Feb. 12, 1935. T. M. INGMAN 1,991,251

APPARATUS FOR AND PROCESS OF DEVELOPING FILM

Filed Feb. 5, 1934 2 Sheets-Sheet 1

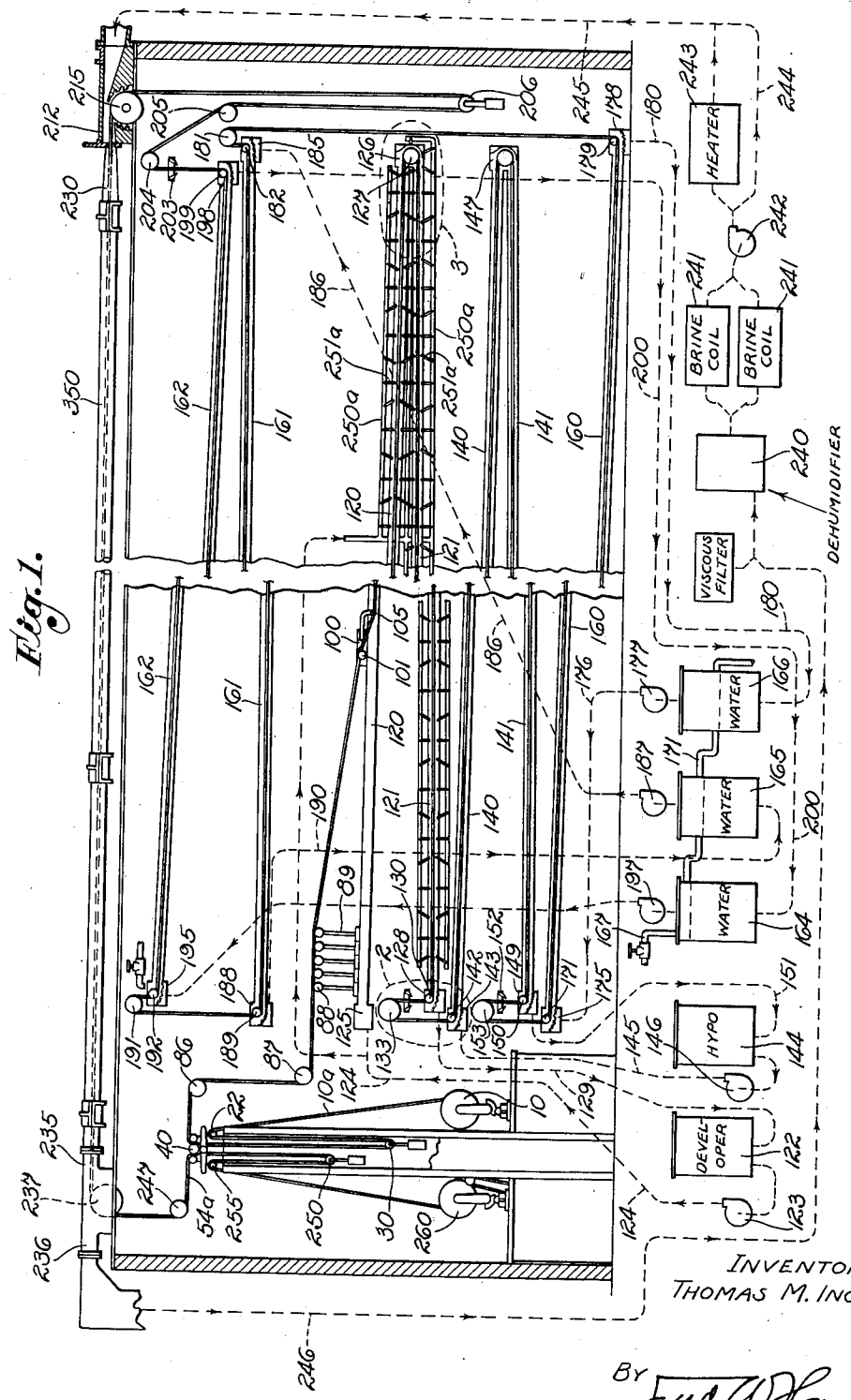


Fig. 1.

INVENTOR
THOMAS M. INGMAN

BY Fred W. Lamir
ATTORNEY

Feb. 12, 1935. T. M. INGMAN 1,991,251

APPARATUS FOR AND PROCESS OF DEVELOPING FILM

Filed Feb. 5, 1934 2 Sheets-Sheet 2

Fig. 2.

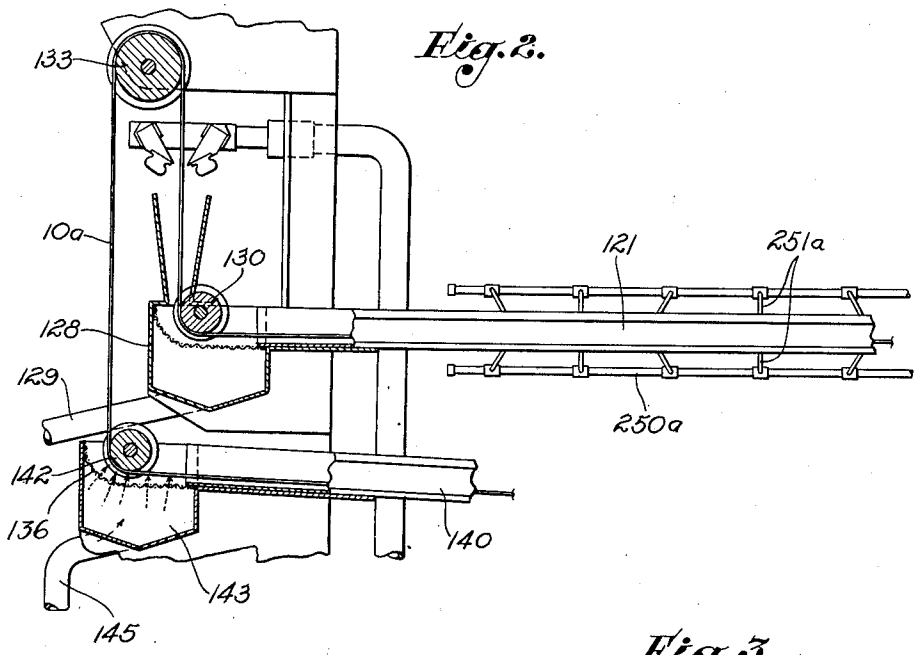


Fig. 3.

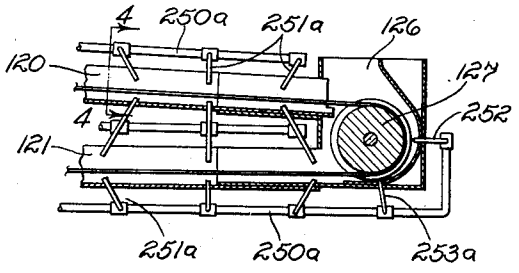
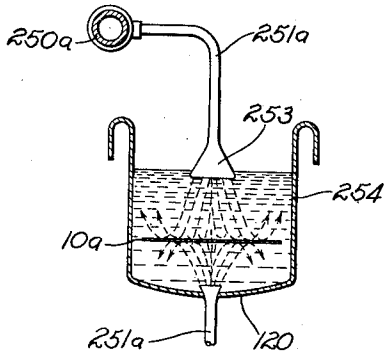


Fig. 4.



INVENTOR
THOMAS M. INGMAN

BY Fred W. Lamb

ATTORNEY.

Patented Feb. 12, 1935 1,991,251

UNITED STATES PATENT OFFICE

1,991,251

APPARATUS FOR AND PROCESS OF DEVELOPING FILM

Thomas M. Ingman, Los Angeles, Calif.

Application February 5, 1934, Serial No. 709,736

34 Claims. (Cl. 95—94)

My invention relates to the development of motion picture film and relates in particular to a process and apparatus for film development having its greatest utility in the development of motion picture film having sound tracks thereon.

The continuous development of film by conveying the film strip continuously through treating solutions, although it has shown some very marked advantages, has been accompanied by some very pronounced disadvantages, one of which is the formation of halos adjacent images, ghostlike effects, and false images resulting from density distortion. Another pronounced defect resulting from the present methods of continuous motion picture development is the distortion of the sound track image due to influence of the picture images lying along a side of the sound track of the film.

I have found that a condition which I will hereinafter refer to as image drag or bromide drag is to a great extent responsible for the above mentioned phenomena, and I have arrived at the further conclusion that the change in strength of the developer solution lying in close proximity to the film also contributes to the above defects. Relative to the condition referred to as bromide drag, the movement of the developer across the surface of the film being treated carries chemical reaction products, such as bromides, laterally upon the surface of the film from the point of origination of such reaction products. Some of these displaced reaction products adhere to the film adjacent the image portions in which they were formed and produce secondary images or deform the images on those portions of the emulsion to which they adhere. The result of this is that the final positive film has halos or ghostlike areas adjacent the constituent parts of the complete photographic image, and it is likewise true that the drag of reaction products over the sound track of a talking motion picture film results in a distortion of the sound track image. The second defects hereinabove mentioned, relating to the weakening of the developer which lies in close proximity to the emulsion of the film being treated, results in density distortion owing to the fact that a developer which has been weakened by previous use has not the developing capacity of a full strength solution. My investigations of this phenomenon indicate that a film of developer forms on the surface of the emulsion, which film moves relatively slowly across the surface of the emulsion and is changed in strength in accordance with the characteristics of the image portion on which it operates. Through the manifestations of this phenomenon I am convinced that the sound track density of a motion picture film is caused to fluctuate in accordance with the characteristics of the image lying therealong.

I have found that by continuously and positively changing the solution which is in direct contact with the surface of the emulsion, that is, by constantly replacing the above-noted film of solution with full strength solution, and that by removing the solution from the surface of the film in a relatively rapid manner, the reaction products may be carried off without being dragged over portions of the emulsion adjacent the points of origination of the reaction products, and a relatively perfect development of film may be accomplished in which the above-noted defects are not noticeably present.

This application is a continuation in part of the copending application of Thomas M. Ingman, Frank E. Garbutt, and Leigh M. Griffith, Serial No. 604,716, filed April 12, 1932, for Process of and apparatus for developing film, and sets forth an invention having for its principal object to avoid the hereinabove discussed disadvantages and defects by the use of high turbulence in a developer solution lying adjacent the surface of an emulsion of a film, and the direction of streams or jets of a treating solution, such, for instance, as the developer, against the image or emulsion in such a manner that the solution in direct contact with the film is kept substantially at full strength and the reaction products, such as bromides, are carried off without dragging.

Further objects and advantages of the invention will be made evident throughout the following part of the specification.

Referring to the drawings, which are for illustrative purposes only,

Fig. 1 is a schematic view showing a motion picture developing apparatus employing my invention.

Fig. 2 is an enlarged fragmentary view of the portion of the apparatus included within the dotted line 2 of Fig. 1.

Fig. 3 is an enlarged fragmentary sectional view of the area included within the dotted line 3 of Fig. 1.

Fig. 4 is an enlarged cross-section on the plane 4—4 of Fig. 3.

Referring to Fig. 1, the film treating device includes a feed reel 10 from which a film 10*a* to

be treated is fed over a roller 22 to a weighted take-up roller 30, from which the film 10*a* is carried upwardly into engagement with one side of a movement control sprocket and thence over guide sprockets 86 and 87 and adjustable supporting sprockets 88 carried on movable standards 89, to a positioning or guiding device 100 which is movable along a conduit or trough 120 so as to vary the point at which the film is actually fed into the solution carried in the trough 120, this positioning device 100 having a roller 101 over which the film is carried to a roller 105 disposed within the trough.

The apparatus shown in Fig. 1 includes a number of troughs having developer therein, a number of troughs containing hypo, troughs containing wash water, and conduits in which the film is subjected to a drying fluid, such as preconditioned air. Developer is contained in the trough 120 and a trough 121 connected thereto by means of a return bend 126 having a guide roller therein over which the film is carried from one trough to the other. Developer is conducted into the inlet end 125 of the upper trough 120 through piping 124 which leads from a developer vat 122 and through which the developer is forced by means of a suitable pump 123. The developer which is introduced through the inlet 125, together with other developer as will be hereinafter described in detail, flows downwardly or rightwardly through the trough 120 to the return bend 126, into the trough 121, and thence through the trough 121 to the outlet chamber 128 at the lower leftward end thereof, this chamber 128 being connected through a pipe 129 with the developer vat 122. The film is conducted under a roller 130 at the leftward end of the trough 121 and thence upward over a pulley 133, an air blast squeegee being employed for the purpose of blowing off adhering drops of developer from the surfaces of the film as it passes from the roller 130 to the roller 133. From the roller 133 the film is carried under a roller 142 situated in the inlet chamber or member 143 at the upper leftward end of a trough 140 which connects through a return fitting 147 at its lower rightward end with the upper rightward end of a trough 141. The troughs 140 and 141 may contain a fixing solution which serves in further treatment of the film, and for the purpose of delivering solution to the troughs 140 and 141 a hypo vat 144 is connected through piping 145 connecting a pump 146 therein with the inlet chamber 143 of the trough 140. The hypo solution discharges upwardly through the orifices of a perforate member or screen 136 in the form of jets of fluid which impinge against the emulsion of the film so as to produce turbulence and carry therefrom reaction products in the effective manner forming a part of our conception, and flows rightwardly in the trough 140 in engagement with the film contained therein and then leftwardly through the trough 141, likewise in engagement with the film, to be discharged through an outlet chamber 149 at the leftward end of the trough 141 into return piping 151 leading to the hypo vat 144. Troughs 160, 161, and 162 are employed for wash water, the inlet member 175 of the trough 160 being disposed in such position that the film leaving the trough 141 may be conducted over a guide roller 150 in the outlet member 149, past a squeegee 152, over a guide roller 153, and downwardly under a guide roller 171 mounted in the inner chamber 175 of the trough 160. At the rightward end of the trough 160 is an outlet chamber 178 having a roller 179 therein under which the film is carried and from which the film is extended upwardly to a guide roller 181 from which it is carried downwardly into an inlet chamber 185 situated at the upper rightward end of the trough 161. The film passes under the guide roller 182 in the inlet chamber 185 and is carried leftwardly through the trough 161 to a guide roller 189 in an outlet chamber 188 at the leftward end of the trough 161. From the roller 189 the film is carried upwardly to a guide roller 191 disposed above the inlet chamber 195 at the upper end of the trough 162. From the roller 191 the film is carried downwardly to a guide roller 192 and then rightwardly through the trough 162 to a guide roller 199 disposed in an outlet chamber 198 situated at the lower or rightward end of the trough 162. Interconnected water containers 164, 165, and 166 are employed, and piping is provided for connecting these water containers with the wash troughs 160, 161, and 162. Clean water is conducted into the first of the containers 164 through piping 167 and is carried upwardly to the inlet chamber 195 at the upper end of the trough 162 through piping having a pump 197 therein. The outlet chamber 198 of the trough 162 is connected by return piping 200 with the lower end of the container 164. Water from the container 164 overflows into the container 165 and is conducted from the container 165 through piping 186 having a pump 187 therein to the inlet chamber 185 situated at the upper or rightward end of the trough 161. From the outlet chamber 188 of the trough 161 the water is returned through piping 190 to the container 165 which is connected through piping 171 with the container 166. From the container 166 water is carried through piping 176 having a pump 177 therein to the inlet chamber 175 at the leftward end of the trough 160 through which it flows to the outlet chamber 178 at the rightward end of the trough 160 and is then returned through piping 180 to the tank 166. From the foregoing it will be perceived that the film 10*a* in passing through through the conduits or troughs 120, 121, 140, 141, 160, 161, and 162 is brought consecutively into treating engagement with developing solution, fixing solution, and wash water.

From the guide roller 199 situated in the outlet chamber 198 at the rightward end of the trough 162, the film is carried upwardly through a squeegee 203 to a guide roller 204 and thence to a guide roller 205. From the guide roller 205 the film is carried downwardly under a weighted roller 206 and then upwardly to a guide roller 215 in an inlet device 212 which connects through a conical member 230 with a conduit 350 preferably consisting of glass tubes. Through the conduit 350 the film is carried leftwardly to an outlet fitting 235 and passes over a guide roller 237 downwardly to a guide roller 247, from whence the film is carried as indicated at 54*a* into contact with the left side of the movement controlling sprocket 40. From the sprocket 40 the film passes around a weighted pulley 250 so as to form a take-up loop and then passes over a guide pulley 255 to a take-up reel 260 which is yieldably driven so as to wind the film in accordance with the speed at which it issues from the developing machine. In passing through the conduit 350 the wet film is subjected to the drying action of a flow

of air which is delivered through piping 245 to the fitting 212 leading into the rightward end of the conduit 350. The air which leaves the leftward end of the drier conduit 350 passes through the discharge end 236 of the fitting 235 into piping 246 by which it is carried to a dehumidifier 240. From the dehumidifier 240 the air passes through refrigerating devices 241, causing the precipitation of moisture from the air, and from the refrigerating devices 241 the air is pumped by means of a pump 242 either through a heater 243 or through piping 244, as conditions of operation may require, to the piping 245 which leads to the inlet member 212.

It will be recognized that the arrangement of the trough members, such, for instance, as the members 120 and 121, may be varied in accordance with the special considerations and other considerations, such as the strength of solutions, time the film must be kept in engagement with such solutions, etc. Accordingly, the troughs 120 and 121 representing the containers for developer may be combined into one very long trough or may be divided into a larger number of shorter troughs, the slope of these troughs being such that a sufficient velocity of fluid may be maintained therein to propel the motion picture film through the device and to properly wash the surface of the emulsion. Relative to the washing of the surface of the emulsion, the problems of bromide drag and density distortion are encountered. The flow of a treating solution across the face of a film tends to carry reaction products, and such reaction products are consequently spread or dragged over adjacent portions of the emulsion. My invention avoids the defects set forth in the preamble of this specification by causing jets of fluid to be carried directly against the face of the emulsion so that the travel of the developer relative to the surface of the emulsion is of a turbulent character and is not parallel to the surface of the film. In other words, a flow or jet of developer directed against the surface of the film is reflected angularly therefrom and carries reaction products away from the face of the film instead of spreading such reaction products over adjacent image portions. Likewise, such jets of developer and adjacent turbulent waves or currents of developer produced by the jet action penetrate the surface film of developer liquid adhering to the emulsion so that the developer, which is weakened during reaction in direct engagement with the surface of the emulsion, is quickly removed and replaced by fresh developer, with the result that the emulsion itself is kept practically constantly subjected to full strength developer. The effect produced in the treating or developing of a motion picture film, in addition to rapid developing action, is to reduce bromide drag and density distortion to a minimum. Present continuous methods of motion picture film development often produce a density distortion as high as 20 to 25%, but my new process produces this distortion in most instances to around 1%, so that for all practical purposes the film may be considered as having no density distortion. Likewise, the pronounced halos or ghosts produced in ordinary continuous film developing machines are eliminated to such an extent as to be unnoticeable or in many cases entirely absent, owing to the fact that the method of applying jets of developer to the surface of the film carries reaction products outwardly rather than laterally across the face of the film. The jets of fluid produce turbulence in areas adjacent thereto so that it is not the fluid jet alone which accomplishes the desired result, but the beneficial effect is contributed to, to a greater or lesser extent, by the turbulence existing in the liquid adjacent the points of application of the jets. This feature of the invention is best illustrated in Figs. 2 and 3, in which I show fluid header piper 250*a* extending along the troughs 120 and 121 in such positions that short jet pipes 251*a* may be extended upwardly and downwardly therefrom toward the emulsion of the film. In the disclosed practice of the invention the header pipes 250*a* are placed above and below the troughs in approximately opposing relation so that the forces thereof will be balanced and hold the film in the solution flowing down the trough. Consequently, if a pair of films are carried through the device in back-to-back relation, or if a double-coated film is treated, the jets placed above and below the path of movement through which the films travel in the trough have the function of accomplishing the hereinabove set forth valuable effects in both emulsions of the film. Assuming that in traveling down the trough 120 the film has the emulsion on the upper surface thereof, the downwardly projecting nozzles 251*a* will accomplish the desired treating effect, but when the position of the emulsion is reversed due to the film passing over the roller 127, the upwardly projecting nozzles 251*a* lying along the trough 121 will accomplish the treating effect, and the downwardly projecting nozzles along this trough 121 will produce jets of fluid acting downwardly against the back of the film to offset the upward force of the lower jets issuing from the lower nozzles 251*a*. Practice indicates that it may be desirable to place succeeding nozzles in varying angular relation as shown, placing diagonal nozzles in interspersed relation to transverse nozzles, so that the surface of the film will be subjected to jets of fluid approaching the surface of the film from different directions, thereby producing a maximum dislodging effect so as to attain maximum treatment of the surface of the emulsion for the purpose of producing a high relative velocity between the surface of the emulsion and the solution in actual contact therewith, carrying off reaction products, breaking up the adhering film of liquid on the surface of the emulsion, and keeping the solution in contact with the emulsion at as nearly full strength as possible.

Although I have herein shown and described my invention in simple and practical form, it is recognized that certain parts or elements thereof are representative of other parts, elements, or mechanisms which may be used in substantially the same manner to accomplish substantially the same results; therefore, it is to be understood that the invention is not to be limited to the details disclosed herein but is to be accorded the full scope of the following claims.

I claim as my invention:

1. A film treating device of the character described, including: a pair of conduits through which a film to be treated may be moved, said conduits being joined at an angle bend; guide means in said angle bend for directing said film from one of said conduits to the other; and means for directing a jet of developer against said film as it passes around said bend.

2. A film treating device of the character de-

scribed, including: conduit means through which a film to be treated may be moved; means for producing a flow of a developer fluid through said conduit means in contact with said film; and means for producing turbulence in parts of said fluid engaging the emulsion on said film, whereby to reduce image drag to a minimum.

3. A film treating device of the character described, including: means for moving a film in engagement with a developer fluid; and means for producing turbulence in portions of said treating fluid in contact with the emulsion of said film of such character as to minimize bromide drag and expedite the treatment of said film.

4. A film treating device of the character described, including: means forming a container through which a film to be treated may be moved in engagement with a treating solution; and means for directing jets of treating fluid within the body of treating solution against the emulsion of the film.

5. A film treating device of the character described, including: conduit means through which a film to be treated may be moved; and means for directing jets of treating fluid against the emulsion of said film, whereby to dislodge from the face of the emulsion of the film the thin layer of treating fluid adhering thereto.

6. A film treating device of the character described, including: a container through which a film to be treated may be moved; means for maintaining in said container a sufficient quantity of developer fluid to provide a continuous contact thereof with the emulsion of the film; and means for directing jets of developer fluid against the emulsion of said film with sufficient force to remove reaction products from the surface of the emulsion.

7. A film treating device of the character described, including: means forming a container through which a film to be treated may be moved in engagement with a developer solution; and means for directing jets of developer fluid within the body of developer solution against the emulsion of the film.

8. A film treating device of the character described, including: a container through which a film to be treated may be moved; means for maintaining in said container a sufficient quantity of developer fluid to provide a continuous contact thereof with the emulsion of the film; and means for directing jets of developer fluid against the emulsion of said film.

9. A method of treating motion picture film, comprising: moving the film through a body of treating solution; and directing jets of such treating solution within said body of treating solution so as to impinge said jets against the emulsion of said film.

10. A method of treating motion picture film, comprising: moving the film through a body of developer solution; and directing jets of such developer solution within said body of developer solution so as to impinge such jets against the emulsion of said film.

11. A method of treating motion picture film, comprising: moving the film in engagement with a body of treating solution; and producing in the portions of such treating solution in contact with and adjacent the emulsion of the film such high degree of turbulence as to carry reaction products outwardly away from the emulsion and to maintain the treating solution in thoroughly mixed condition.

12. A method of treating motion picture film, comprising: moving the film in engagement with a body of developer solution; and producing in the portions of such developer solution in contact with and adjacent the emulsion of the film such high degree of turbulence as to carry reaction products outwardly away from the emulsion and to maintain the developer solution in thoroughly mixed condition.

13. A method of treating motion picture film, including: conducting the film along a path of movement; and delivering toward said film as it passes along said path of movement a plurality of jets of treating fluid which vary in their angular relationship to the face of said film.

14. A method of treating motion picture film, including: conducting the film along a path of movement; and delivering toward said film as it passes along said path of movement a plurality of jets of treating fluid disposed in opposing relation on opposite sides of the film so that the forces applied thereby to the film will be in substantially balanced condition.

15. A method of developing motion picture film, including: conducting the film along a path of movement; and delivering onto said film as it passes along said path of movement a plurality of jets of developing fluid which vary in their angular relationship to the face of said film.

16. A method of developing motion picture film, including: conducting the film along a path of movement; and delivering onto said film as it passes along said path of movement a plurality of jets of developing fluid disposed in opposing relation on opposite sides of the film so that the forces applied thereby to the film will be in substantially balanced condition.

17. A film treating device of the character described, including: means forming a path of movement for said film; jet forming means placed along said path of movement for directing jets of treating fluid onto the surface of said film; and means for supplying treating fluid under pressure to said jet forming means.

18. A film treating device of the character described, including: means forming a path of movement for said film; jet forming means placed along said path of movement on opposite sides thereof for directing jets of treating fluid onto the surface of said film; and means for supplying treating fluid under pressure to said jet forming means.

19. A film treating device of the character described, including: means forming a path of movement for said film; jet forming means placed along said path of movement on opposite sides thereof and in opposing relationship for directing jets of treating fluid onto the surface of said film; and means for supplying treating fluid under pressure to said jet forming means.

20. A film treating device of the character described, including: means forming a path of movement for said film; jet forming means placed along said path of movement for directing jets of treating fluid onto the surface of said film, said jet forming means being successively disposed at different angles relative to the face of said film; and means for supplying treating fluid under pressure to said jet forming means.

21. A device for developing motion picture film without harmful image drag and distortion, including: means forming a path of movement

for said film wherein said film is brought into contact with a developer; jet forming members disposed along said path of movement in suitably spaced relation for directing onto said film jets of developer of sufficient intensity to remove reaction products from the surface of the film; and means for supplying developer to said jet forming members.

22. A device for developing motion picture film without harmful image drag and distortion, including: means forming a path of movement for said film wherein said film is brought into contact with a developer; jet forming members disposed on opposite sides of said film along said path of movement in suitably spaced relation for directing onto said film jets of developer of sufficient intensity to remove reaction products from the surface of the film; and means for supplying developer to said jet forming members.

23. A device for developing motion picture film without harmful image drag and distortion, including: means forming a path of movement for said film wherein said film is brought into contact with a developer; jet forming members disposed on opposite sides of said film along said path of movement in suitably spaced relation for directing onto said film jets of developer of sufficient intensity to remove reaction products from the surface of the film, the jet forming members being placed on the opposite sides of said path of movement in such position that the forces of the jets of developer delivered therefrom will be substantially balanced; and means for supplying developer to said jet forming members.

24. A film treating device of the character described, including: conduit means through which a film to be treated may be moved; means for producing a flow of treating fluid through said conduit means in contact with said film; and means for producing turbulence in parts of said fluid engaging the emulsion on said film, whereby to reduce image drag to a minimum.

25. A film treating device of the character described, including: a pair of conduits through which a film to be treated may be moved, said conduits being joined at an angle bend; guide means in said angle bend for directing said film from one of said conduits to the other; and means for directing a jet of treating fluid against said film as it passes around said bend.

26. A film treating device of the character described, including: means for moving a film in engagement with a treating fluid; and means for producing turbulence in portions of said treating fluid in contact with the emulsion of said film of such character as to minimize bromide drag and expedite the treatment of said film.

27. A film treating device of the character described, including: means forming a container through which a film to be treated may be moved in engagement with a treating solution; and means for directing jets of treating fluid within the body of treating solution against the emulsion of the film whereby to cleanse the same.

28. In a motion picture film developing device, a means for preventing harmful image drag and distortion, including: container means through which the film may be moved in contact with a developer; and means for directing jets of developer toward the emulsion of the film whereby to dislodge from the face of the emulsion the adhering reaction products and the thin layer of developer.

29. A motion picture film treating device of the character described, including: walls forming a treating chamber; means for moving said film through said chamber; and means in said treating chamber for directing jets of fluid against the emulsion of said film to dislodge from the face thereof the thin layer of treating fluid which tends to adhere thereto.

30. In a motion picture film developing device, a means for preventing harmful image drag and distortion, including: a container for a developer; means for moving a motion picture film through said developer; and means for directing jets of said developer against the emulsion of said film in a manner to prevent harmful image drag and distortion.

31. In film developing apparatus of the character described, the combination of: means for moving a film through a body of developer; and means for producing in the body of developer in contact with the emulsion of the film a turbulence of sufficient intensity to remove from the surface of the emulsion those reaction products which come to the surface, so as to prevent drag of the reaction products on the face of the emulsion.

32. A method of preventing harmful image drag and distortion in the developing of motion picture film, comprising: moving the film through a body of developer; and directing onto the emulsion of the film jets of developer of such intensity as to remove reaction products from the surface of the emulsion.

33. A method of preventing harmful image drag and distortion in the developing of motion picture film, comprising: moving the film through a body of developer; and producing in the developer in contact with the emulsion of the film a turbulence of sufficient intensity to remove reaction products from the surface of the emulsion.

34. A method of preventing harmful image drag and distortion in the developing of motion picture film, comprising: moving the film through a body of developer; and producing in the developer in contact with the emulsion of the film a turbulence of sufficient intensity to remove reaction products from the surface of the emulsion and displace the film of developer which tends to adhere to the surface of the emulsion.

THOMAS M. INGMAN.