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Roman

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[54] **HEAT PROCESSOR FOR PHOTOGRAPHIC FILMS**

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[73] Assignee: **The Perkin-Elmer Corporation,** Norwalk, Conn.

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[52] **U.S. Cl.** **34/155,** 34/66, 34/160

[51] **Int. Cl.** **F26b 13/00**

[58] **Field of Search** 34/6, 23, 24, 62, 66, 67, 34/151, 152, 155, 158–161

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Attorney, Agent, or Firm—John K. Conant

[57] **ABSTRACT**

In apparatus for processing photographic ribbon film that has a photosensitive coating on one side which is developed and fixed by heat, the film is moved along a spiral path through a heat chamber which accommodates a long length of film in a relatively small space, and in a manner such that the coated side of the film does not come in contact with any support surface. Heat is applied to the coating in a uniform manner by jets of hot air from nozzles spaced along the path of the film. The jets of hot air impinge on the coated side of the film at an acute angle and the nozzles are spaced so that the hot air sweeping over the coating carries the effluent gases, which are released by the developing photosensitive material, away from the coated surface of the film and into streams of exhaust gases which flow along in back of the nozzles to an exhaust port. The film is drawn from the heat chamber, out and through an adjacent cooling chamber prior to its collection on a take up reel. An exhaust port in the cooling chamber serves to draw cool clean outside air through the cooling chamber to cool the film. The heat chamber and cooling chamber exhaust ports straddle the film exit opening from the heat chamber to the cooling chamber and prevent the air from one chamber from contaminating the other chamber.

4 Claims, 6 Drawing Figures

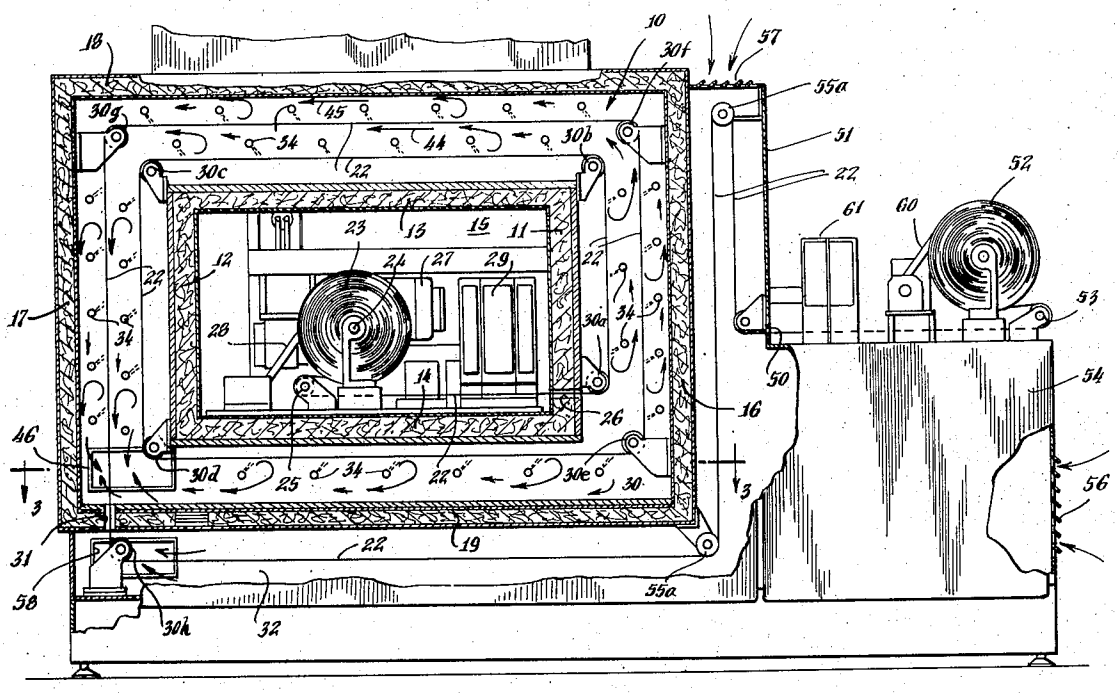


Fig. 1.

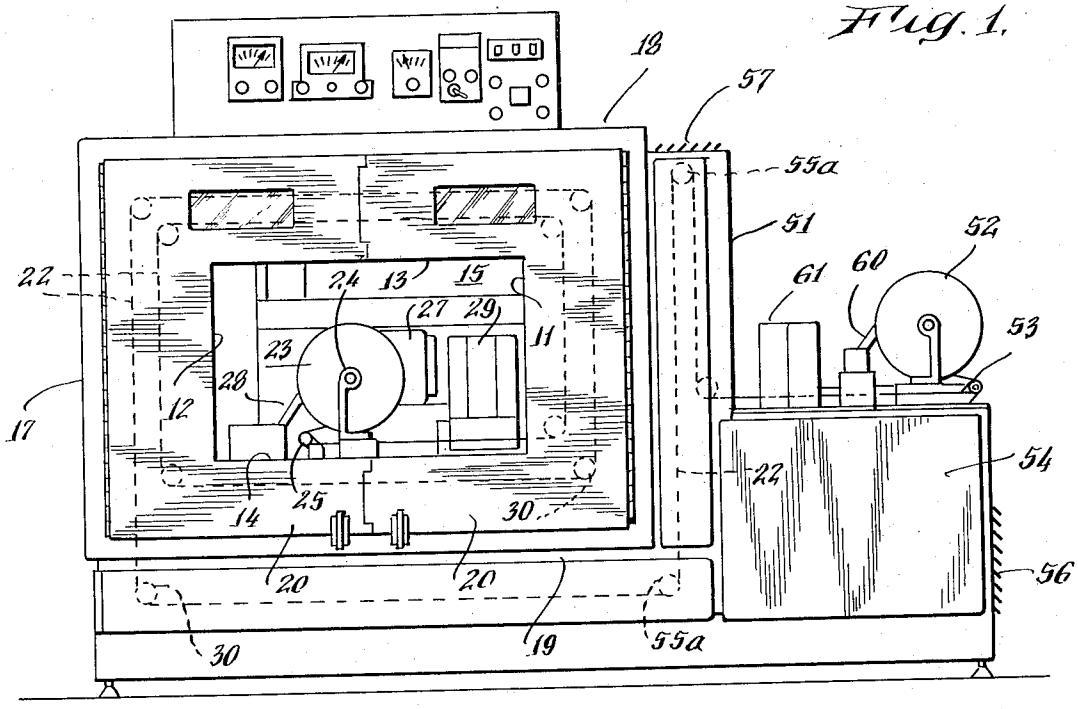

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Fig. 4.

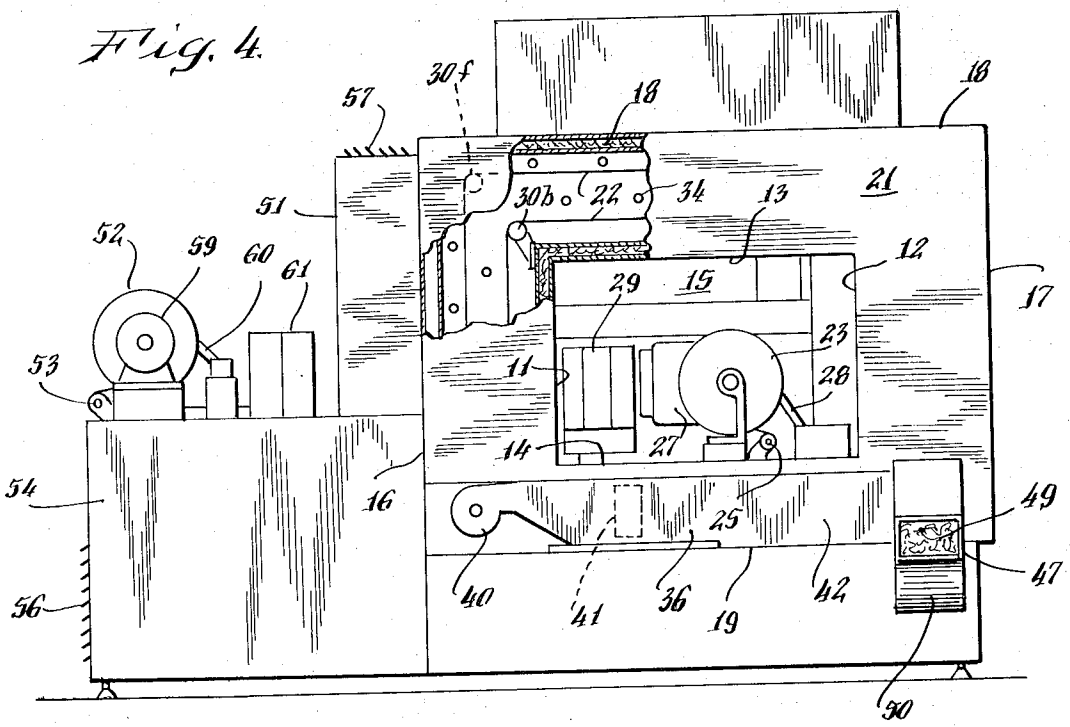

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Fig. 2.

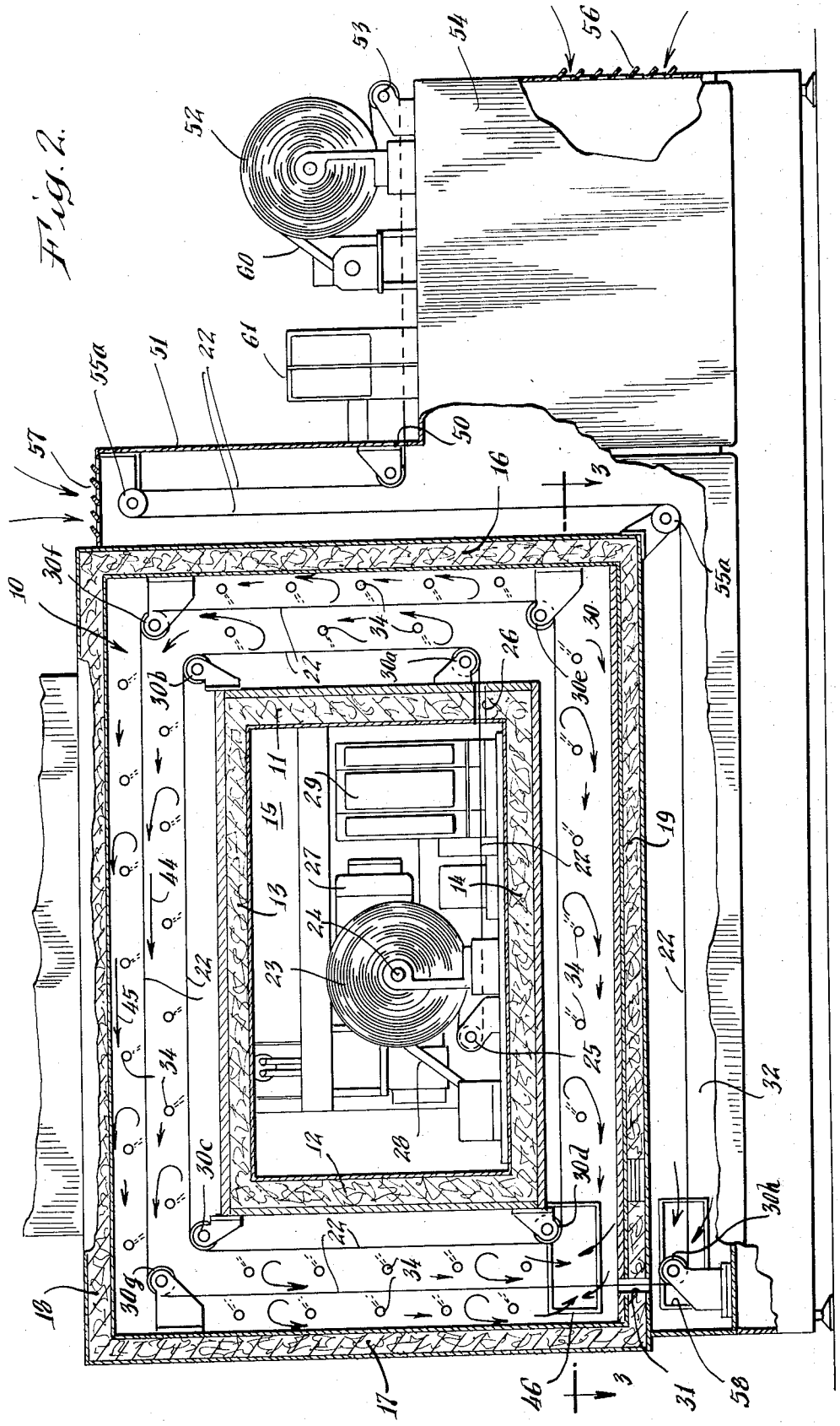

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Fig. 3.

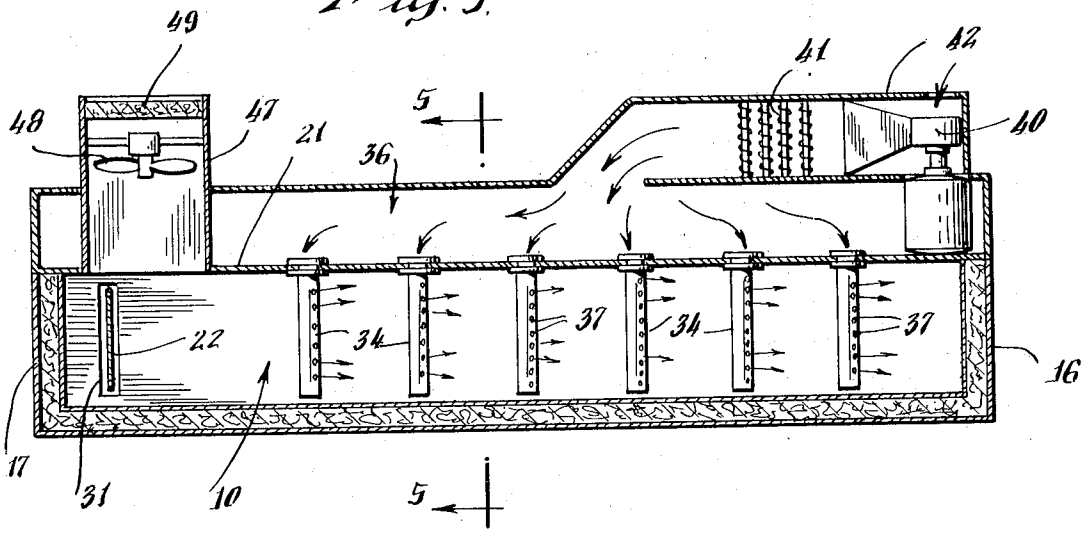


Fig. 5.

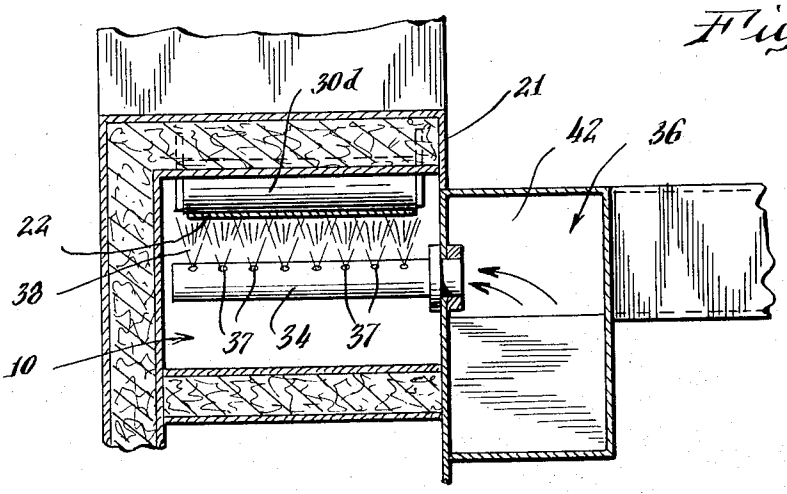
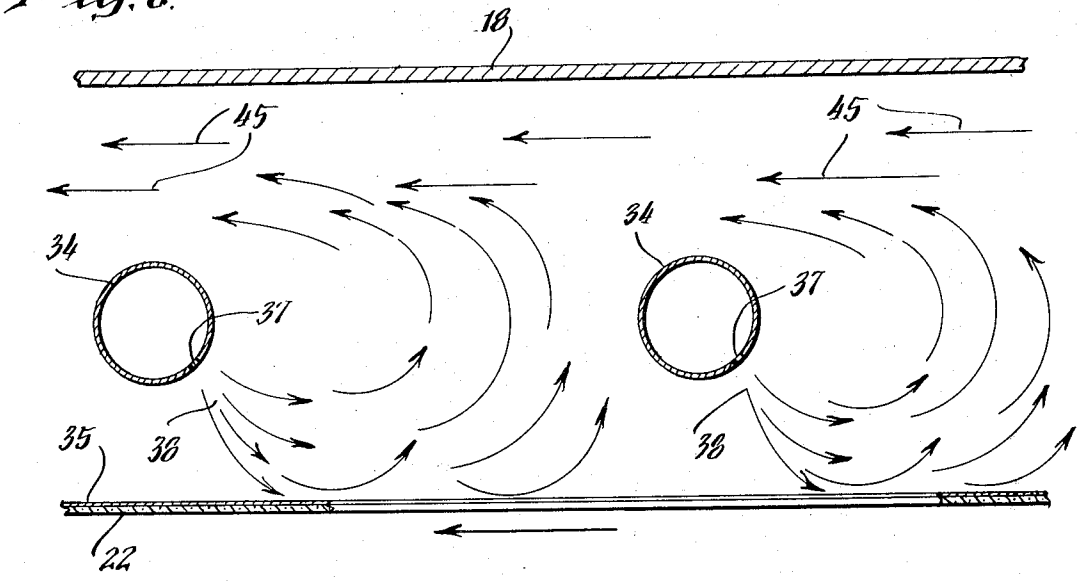


Fig. 6.



HEAT PROCESSOR FOR PHOTOGRAPHIC FILMS

BACKGROUND OF THE INVENTION

The present invention relates to apparatus for processing photographic film of the type in which a latent image previously formed in a photosensitive coating on the film is developed and fixed by heat. In particular the invention is relatively compact apparatus for rapidly and effectively heat processing long strips or ribbons of such film.

In general, the subject film is developed and fixed by heating it to a particular temperature for a specified time and then cooling it. The problems involved in thus processing it are that when heated, the photosensitive coating, which is on one side of the film, is soft and easily scratched or marred so that the coated side must be kept out of contact with other surfaces, and the heating must be uniform or else the image density will vary. Also, as the photosensitive material develops and is fixed by heat, it gives off gases which must be removed quickly from the vicinity of the coating so as not to fog the developing images.

In known prototype apparatus for heat processing long lengths of film of the subject type, the film from a supply reel is drawn in a straight line through an elongated heat chamber out through a cooling chamber or through a span of open air to a take up reel. A principal problem with this known heat processing apparatus is that the effluent gases from the heated film tend to circulate back in contact with the film and cause fogging. Also, eddy currents produced in the stream of hot air traveling through the heating chamber cause variations in the temperature rise of the film at different areas of the film which result in variations in the image density.

BRIEF DESCRIPTION OF THE INVENTION

A principal object of the present invention is to provide apparatus for heat processing film of the subject type that assures even heating of the film and effective removal of the effluent gases so that the problems of variations in image density and fogging of the film are avoided, and to provide such apparatus which is more compact so as to be accommodated in less horizontal and/or vertical space than previous apparatus for the same purpose.

In accordance with the invention the heat chamber is an annular chamber separated from a compartment in the center of the annulus. Film from a supply reel mounted in the center compartment is fed into the heat chamber through which it moves along a spiral path, defined by support rollers, to an exit into a cooling chamber and through the cooling chamber to a take up reel. The spiral path of the film through the heating chamber is such that only the uncoated non-sensitive side of the film comes in contact with support rollers which define the path.

Heat for processing the film in the heat chamber is applied by jets of hot air from a plurality of nozzles spaced along the spiral path of the film and arranged so that the jets of hot air impinge on the photosensitive coating of the film at an acute angle so that the hot air sweeps or scrubs the film, sweeping the effluent gases away from the coated surface and out between adjacent nozzles into an exhaust stream of gases which flows back of the nozzles to an exhaust port. The hot air jets thus serve the dual functions of applying heat uniformly to the film and of immediately carrying the effluent gases away from the film.

The exhaust port for drawing effluent gases from the heat chamber, and an exhaust port in the cooling chamber, for drawing cool outside air therethrough, are adjacent to the film exit from the heat chamber to the cooling chamber and cooperate to prevent air from one chamber from contaminating the air in the other.

In addition to the advantages of the apparatus of this invention indicated above, the structure is such that the apparatus can be built for processing film of varying size, from 35mm to 9½ inch wide film, without having to substitute parts.

Further objects, advantages and features of the apparatus of this invention will be apparent from the following more detailed description of an illustrative embodiment shown in the accompanying drawings, in which:

FIG. 1 is a front elevational view of film heat processing apparatus of this invention;

FIG. 2 is an enlarged front view partly in section of the apparatus of FIG. 1;

FIG. 3 is a section along the line 3—3 of FIG. 2;

FIG. 4 is a rear elevational view of the apparatus shown in FIG. 1;

FIG. 5 is a section along the line 5—5 of FIG. 3; and

FIG. 6 is an enlarged end view of an adjacent pair of the nozzles in the heat chamber, showing the jets of air flowing out from the nozzles.

Referring to FIGS. 1 and 2 of the drawings, the film heat processing apparatus of this invention includes an annular heating chamber **10** having inner side walls **11** and **12** and inner top and bottom walls **13** and **14** defining a central compartment **15** and outer side walls **16** and **17** and outer top and bottom walls **18** and **19.** The front of the chamber **10** is closed by a pair of doors **20** which are each shaped like a U on its side so as to leave the central compartment **15** open to the front and rear when the doors are closed. The doors open to expose the interior of the heat chamber **10** for cleaning and for initially threading a film therethrough; it also provides access to the film in the chamber, to repair a break in the film, for example. The back of the heat chamber **10** is closed by a back wall **21** (FIGS. **3** and **4**).

A supply of heat processable film **22** is provided on a supply reel **23** supported on a spindle **24** in the compartment **15.** From the supply reel **23** the film feeds over an idler roller **25** and thence into the heat chamber **10** through an entrance opening **26** through the chamber side wall **11.** The spindle **24** is driven by conventional drive connections to a variable speed motor **27.** The speed of the motor **27** and thus the rotation of the supply reel **23** is adjusted over a predetermined range of speeds by means of conventional speed control mechanism. A feeler arm **28** resting on the roll of film **22** on the reel **23** measures the amount of film on the reel and provides a signal to the motor speed control mechanism to assure constant film speed. A conventional limit switch (not shown) is provided to shut off the apparatus (i.e., motors **27** and **53**) when the film supply reel **23** is nearly empty.

Also in the compartment **15** is a conventional film clamping, cutting and splicing unit **29,** which straddles the run of film **22** between the idler roller **25** and the entrance opening **26** to the heating chamber to be used

for attaching the lead end of a supply of film **22** to a leader film strip (not shown) which is threaded through the apparatus and attached to a take up reel for leading film **22** through the apparatus at the start of a processing operation.

Film **22** entering the heat chamber **10** from the entrance opening **26** moves along successive convolutions of a spiral path formed by idler rollers **30***a*, *b*, *c* and *d*, which define the innermost convolution of the spiral, and idler rollers **30***e*, *f*, *g* and *h*, which define the outermost convolution. Between the idler rollers **30***g* and **30***h* the film passes out of the heat chamber through an exit opening **31** into a cooling chamber **32** in which the idler roller **30***h* is mounted. As shown, the film **22** passes around the successive rollers **30***a* to **30***h* so that only the inward side of the film **22** comes in contact with the roller surfaces. Thus the outward side of the film **22**, which will be the sensitive side, does not come in contact with any surface while the film **22** is in the heating chamber **10**.

Heat is applied to photographic material on the outward side of film **22** moving through the heating chamber **10** by means of nozzles **34** which are mounted at spaced intervals along the path of a film **22** through the heating chamber to be adjacent the outward sensitive side of film moving along the path. As best seen in FIGS. **3** and **5**, the nozzles **34** are elongated, hollow tubular elements mounted on the back wall **21** of the heating chamber to extend across the width of photosensitive material **35** on a film **22** moving along the aforesaid path. The interior of each nozzle **34** opens through the wall **21** into a plenum chamber **36** which is back of the heating chamber **10**, and which supplies hot air under pressure to the nozzles. The other ends of the nozzle elements **34** are closed and a plurality of holes or other openings **37** through the sides of the nozzles direct jets **38** of the hot air under pressure, out of the nozzles to impinge on a film **22** on the path through the chamber.

Referring to FIGS. **3** and **4**, hot air under pressure is supplied to the plenum chamber **36** by a motor driven fan **40** and a heating unit **41** mounted in an inlet conduit **42** which opens into the plenum chamber **36** at one end and to the outside air at the other. The fan **40** draws outside air into the conduit **42** and blows it through the heating unit **41** into the plenum chamber **36**.

As best in FIGS. **2**, **5** and **6**, the holes **37** in the nozzles **34** are arranged so that the jets **38** of hot air impinge on the photosensitive coating **35** of film **22** at an acute angle. The air forming the jets **38** diverges as it emerges from the holes **37** so that the jets are conical in shape, and the holes **37** are spaced so that the cones overlap prior to reaching the area of impingement. The hot air jets **38** of each nozzle **34** thus provide a lateral band of hot air impinging on the photosensitive coating **35** in a continuous band across the width of the layer of photosensitive coating.

As illustrated in FIGS. **2** and **6**, the nozzles **34** are spaced apart and arranged along the path of a film **22** so that the hot air jets **38** impinge on the photosensitive coating **35** on the film at an acute angle and, from the direction in which the film is moving so that the direction of impingement of the jets **38** on the film is opposite the direction of film movement, thereby producing a good scrubbing action. The jets **38** of hot air thus sweep and scrub the photosensitive coating **35** on the film, and then deflect and circulate outward between adjacent nozzles and into exhaust streams of the hot air and effluent gases from the heated photosensitive film coating. These exhaust streams, as indicated by arrows **44** and **45**, flow back of the outward sides of the nozzles **34**. These exhaust streams flow along flow paths provided by the spacing of the nozzles **34** from the adjacent path of the film and from the outer walls **16**, **17**, **18** and **19** of the heating chamber; the exhaust flow is initiated and maintained by a combination of the positive pressure provided by the hot air jets **38** as deflected by the film **22** and a negative pressure applied at an exhaust port **46** which opens across a major portion of the annular width of the chamber **10** through a portion of the back wall **21** adjacent the film exit opening **31**. The hot air jets **38** thus not only heat the photosensitive coating **35** on film **22** but also carry off the effluent gases generated by the heat developing and fixing process into exhaust streams that carry the effluent gases from the chamber in a manner which prevents the effluent gases from coming in contact with the photosensitive coating.

Referring to FIG. **3**, an exhaust conduit **47** is provided at the back of the apparatus and the exhaust port **46** of the heat chamber **10** (as well as an exhaust port **58** from a cooling chamber **32**, subsequently described) opens into the exhaust conduit **47**. The other end of the exhaust conduit **47** opens to the air, suitably outside the building in which the apparatus is located and negative pressure is created at the exhaust port **46**, and at cooling chamber exhaust port, for assisting the exhausting of the effluent gases by suitable means such as a motor driven exhaust fan indicated at **48** in the exhaust conduit **47**. It will usually be desirable to filter the exhaust gases as they leave the apparatus by suitable means, such as a charcoal filter **49** shown in the conduit **47**, to remove any noxious materials from the exhaust gas.

As previously mentioned, film **22** exiting from the heat chamber **10** through the exit opening **31** passes into an adjacent cooling chamber **32**. As shown in FIG. **2**, the cooling chamber **32** is an enclosed space or conduit extending along the length of the bottom of the apparatus up along the right side with an opening **50** in a cooling chamber end wall **51** through which the film **22** is to be wound on a take up reel **52** after passing around an idler roller **53** which is mounted on a cabinet portion **54** of the apparatus.

Film **22** is supported in a predetermined path through the cooling chamber **32** by passing around the roller **30***h* adjacent the exit opening **31** from the heating chamber. From the roller **30***h* the film passes around rollers **55***a*, *b* and *c* and then out through chamber opening **50**.

The film passing through the cooling chamber **32** is cooled by outside air flowing into the chamber through louvered openings as indicated at **56** and **57** in walls of the cooling chamber by the negative pressure applied at an exhaust port **58** which is in the cooling chamber adjacent the exit opening **31** from the heat chamber and which causes the cool air drawn into the cooling chamber to move in the reverse direction to the movement of the film **22**.

The take up reel **52** is suitably mounted on the cabinet portion **54** and is driven through suitable connections to a take up motor **59**. The motor **59** is a torque motor, the torque of which is controlled by conven-

tional control circuitry. This motor maintains the film **22** under substantially uniform tension. A feeler arm **60** resting on the film accumulated on the take up reel **52** provides a signal to the control circuit of the motor **59** to assure constant film tension. The film speed is regulated by the rotational speed of the supply reel motor **27.** The feeler arm **28** resting on film on the supply reel **23** and the feeler arm **60** resting on film as the take up reel **52** are each operatively connected to, or have incorporated therein, potentiometers which supply corrective signals to the respective motor control circuits for adjusting the rotational speeds of the respective motors to assure a constant film speed and uniform tension. A limit switch associated with feeler arm **28** is arranged and connected to shut off the supply motor reel, and thus stop the film transport when the supply reel **23** is almost empty.

Between the opening **50** in the downstream end of the cooling chamber and the roller **53** on the cabinet portion **54** is a clamping device **61** which straddles the path of film **22** to the take up reel **52** for clamping the film so as to provide a trailer strip of film that may be left threaded through the apparatus to become the leader for a new roll of film to be processed. When the film **22** is thus clamped the film is cut at the take up reel for removal of the take up reel of processing film.

In practice, a leader-trailer film strip is normally left threaded through the heating chamber **10** and cooling chamber **32** with its ends clamped respectively at the clamping devices **29** and **61** when the apparatus is not in use. Then for operation of the apparatus, a supply reel **23** of film **22** to be processed is mounted on the spindle **24,** the lead end of the film is drawn around the roller **25** to the clamping, cutting and splicing device **29** and there spliced to the end of the leader-trailer strip. The other end of the leader-trailer strip which is clamped in the device **61** and extends to the take up reel location, is attached to a take up reel **52.** For starting the processing the exhaust fan **48** is first turned on, then the heating unit **41** is turned on, and both are allowed to run for a short time before starting the motors **27** and **59** so as to allow the heating chamber to preheat to the required temperature before the movement of film **22** is started. After sufficient preheating, the transport system speed is set, the clamps **29** and **61** are released and the supply reel motor **27** and take up reel motor **59** are turned on, the control feelers **28** and **60** having been positioned against the portions of film on the respective reels. As indicated above, the supply rolls of film **22** to be processed are preferrably supplied with a leader-trailer strip at their end which will be the last through the apparatus to be cut off and clamped at the clamping device **60** when the tail end of the film reaches the latter device, so as to leave a leader-trailer strip threaded back to the apparatus to the clamping, cutting and splicing device **29** in readiness for processing the next reel of film. When the film transport motors **27** and **59** are shut off either by pushbotton on the front panel or by operation of the limit switch associated with the feeler arm **28,** the heating unit **41** is turned off, but the exhaust fan **48** is left on long enough to be sure that all noxious gases are removed from the heating chamber.

What is claimed is:

1. Apparatus for processing ribbon film which has on one side a photosensitive material that is developed and fixed by heating, comprising,

a heating chamber,

means moving a length of said film along a predetermined path through the chamber,

a plurality of elongated hollow nozzle elements mounted in the chamber and extending across said path at spaced intervals to be adjacent one side of a film on said path, and

means feeding heated air under pressure to the interiors of the nozzle elements, said nozzle elements having constricted openings from their hollow interiors located and dimensioned for producing jets of said heated air, and said nozzle elements being positioned for said jets to impinge on the adjacent side of a film on said path at an acute angle over an area extending at least across the width of photosensitive material on said side of a film on the path,

said apparatus characterised in that

a film moving through the heating chamber proceeds from a chamber entrance opening along increasingly larger convolutions of a spiral path to a chamber exit opening, said spiral path being defined by supports over which said film passes, said supports being arranged so that only the inward side of said film comes in contact with the supports whereby photosensitive material on the outward side of the length of film in the chamber is free from contact with any surface in the heating chamber,

an exhaust port opening into the heating chamber at a location adjacent said exit opening,

means for applying relative negative air pressure at said exhaust port for drawing effluent gases out of the heating chamber and for immediately exhausting any air entering the chamber through said exit opening, said nozzle elements being adjacent the outward side of a film on said path and being spaced apart for heated air from the nozzle elements after impinging on said film to circulate outwardly between adjacent nozzle elements, and

the nozzle elements adjacent the convolutions of a film on said path being spaced respectively inward from the next outward convolution of said film and from the outward walls of the chamber to provide exhaust flow paths for air and effluent gases circulating outward from between the nozzle elements to be drawn along said flow paths to said exhaust port by relative negative pressure applied at the exhaust port.

2. The apparatus of claim **1** in which the constricted openings in said nozzle elements are small generally circular holes for producing outwardly diverging conical jets of air therefrom, the holes being spaced so that the conical jets from adjacent holes overlap prior to their impingement on the adjacent portion of a film on said path.

3. The apparatus of claim **1** in which said heating chamber is an annulus defining a central compartment, said entrance opening of the chamber opening into said compartment, and including means for mounting a supply reel of said film in said compartment in position to feed film from a supply reel on the mounting means into the chamber through the entrance opening, means mounting a take up reel for said film outside the chamber in position for thereon film emerging from said exit opening in the chamber, first power drive means for rotating a supply reel of film on said mounting means therefor, second power drive means for rotating a take

up reel on said mounting means therefor, and first and second feeler gauge means engaging said supply and take up reels, respectively, for controlling the speed and tension of a film moving from said supply reel to said take up reel.

4. The apparatus of claim 3 including a cooling chamber adjacent the exit opening in the heating chamber and enclosing at least a portion of said predetermined path of a film from the heating chamber exit opening to a take up reel on the mounting means therefor, an exhaust port opening into said cooling chamber adjacent said exit opening of the heating chamber, said cooling chamber being defined by walls having vents therethrough, for surrounding air to enter, said vents being located downstream along the path of a film through said cooling chamber from said exit opening of the heating chamber, and means to apply negative air pressure at said exhaust port opening into the cooling chamber for circulating air through the cooling chamber from said vents to said exhaust port in a direction opposite the direction of movement of a film through the cooling chamber.

* * * * *