal rollers may also be used if desired for one of the rollers. The rollers are synchronously driven to avoid uneven pull on the film and especially the emulsion covering. Similarly, all the rollers **61, 62, 64** and **66** are powered by drive means **55** and synchronously driven.

It has been found that effective and uniform agitation of the processing fluid between the upper run of the belt and the film is achieved when the linear speed of the belt greatly exceeds the speed of film feed through the processor. A belt speed of approximately 100 times the film speed creates the desired flow to minimize the diffusion layer **58***a* of processing fluid **68** on the two faces of the film. The moving belt not only provides effective agitation of the thin layer of fluid between the film and the belt but also provides a constant stirring and mixing action of the processing fluid in the tray **50**.

It will also be quite evident from a study of the structure shown, that the relative positioning of film feed and delivery rollers **61, 62, 64** and **66** is independent of the belt rollers **52** and **54**. Thus, the clearance and hence the thickness of the layer of fluid between the film and the belt is adjustable. Indeed, this independence is a very attractive feature of the invention for it completely avoids film-roller or belt contact heretofore believed essential. Such contact frequently altered the acuity characteristics of the developed film.

In one instance, the clearance used was .001 inch between the belt and the film. This adequately accommodated the viscosity of the processing fluid, which was substantially similar to water. Typical processing compositions used were those indicated in Lange's Handbook of Chemistry, Handbook Publishers, Inc., Sandusky, Ohio, in the section entitled, "Photographic Solutions."

It can be seen from FIG. 1 that the top run **60** of the belt is moving in the same direction as the film **58**. Thus, the processor is self-threading, for the belt **56** can carry a film leader from the feed rollers to the delivery rollers. This facilitates use of the apparatus for short lengths of film.

This invention may be employed as a single stage processor, i.e., with a "monobath" wherein only a single processing fluid is needed. The above embodiment may also be included in a film processing system wherein a series of adjacent spaced units are employed to process film. In such a system, the film may be moved through several processors having different processing fluids for "conventional" film processing. Thus, successive processors may contain a developer, doctoring developer inhibitor, fixer and wash fluids, for example. The feed and the delivery rolls, coupled with appropriate wiper blades (not shown) acting thereon to wipe off fluid, inhibits dilution of each succesive solution by the preceding solution.

The apparatus of the invention also exhibits versatility in handling varying widths of film. The embodiment shown in FIGS. 1 and 2 can process film of 16, 35 or 70 millimeter widths without adjustment.

The invention has a number of advantages. The apparatus is relatively simple and inexpensive to manufacture, and, the processing fluid may be recycled, thus cutting the operation costs of processors employing the invention.

Moreover, developing time has been substantially reduced, and this makes the apparatus very suitable for use with microfilm or with other data storage applications. The vigorous agitation of the processing fluid at the emulsion surface of the film is the primary factor in the increase in developing speed.

The quality of film processing is also exceptionally high, and therefore the invention may be used in applications where uniformity of tone of the finished film is critical. The agitation of the fluid over the film emulsion is uniform and develops film with accurate tone qualities.

It should be understood that the processing apparatus of the invention may also be applicable for processing strip material other than photographic film in the strict sense. Data storage tapes may be treated for example, wherein the information is recorded magnetically or by a thermal process. The invention can thus be employed in these applications where it is desirable to agitate processing fluid at the surface of the information being material and where damage to the strip material should be minimized during processing.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained and, since certain changes may be made in carrying out the above process and in the constructions set forth without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the following claims are intended to cover all of the generic and specific features of the invention herein described, and all statements of the scope of the invention, which, as a matter of language, might be said to fall therebetween.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Processing apparatus for fluid treatment of strip material comprising, in combination:

fluid carrier means for supporting and transporting a layer of processing fluid;

means for supplying a layer of processing fluid to said fluid carrier means;

drive means for moving said fluid carrier means with said layer of processing fluid thereon at a first speed;

means for moving a strip of material relative to and in operative juxtaposition with said layer of processing fluid at a second speed so that said layer of proc-

essing fluid provides support for said strip of material.

2. The processing apparatus of claim **1**, wherein said fluid carrier means includes a belt.

3. Processing apparatus for fluid treatment of information bearing strip material, comprising, in combination, a continuous belt having substantially horizontal top and bottom runs, a pair of rollers for supporting and driving said belt, a reservoir positioned to bathe the bottom of said belt with processing fluid as said belt is moved therethrough, means to drive said rollers at a rate of speed sufficient to carry substantial fluid from said reservoir with said belt, and feed means adjacent said belt and independently positionable therefrom for positioning said strip material in operative juxtaposition over

the top run of said belt whereby the strip material will be processed by contact with said fluid being carried from said reservoir by said belt.

4. Apparatus as defined in claim **3** wherein said feed means includes two pairs of rollers having substantially parallel axes and wherein the uppermost roller of each pair moves the strip material over the top run of said belt and the lowermost roller of each pair is an idler.

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CHARLES A. WILLMUTH, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,221,755 December 7, 1965

Malor Wright

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 5, line 10, before "of" insert -- run --.

Signed and sealed this 8th day of November 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents