

United States Patent

[11] 3,615,814

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[73] Assignee **Eastman Kodak Company
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2,792,674	5/1957	Balamuth et al.....	310/26 X
2,967,119	1/1961	Gutterman	134/1
3,072,808	1/1963	Plesset et al.	310/26
3,173,034	3/1965	Dickey et al.	134/1 X
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FOREIGN PATENTS

931,653	7/1963	Great Britain.....	134/15
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[54] **METHOD OF AND APPARATUS FOR
ULTRASONICALLY CLEANING A WEB OF FILM**
5 Claims, 2 Drawing Figs.

[52] U.S. Cl. **134/1,
15/94, 15/100, 134/9, 134/184, 355/30**

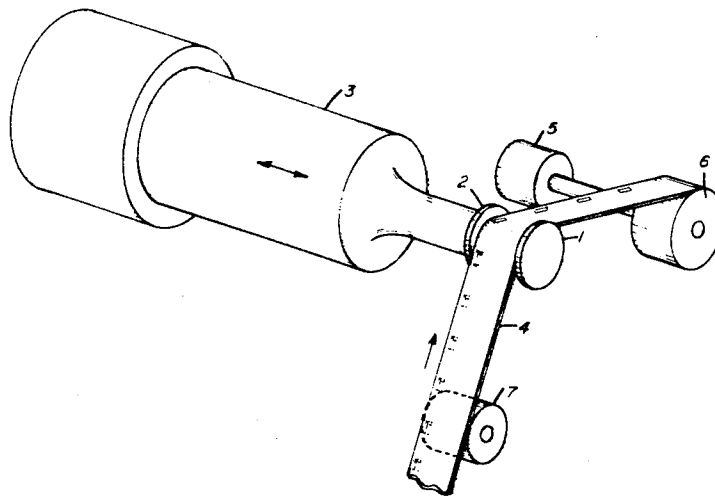
[51] Int. Cl. **B08b 7/02**

[50] Field of Search..... **134/1, 6, 9,
15-17, 64, 122, 184; 15/94, 100; 355/15, 30;
68/355**

[56] **References Cited**
UNITED STATES PATENTS

2,460,919	2/1949	Bodine	134/1 UX
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ABSTRACT: Dirt particles are cleaned from a web of flexible material such as photographic film or paper by applying ultrasonic vibrations to the web in a direction transversely of the web. The cleaning apparatus comprises an ultrasonic horn having a pair of circular opposed shoulders spaced from one another lengthwise of the horn, defining a circular channel between the shoulders for confining the web, and mechanism for advancing the web through the channel in contact with the shoulders.



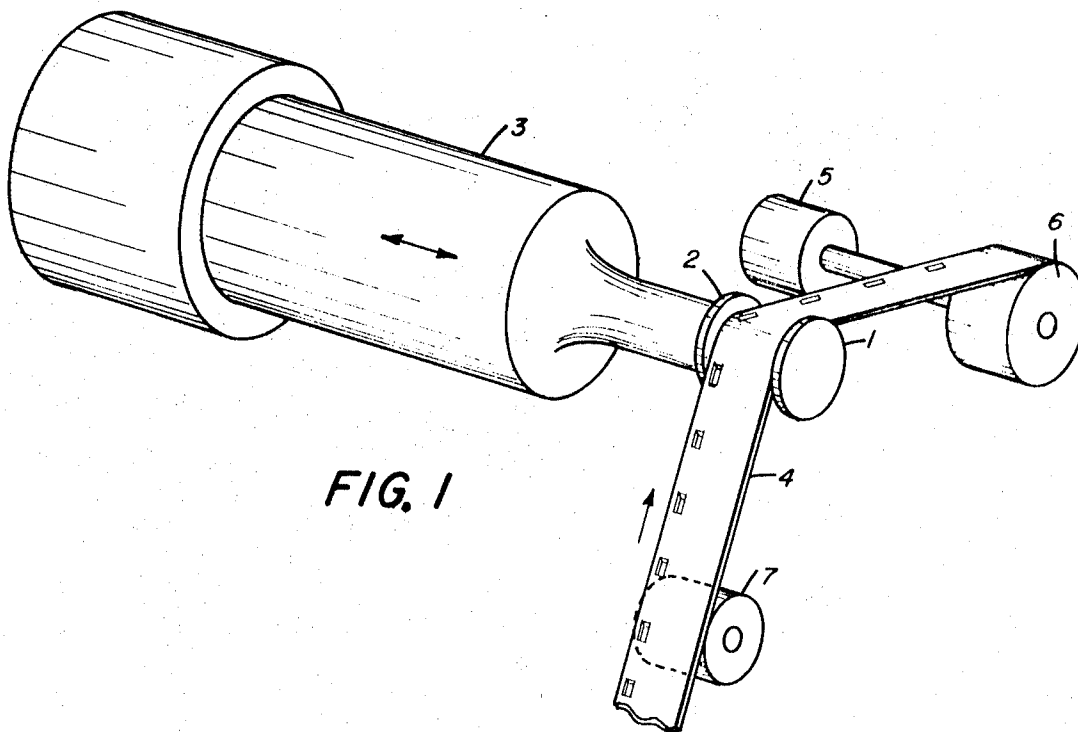


FIG. 1

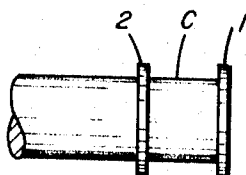


FIG. 2

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METHOD OF AND APPARATUS FOR ULTRASONICALLY CLEANING A WEB OF FILM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a novel method of and apparatus for ultrasonically cleaning dirt from a web of flexible material such as photographic film or paper.

During the manufacture of webs of photographic film or paper, it is important that dirt particles be prevented from accumulating on a web because such particles will adversely affect the quality when photographic emulsions are coated over such particles. Moreover, if dirt particles should accumulate on the top of the finished web (before or after exposure and development) the quality of the photographs may be impaired, and the film may be scratched as it passes through a projector.

Dirt particles can accumulate from the ambient atmosphere, or can result from slitting and punching operations normally employed during the manufacture of photographic film and paper.

The Prior Art

In the past, photographic film has been cleaned by immersing it in a liquid bath, which is then subjected to ultrasonic vibrations, cleaning being accomplished by cavitation of the liquid. (See U.S. Pat. Nos. 2,967,119 and 3,422,479.) This requires the introduction of bulky equipment into the production line for both the cleaning operation, and for subsequent drying. Moreover, liquids may chemically affect the properties of photographic emulsion, and may cause streaks or to the undesirable effects.

Also, sonic air blasts have been suggested for blowing particles from a web (see U.S. Pat. No. 3,420,710).

SUMMARY OF THE INVENTION

In accordance with the present invention, a web of flexible material such as photographic film or paper is ultrasonically cleaned of small solid particles of dirt in an essentially dry condition by subjecting the web to ultrasonic vibrations in a direction transversely of the web and in the same plane as the web, to shake off the dirt particles. This operation desirably is performed by engaging at least one edge, and preferably both edges, of the web with an ultrasonic horn having its major vibration along the longitudinal axis of the horn in a direction normal to the web.

When a long narrow web is being cleaned, it is moved across and in contact with the horn, preferably in a continuous and uninterrupted manner.

THE DRAWING

In the drawing:

FIG. 1 is a perspective view showing schematically an arrangement of apparatus for continuously ultrasonically dry cleaning moving picture film by engaging its edges with a vibrating ultrasonic horn;

FIG. 2 is a side elevational view of an end portion of the ultrasonic horn shown in FIG. 1.

THE PREFERRED EMBODIMENT

Referring to FIGS. 1 and 2, there is shown an ultrasonic horn having two annular flanges 1 and 2 projecting laterally therefrom at positions spaced longitudinally from each other, thus forming a pair of opposed circular shoulders or abutments which define a circular channel C of cylindrical shape therebetween.

The horn is operatively connected to an ultrasonic transducer 3 which may be of the electrostrictive (piezoelectric) or magnetostrictive types, such as have been described in many U.S. Pat. Nos., for example in 2,748,298 (Calosi et al.—magnetostrictive); 3,022,814 (Bodine—both types); and

3,328,610 (Jacke et al.—piezoelectric). The major direction of vibration should be along the longitudinal axis of the horn, as shown by the double pointed arrow. Of course, the transducer 3 should be clamped in a suitable holding device (not shown).

In operation, a web 4 of flexible material, shown as moving picture film having perforations along one side, is transported from a source over a roll 7 to the ultrasonic horn. Film 4 is bent around the horn within channel C and is taken up on a spool 6 driven by a motor 5. As the film moves continuously through channel C, the transducer 3 is energized to impart back-and-forth vibrations to the flanges 1 and 2 which engage both edges of the film and impart the vibrations to the film in the film plane, thus shaking off from both top and bottom surfaces any dirt particles present. Surface particles have been successfully removed dry which are of the order of three microns, and of ten microns and larger.

It is sometimes desirable to lightly spray a volatile liquid such as methyl chloroform onto the vibrating film surfaces to add mass to the dirt particles and increase their inertia. Other suitable volatile liquids are freons, trichloroethylene, trichloromonofluoromethane, perchloroethylene, carbon tetrachloride, dichlorodifluoromethane, dichloromonofluoromethane, monochlorotrifluoroethane, and dichlorotetrafluoroethane.

The success of our method results from so rapidly accelerating the web relative to the dirt particles (which have extremely small inertia) that the particles are torn loose from the web. In one example, an ultrasonic horn as shown was operated at 20 kHz. with a longitudinal excursion of 0.001 inch, providing a web acceleration transversely approximately 40,000 times gravity. Thus, the forces exerted on dirt particles relative to the web were approximately 40,000 times the weights of the particles. This, coupled with the fact that the force is reversing its direction 20,000 times per second, explains the ability of our apparatus to rip dirt particles loose from the web.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention.

We claim:

1. A method for cleaning dirt particles from a web of flexible material comprising moving said web in a direction lengthwise thereof while contacting at least one edge of said web with a solid ultrasonically vibrating abutment, and ultrasonically vibrating said contacting abutment in a direction transversely of said moving web.
2. A method in accordance with claim 1 wherein both edges of said web are contacted with solid ultrasonically vibrating abutments.
3. Apparatus for cleaning dirt particles from a web of flexible material by applying ultrasonic vibrations to said web in a direction transversely thereof comprising, in combination: an ultrasonic horn having abutment means extending transversely from a side surface thereof; mechanism for advancing a web to be cleaned transversely across said horn with at least one edge of said web engaging said abutment means; and means coacting with said horn for imparting ultrasonic vibrations thereto in a direction lengthwise of said horn, to shake said particles from said web.
4. Apparatus in accordance with claim 3 wherein said abutment means is a pair of opposed shoulders spaced from one another lengthwise of said horn and defining a channel therebetween for confining said web during movement thereof.
5. Apparatus in accordance with claim 4 wherein said shoulders are circular in shape and parallel to one another, and the part of said horn between said shoulders is cylindrical in shape, forming a cylindrical channel.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,615,814 Dated October 26, 1971

Inventor(s) Howard F. Ott et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 32, "to the" should read -- other --.
Column 2, line 47, after "transversely" insert -- across the width --; line 60, after "horn" insert -- and transversely across the width of said web --.

Signed and sealed this 9th day of May 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents