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Breschi et al.

[11] **3,900,959**

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[54] **COMBINED INFRA-RED AND AIR FLOW DRYING FOR PHOTOGRAPHIC FILM**

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[52] **U.S. Cl.** ..... **34/155;** 34/41; 96/50 R

[51] **Int. Cl.** **F26b 3/00;** F26b 13/10

[58] **Field of Search** ..... 34/4, 7, 17, 18, 23, 41, 34/155; 96/50 R

[56] **References Cited**

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Attorney, Agent, or Firm—Alexander, Sell, Steldt & DeLaHunt

[57] **ABSTRACT**

Photographic film is quickly and efficiently dried by a combination of infra-red radiation sources and independent non-heated air sources, which combination does not allow the film to be damaged by the drying process.

5 Claims, 6 Drawing Figures

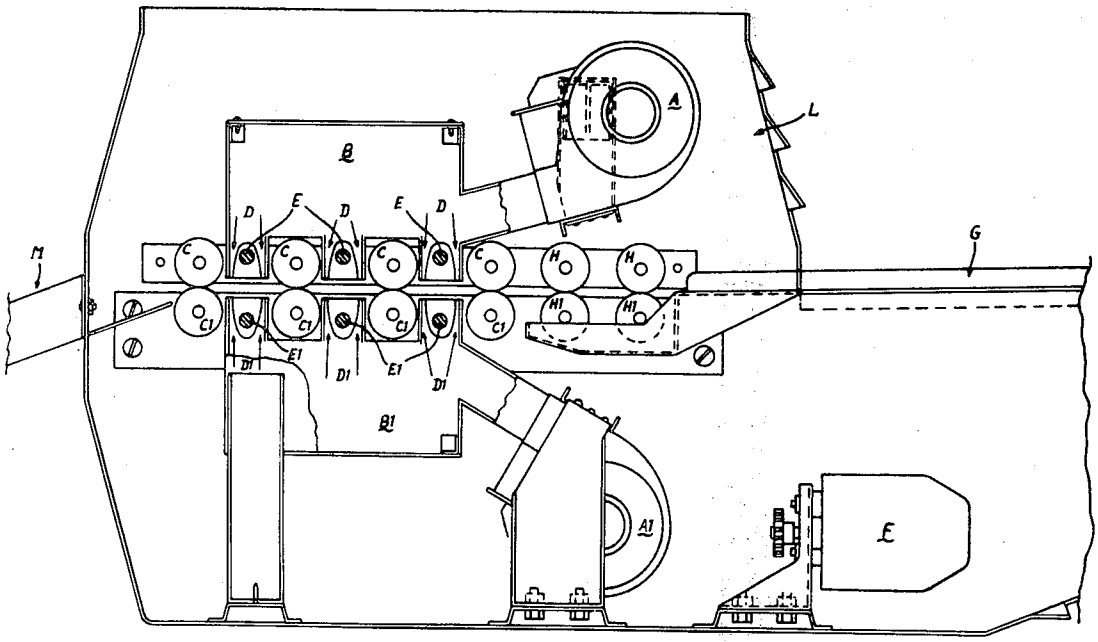
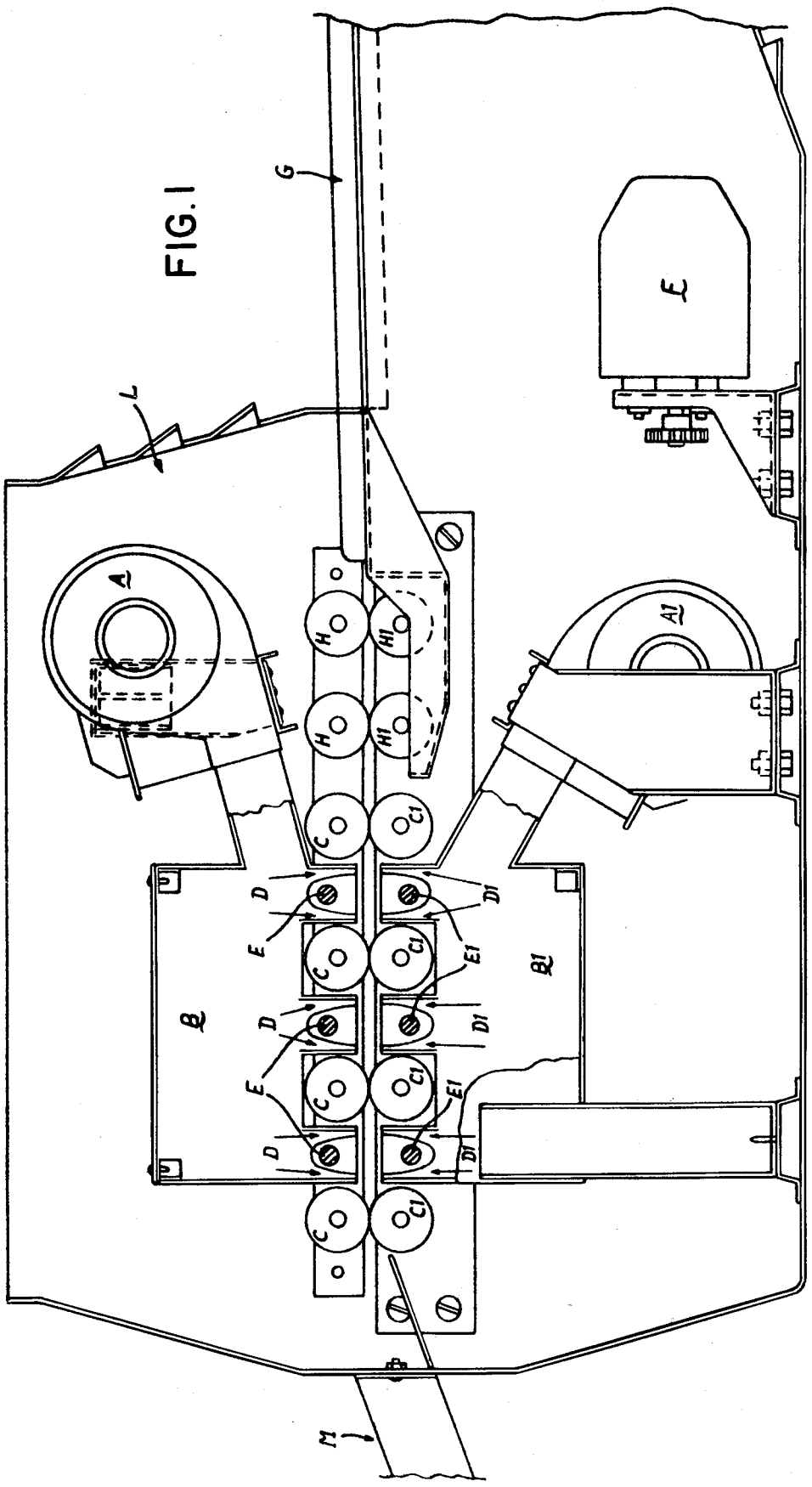


FIG. 1



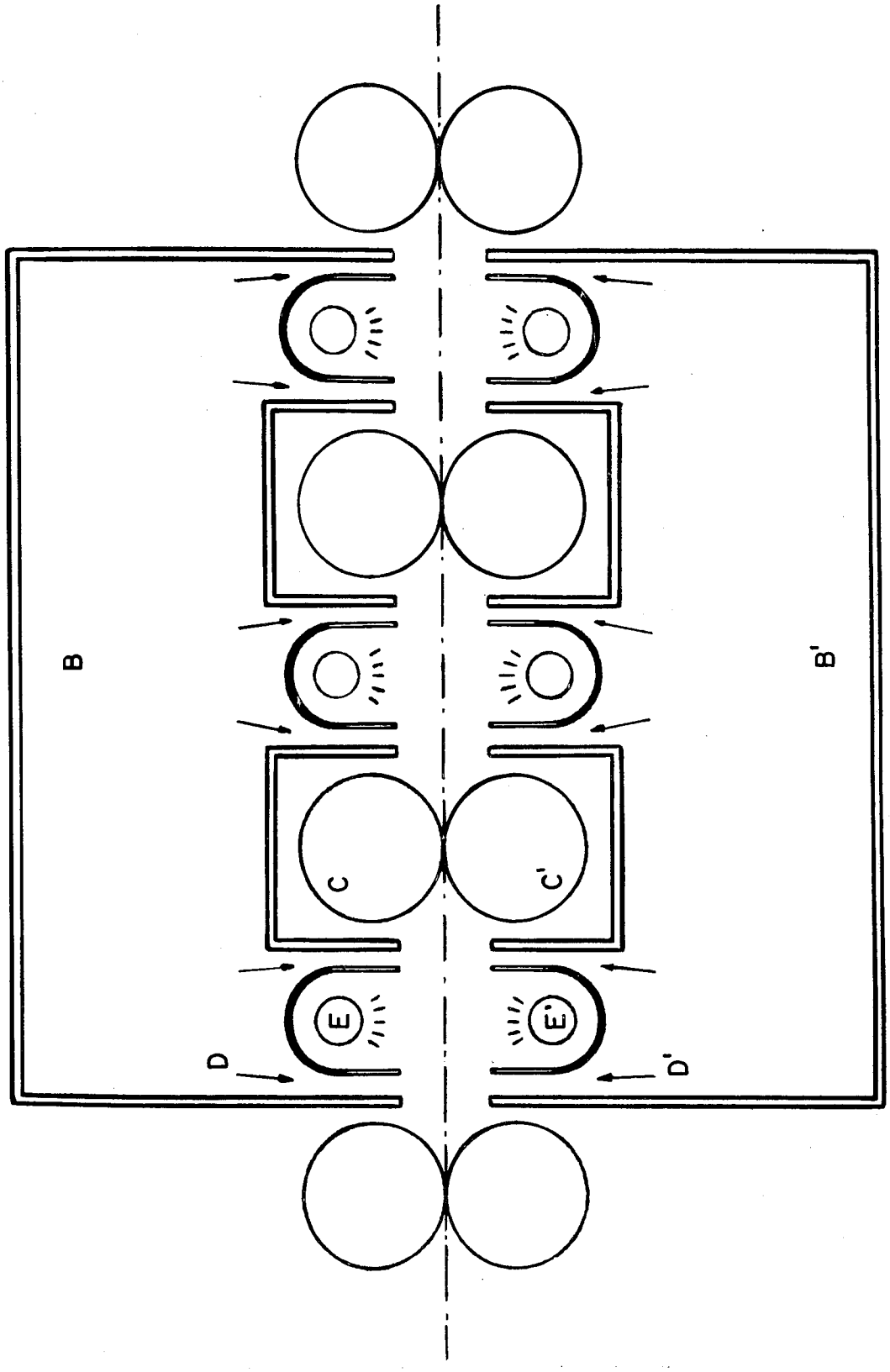


FIG. 2

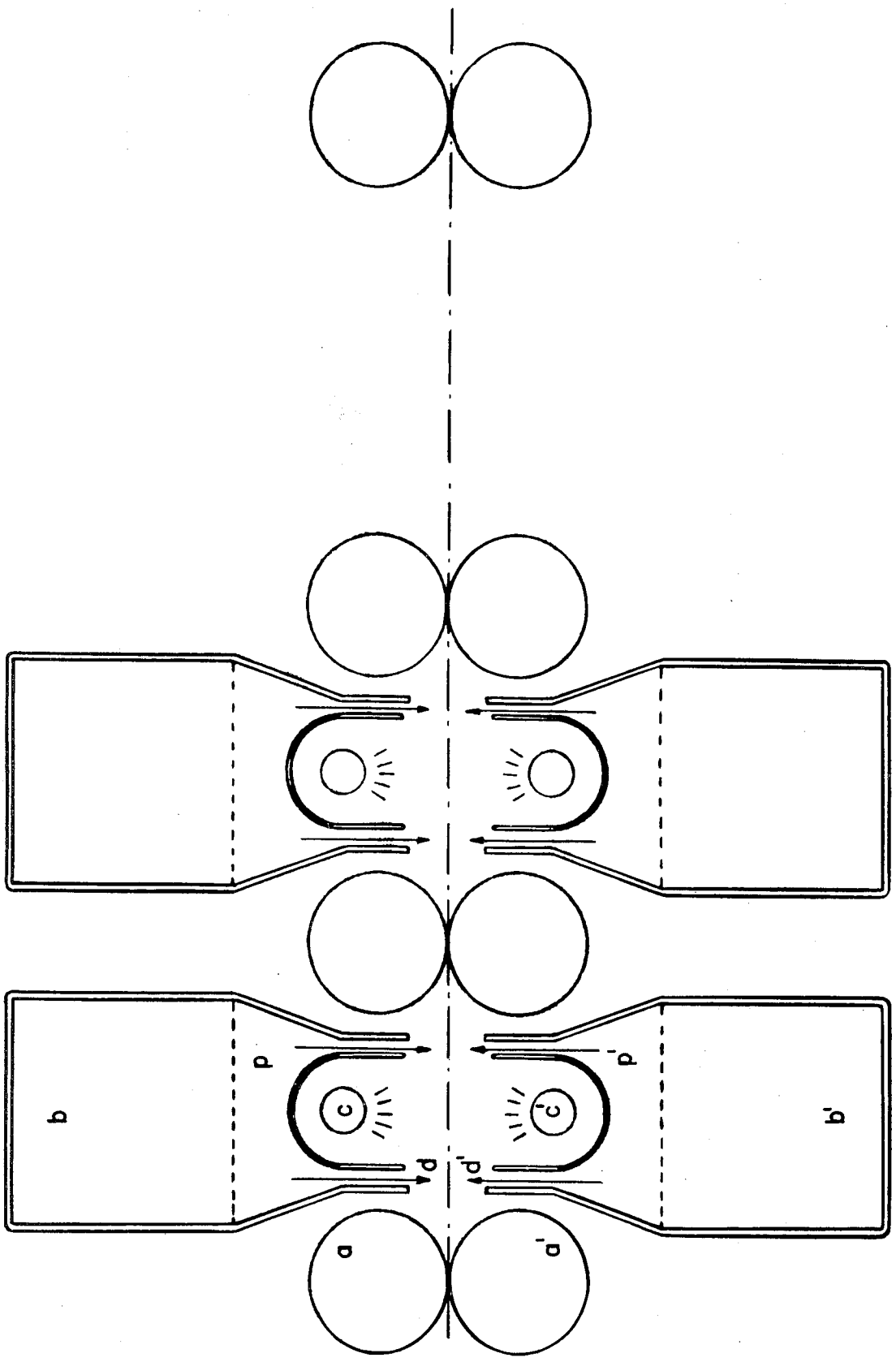


FIG. 3

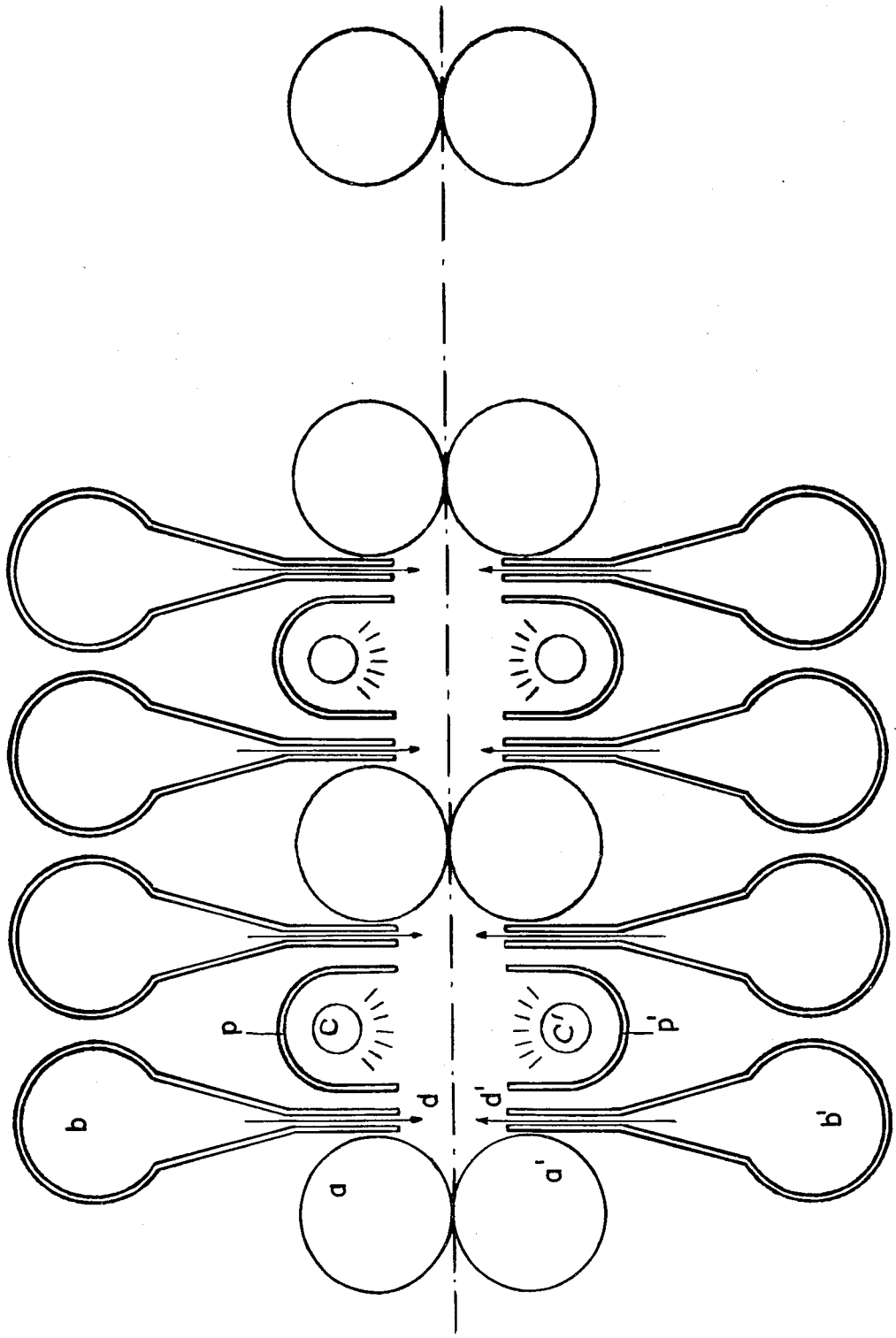


FIG. 4

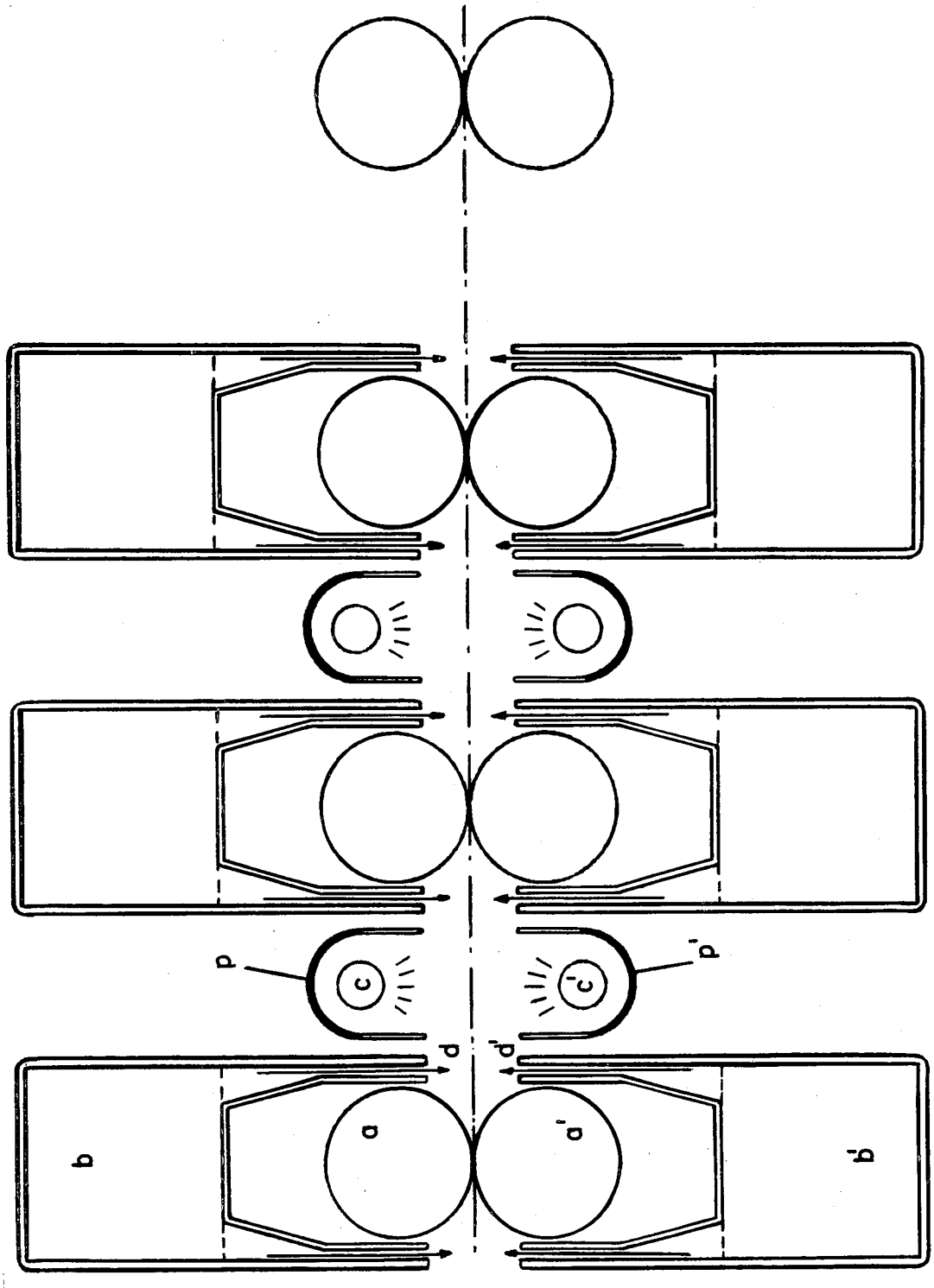


FIG. 5

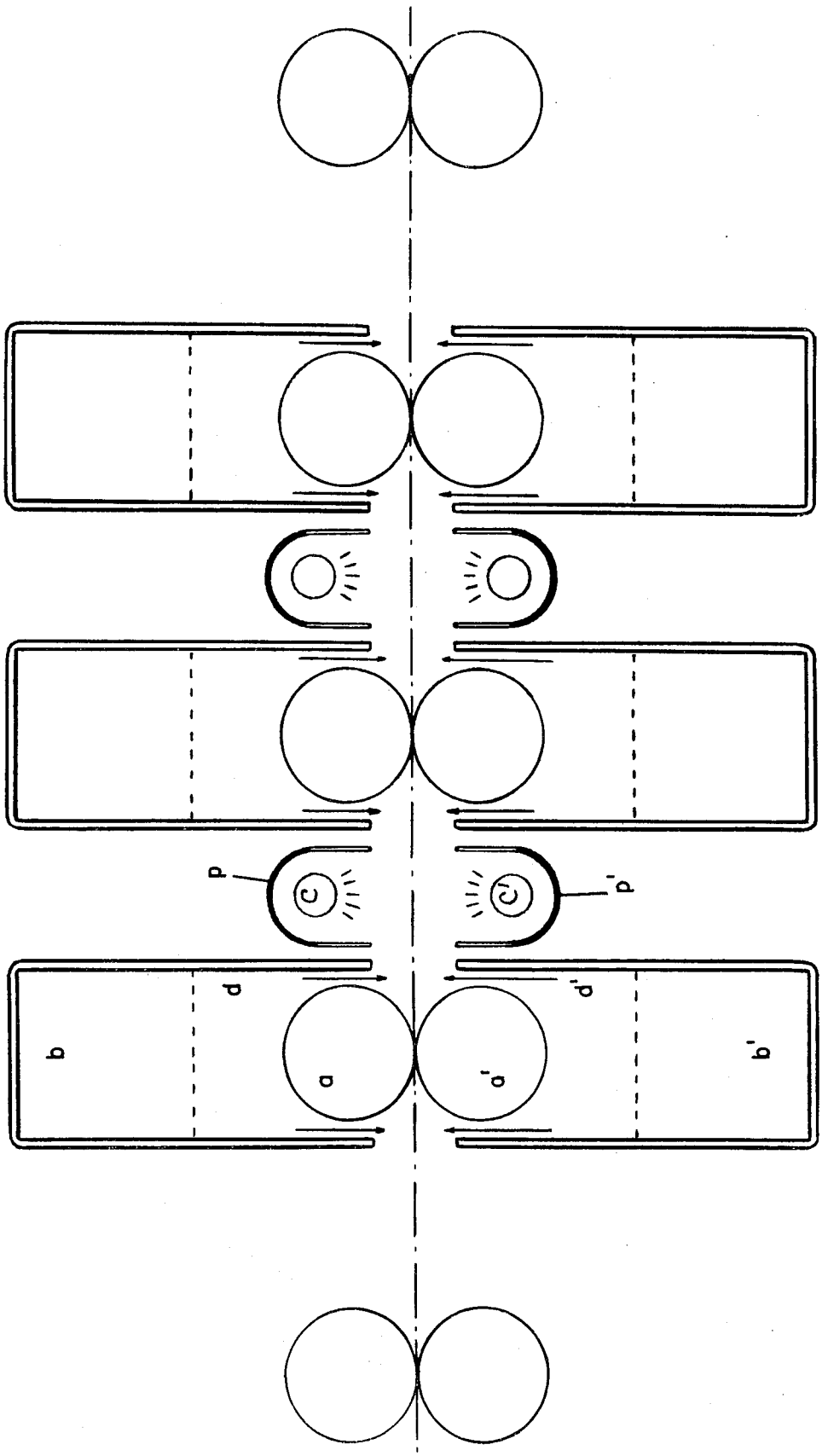


FIG. 6

COMBINED INFRA-RED AND AIR FLOW DRYING FOR PHOTOGRAPHIC FILM

The present invention relates to a new method for drying a photographic film impregnated with water and to devices suitable for realizing such a method, particularly in radiography and graphic arts.

It is known that a photographic film after exposure is photographically processed, washed and then dried to remove the water with which it is impregnated at the end of the processing. Such a film can be dried either by placing it into drying cabinets, where hot, dry air is blown, or by passing the film through a drier consisting of a drying chamber provided with an inlet and an outlet and conveying means at least partially placed inside of the chamber. Said conveying means generally consist of rollers which rotate on their axis, thus causing the film, placed in close contact therewith, to move along a conveying plane formed by the points of contact between the rollers and the film. In particular, said rollers can be arranged in two opposite series in reciprocal contact.

A drying device of the second type generally includes a fan which conveys the air towards a heater and then along both sides of the film passing through the drying chamber. The hot air flow dries the film more quickly the higher is the temperature of the air blowing on the film.

The heater can be a conventional resistor or any heat energy source, such as for instance an infra-red ray source as described in British Pat. No. 1,131,681.

A device of the above described type has particular limits and drawbacks deriving from the fact that the photographic film is damaged if heated up to high temperatures, such as for instance over 60°–70°C. On the other hand, a drying device loses a large part of its efficiency if lower temperature air flow is used in order to avoid damaging the film. Such a device, furthermore, has the drawback of requiring an idling time before the air is heated up to the working temperature.

According to the present invention, we have now found a method which allows photographic film to be dried rapidly and without any excessive heating in drying devices including passages where the film passes through a drying chamber as described above.

According to the present invention, we provide methods and devices, particularly useful in radiography and graphic arts, which allow the photographic film to be dried in a simple and low cost way, with small overall dimensions, without the danger of damaging the film and which are capable of drying the film without any need of pre-heating the same devices.

According to the present invention, the passage of the photographic film through the said drying chamber occurs in the presence of infra-red ray sources which irradiate the film on both sides and in the presence of sources (outlets) of non-heated air (fed by one or more fans) which flows on both sides of the film. The speed of the film, the length of the drying chamber, the power of the said infra-red ray sources, the power and the delivery capacity of the fan(s) feeding the said air sources, the temperature of the air and the geometrical arrangement of the said sources are chosen so that at the end of the passage the film turns out to be dry substantially without having undergone any temperature increase (such as for instance over 5°–10°C). The photographic film is both irradiated with infra-red rays

which cause water to evaporate from the film and also struck by non-heated air jets which remove the water vapor thus formed, and prevent a substantial temperature increase of the film. The intensity of the infra-red radiation and the rate of mass flow of the air should be reasonably balanced so as to prevent any substantial temperature rise in the film.

According to an essential feature of the present invention, the infra-red ray and non-heated air sources are placed in such a relationship that the air is not heated by the infra-red rays and is therefore able to cool the film. According to a preferred feature of the present invention, the infra-red ray sources have an oblong shape and, according to the above mentioned feature, are placed at a distance of 1–3 cm. from the conveying plane of the film.

According to the present invention, the infra-red rays and the non-heated air preferably have independent physically separated sources so that the air is not directly heated by the infra-red source. Non-heated air means air at room temperature, i.e., at a temperature ranging from 15° to 35°C, preferably from 18° to 23°C.

According to the present invention, the said infra-red ray sources are each preferably placed between two air sources. The infra-red ray sources are preferably heated up only during the passage of the film through the device of the present invention, thus allowing an obvious saving of energy.

Briefly, the present invention concerns a method for drying a photographic film impregnated with water, characterized in that the film is irradiated with infra-red radiations and, at the same time, struck by an air jet at room temperature to remove the moisture from the film. The above-mentioned conditions with which the film is both irradiated with infra-red rays and struck with air at room temperature are such that the film is dried without undergoing any substantial temperature increase.

The present invention further relates to a method for drying a photographic film impregnated with water, including the passage of the film through a drying chamber, characterized in that:

a. the passage of the film occurs in presence of infra-red ray and non-heated air sources, which both strike the film;
b. said infra-red ray sources have an oblong shape and are placed on both sides of the conveying plane of the film at a distance ranging from 1 to 3 cm.;
c. the temperature of the air striking the film ranges from 15° to 35°C.

The present invention further concerns a drying device for a photographic film impregnated with water of the type including a drying chamber provided with an inlet and an outlet and conveying means for the film at least partially placed in the said chamber, characterized in that said chamber includes:

1. oblong-shaped infra-red ray sources turned towards the conveying plane of the film and placed on both sides of the said plane at a distance ranging from 1 to 3 cm.;
2. air sources at a temperature ranging from 15° to 35°C turned towards said conveying plane and placed on both sides of said plane.

The present invention further refers to methods and devices for drying a photographic film as described above, wherein the air and the infra-red rays reach the film through separate outlets and/or the drying conditions are such that the film undergoes a temperature

increase not higher than 5°–10°C. The present invention substantially relates to methods and devices as described in the present patent application.

A drying device according to the present invention can either be usefully incorporated in an automatic processor for photographic films for use in radiography or graphic arts or be used as a table drier. If it is used as a table drier, the device of the present invention should be further provided with a support plane and squeezing rollers, as known to those skilled in the art. In both cases, the speed of the passage of the film through the drying chamber, the length of said chamber, the power of the said infra-red sources and the power of the fan or fans, feeding the air sources, will be from time to time chosen by those skilled in the art, in using a device as described in the present invention, according to the particular use intended.

The following table indicates preferred values of such parameters according to three different constructions suitable for drying X-ray films of the type which may be processed in an automatic processor (such as for instance the applicant's radiographic film of the R type).

TABLE

Speed	1 0.9–1.1 cm/sec.	2 1.4–1.6 cm/sec.	3 2–22 cm/sec.
Length of the drying chamber	5–8 cm.	10–15 cm.	15–20 cm.
Power of the infra-red lamps	XXX-500 W – 1000 W	XXX-1000 W – 1500 W	XXX-1200 W – 1800 W
Number of the lamps	2	2–4	4–6
Delivery capacity of the fans	300–600 m³/h	500–700 m³/h	600–900 m³/h
Power of the fans	50–60 W each	60–80 W each	70–100 W each

The infra-red ray sources are quartz tungsten lamps, preferably at a high temperature, with a color like those used for photoreproduction systems, such as for instance of the Toshiba QIR, 13381 X of Philips, or Infra-Red of General Electric.

If the data quoted in the preceding table are compared with those of the devices known prior to the present invention, the efficiency of the methods and devices of the present invention are readily seen. A drying device of the XD-304 type of the applicant has for instance the following characteristics:

speed	0.8 – 1.1 cm/sec.
length of the drying chamber	36 cm.
resistor power	3 KW
fan delivery capacity	980 m³/h
fan power	175 W

A drying device according to the present invention, in a preferred embodiment thereof, and referring to a few alternatives of the very drying area, will be illustrated in the accompanying drawing, wherein:

FIG. 1 is a cross-section view of a table dryer according to the present invention in its preferred embodiment.

FIG. 2 is an enlarged schematic cross-section view of the drying area of the dryer in FIG. 1.

FIG. 3 is an enlarged schematic cross-section view of a second embodiment of the drying area.

FIG. 4 is an enlarged schematic cross-section view of a third embodiment of the drying area.

FIG. 5 is an enlarged schematic cross-section view of a fourth embodiment of the drying area; and

FIG. 6 is an enlarged schematic cross-section view of a fifth embodiment of the drying area.

Referring now to FIG. 1, the device comprises: fans A and A_1, ventilation chambers B and B_1, air sources D and D_1, pairs of feeding rolls C and C_1, infra-red ray lamps E and E_1, a table G, a set of squeezing rolls H, a driving variable speed motor F, all of which held within a casing L. The drying chamber being indicated and defined by the ventilation chambers themselves B and B_1. The film collecting table is shown in M.

In FIG. 2, the drying area is shown in a more detailed manner, though in schematic form.

Lamps E, E_1 are located between the pairs of feeding rolls C, C_1, and each lamp E, E_1 is associated with a substantially U-shaped cross-section reflector R, R_1. Preferably reflectors R, R_1 may take a configuration having a semi-elliptical cross-section.

The feeding rolls which are located between pairs of lamps, are "shielded" by baffles DF, DF_1 in order to avoid any possible overheating of the corresponding feeding rolls, which would harmfully affect the drying operation.

The characteristics of the FIGS. 1 and 2 dryer are as follows:

Speed	1–2 cm/sec.
Lamp Power	1.2 KW
Lamp Number	6
Drying Chamber Length	13 cm.
Total Fan Capacity	600 m³/h
Total Fan Power	160 W

By making an X-ray film, impregnated with water, such as for instance that of the R type of the applicant, pass through the said dryer at a speed of 2 cm/sec., the film is perfectly dried without having undergone any remarkable temperature increase in comparison with the entrance temperature.

Referring to FIG. 4 the outlets of fans A, A_1 are fed by conducts, not shown, to pressure chambers G, G_1, from where by means of openings L, L_1 which straddle reflectors R, R_1, air is thrown against the film passing through rolls C, C_1.

In this way cooling of reflectors and effective shielding of the rolls C, C_1 from lamp E, E_1 thermal radiation are obtained.

Referring to FIG. 4, with the same references as previously used, outlets of fans A, A_1 are fed through conducts not shown, to delivering pipes M, M_1 coupled, on the side facing the film passage plane, to slit ejectors or nozzles N, N_1. It is to be said that in this embodiment air is blown between the walls of reflectors R, R_1 and the walls of rolls C, C_1.

In this case too, besides the action on the film to be dried, there is an effective cooling action on reflectors R, R_1 and rolls, C, C_1 as well.

In FIG. 5, with the same references as above, the air coming from fans A, A_1 is fed through conducts to chambers Q, Q_1 from where it is directed against both

the rolls C, C_1 and the film. This arrangement is the most effective for a good cooling of rolls C, C_1.

In FIG. 6, an alternative to the structure of FIG. 5 is shown, wherein within chambers Q, Q_1 U-shaped baffles are included indicated in T, T_1 in order to shield the walls of rolls C, C_1 and prevent the possible deposition of air-borne particles on the surfaces thereof.

A drying device according to the present invention can be usefully incorporated in an automatic processor for films suitable for radiography. In such device, after having undergone the various processing steps (development, fixing and washing), the film is directly introduced into the drying chamber (realized with a screen like that of FIG. 1) and dried. The characteristics of such a device depend upon the characteristics of the automatic processor in which it is incorporated and above all upon the processing speed. For a speed of 1.6 cm/sec. (corresponding to a processing cycle of 90", as known to those skilled in the art), the other characteristics are preferably the following:

length of the drying chamber	10 – 14 cm.
power of the infra-red lamps	1500 W
number of the lamps	4
delivery capacity of the fans	400–600 m^3/h
power of the fans (each)	60–80 W

What we claim is:

1. Apparatus for the drying of photographic film impregnated with water, said apparatus comprising a drying chamber provided with an inlet and outlet, at least one pair of nip rollers at least partially within said drying chamber for conveying film, said apparatus further characterized by

a. at least two infra-red radiation sources on each side of the conveying plane of the film turned towards the conveying plane at a distance of from 1 to 3 cm., said at least two radiation sources having said at least one pair of nip rollers positioned between them,

b. shields between all of said infra-red radiation sources and all of said nip rollers which prevent them from heating said nip rollers,

c. means for supplying air at the surfaces of the film at a temperature of from 15° to 35°C, said sources directed towards the said conveying plane and placed on both sides of said plane, and

d. paths within said chamber for conveying air away from said chamber after said air has been directed towards said conveying plane.

2. The apparatus of claim 1 in which each of said paths for conveying air away from said chamber are located adjacent to said sources of air.

3. The apparatus of claim 1 wherein the non-heated air flow is supplied at a rate sufficient that the film does not undergo a temperature increase higher than 10°C.

4. The apparatus of claim 1 in which each of said infra-red radiation sources has a said source of air and a said path for conveying air on each side of each said infra-red radiation source.

5. The apparatus of claim 1 in which there are two said sources of air and two said paths for conveying air about each said infra-red radiation source.

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