

United States Patent

[11] 3,532,048

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| [22] | Filed | Sept. 20, 1967 |
| [45] | Patented | Oct. 6, 1970 |

- [54] X-RAY FILM PROCESSING MACHINE**
6 Claims, 17 Drawing Figs.

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| [52] U.S. Cl..... | 95/94, |
| | 95/89 |

- [51] Int. Cl. G03d 3/12

- [50] **Field of Search**..... 95/94, 89,
89(misc). 89(feed). 89(dip)

- ## [56] References Cited

UNITED STATES PATENTS

- | | | | |
|-----------|---------|--------------------|-------|
| 2,685,831 | 8/1954 | Strandberg..... | 95/94 |
| 2,913,974 | 11/1959 | Sabel et al..... | 95/94 |
| 3,025,779 | 3/1962 | Russell et al..... | 95/94 |

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|-----------|---------|----------------------|----------------|
| 3,270,654 | 9/1966 | Russell et al..... | 95/89(Misc.)UX |
| 3,287,013 | 11/1966 | Fairbanks et al..... | 95/94X |
| 3,345,928 | 10/1967 | Krehbiel..... | 95/94 |
| 3,366,025 | 1/1968 | Layne..... | 95/94 |
| 3,418,913 | 12/1968 | Snarr..... | 95/94 |

FOREIGN PATENTS

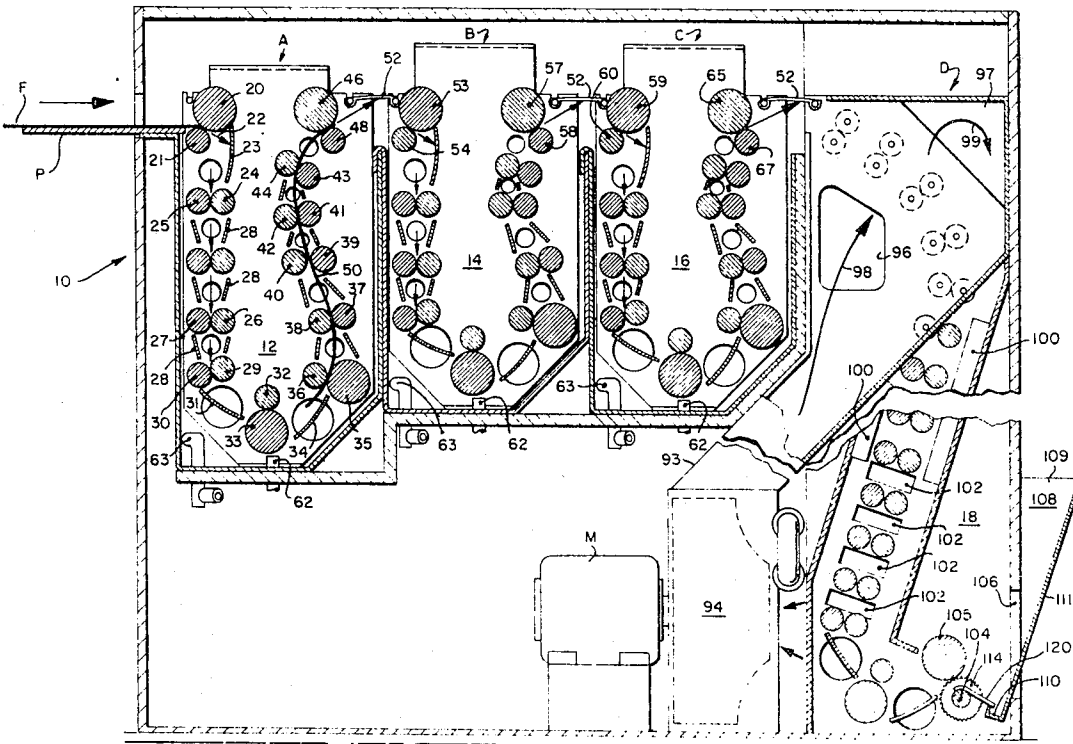
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|-----------|--------|--------------|-------|
| 1,280,994 | 2/1961 | France | 95/94 |
|-----------|--------|--------------|-------|

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ABSTRACT: A machine which automatically receives exposed film and develops, fixes, washes and dries the film, and stores it automatically. The machine includes a film-developing tank, a film-fixing tank and a film-washing tank. The film is propelled in the first two tanks by identical, interchangeable, self-sufficient units. From the washing tank, the film passes into a dryer compartment from which the dried film is discharged.



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Sheet 1 of 10

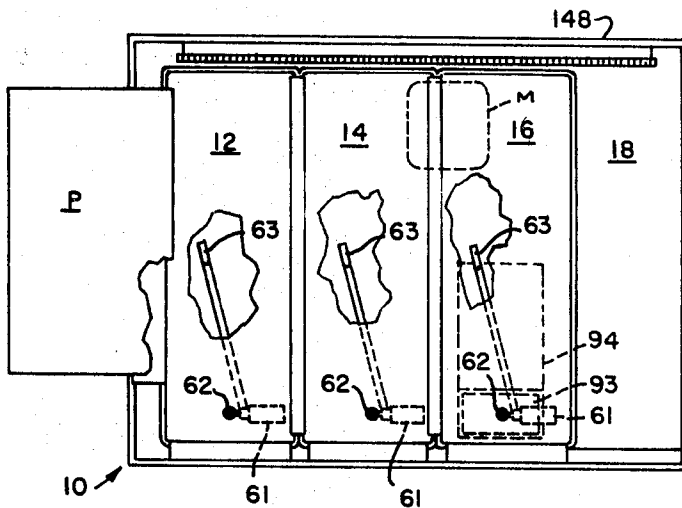


FIG. 2

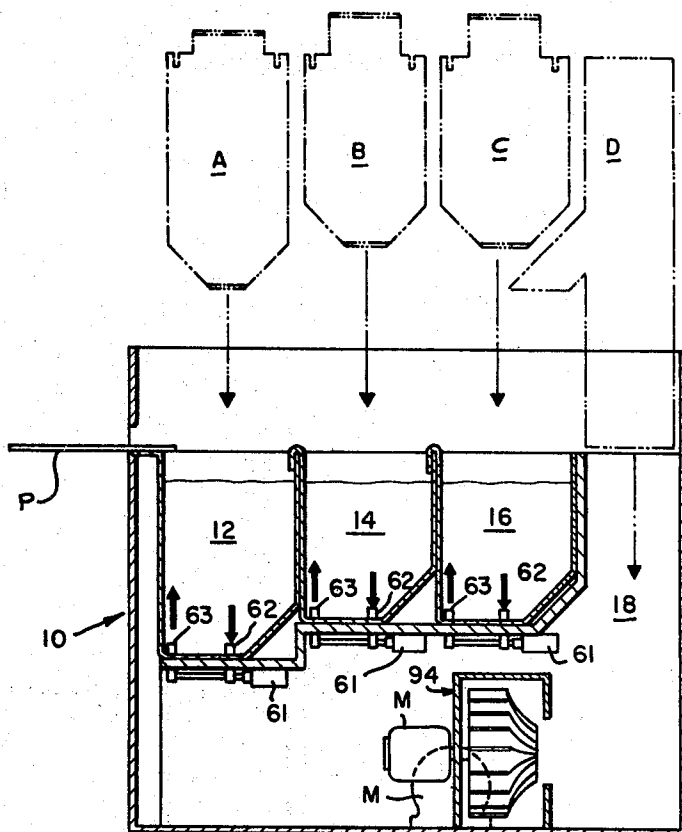


FIG. 1

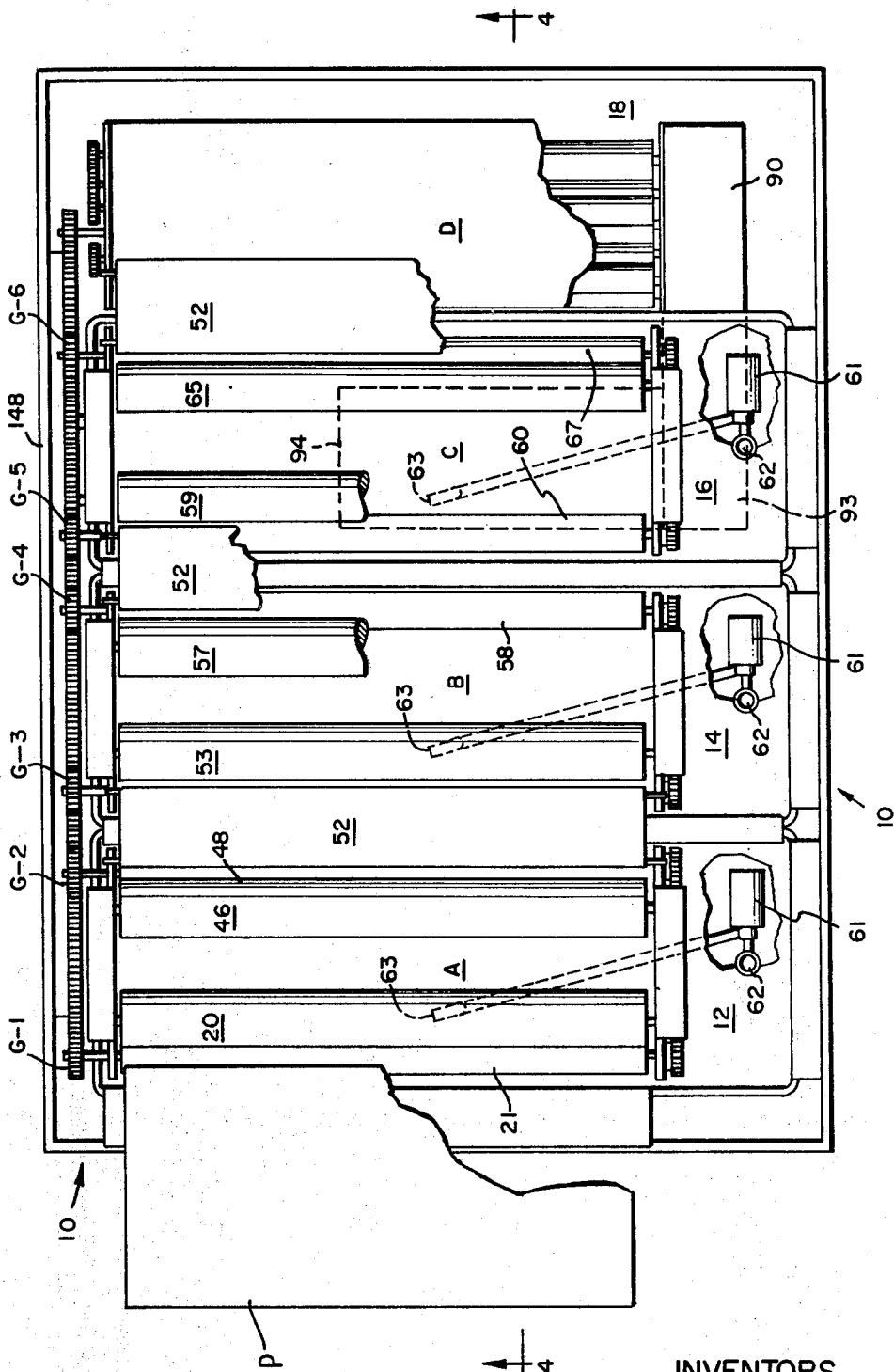
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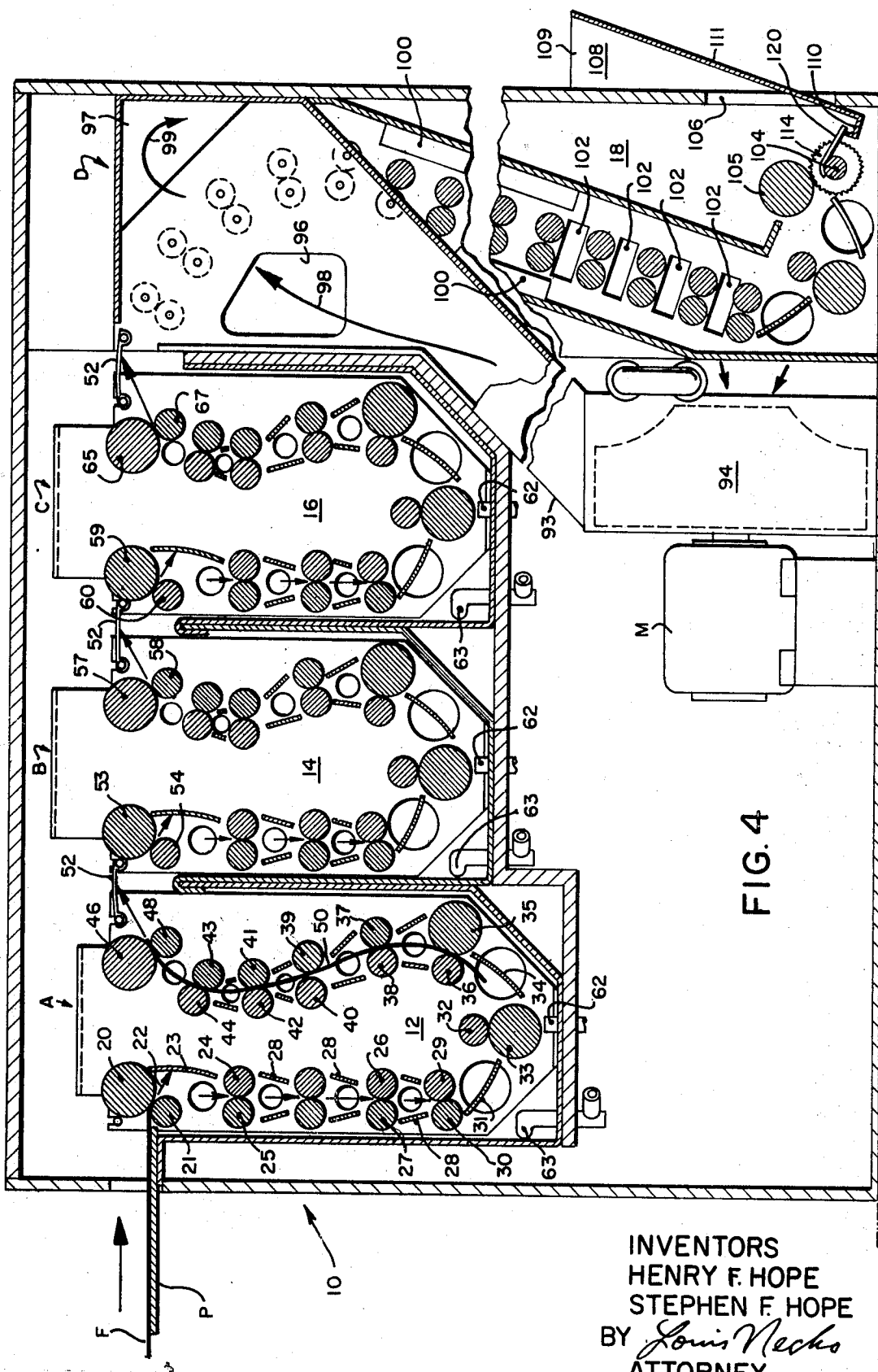
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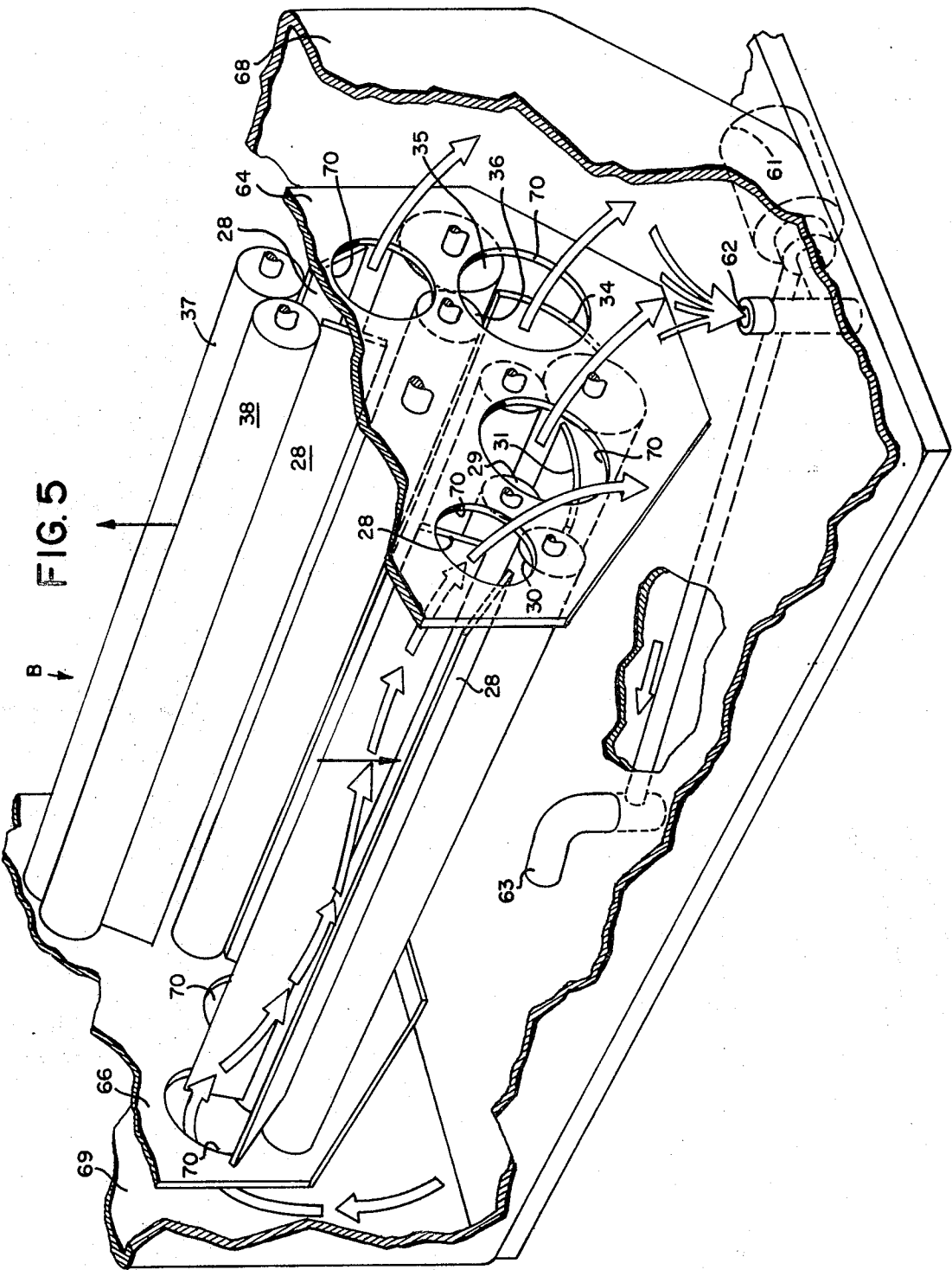
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FIG. 3

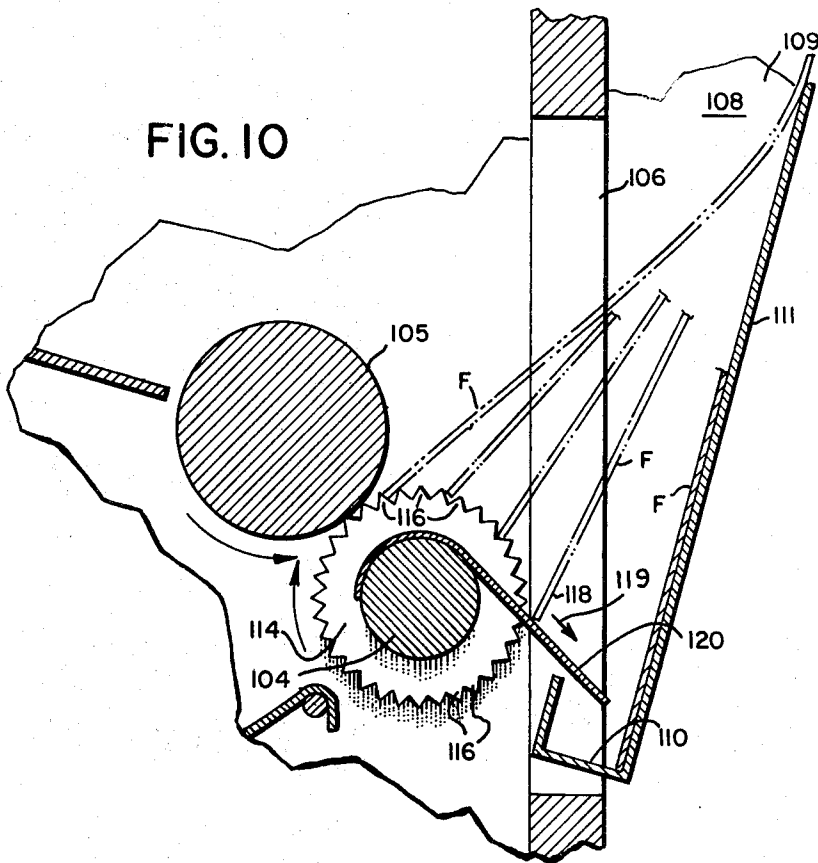
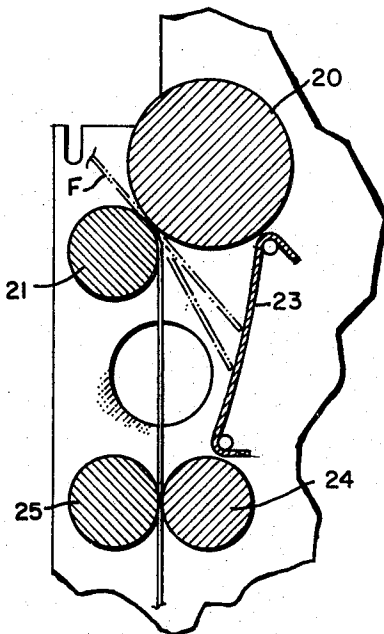
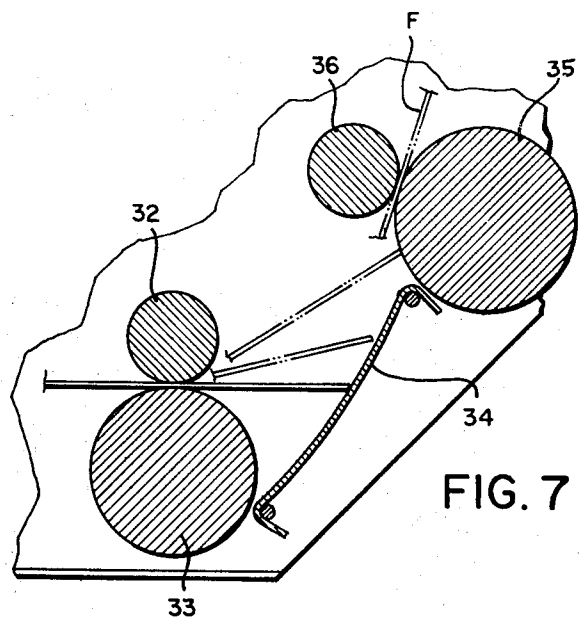


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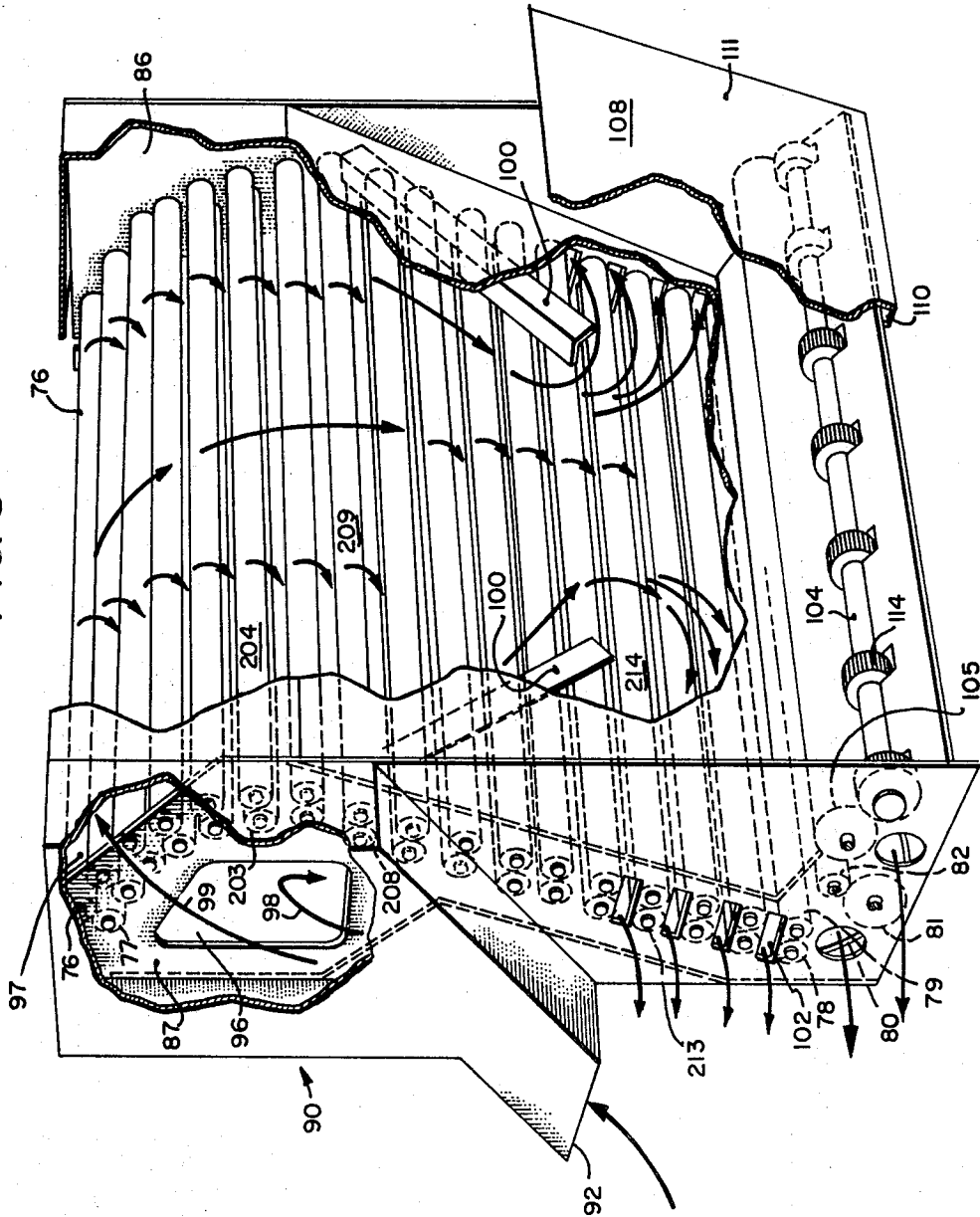


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FIG. 8



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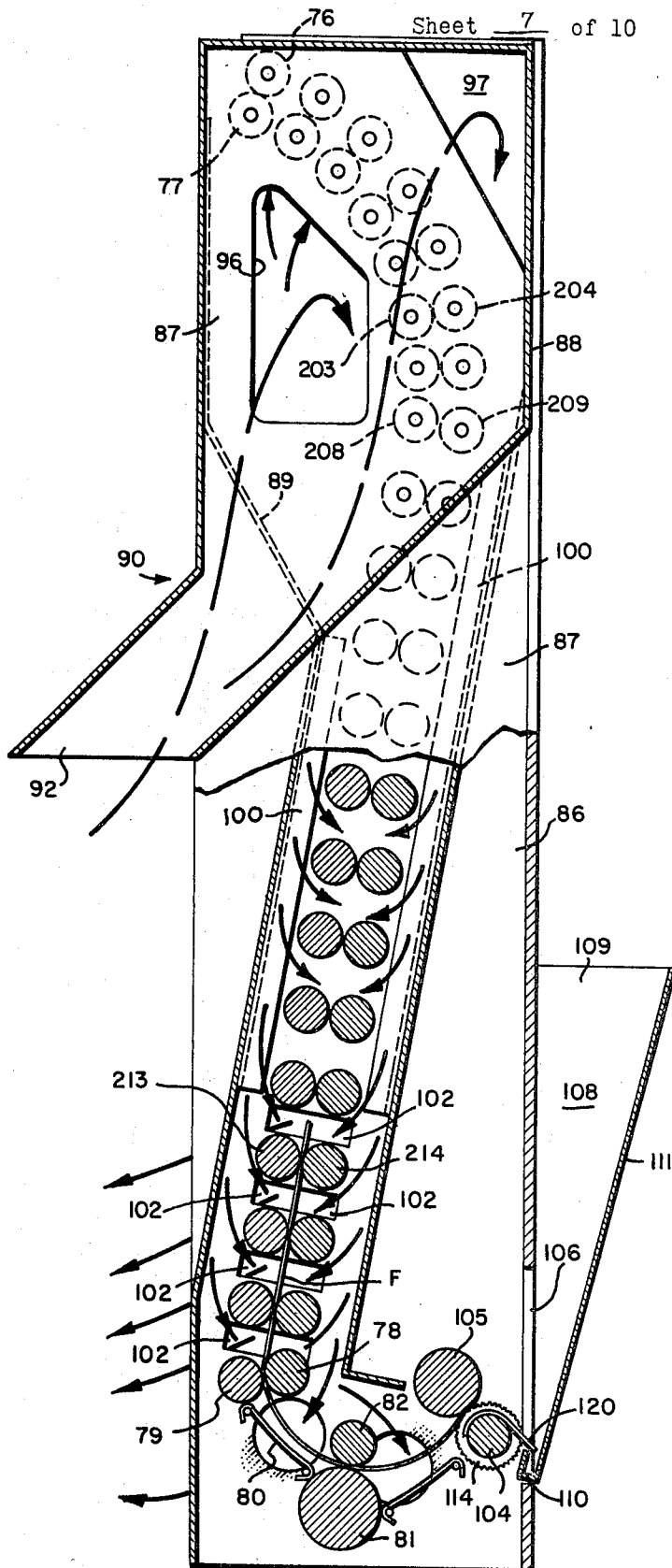


FIG. 11

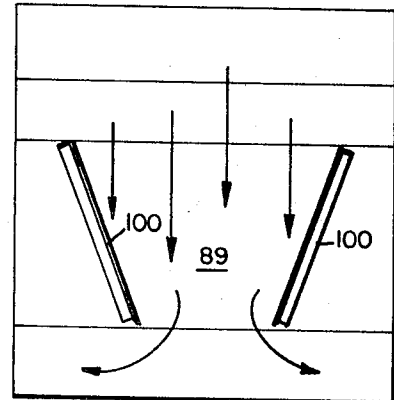
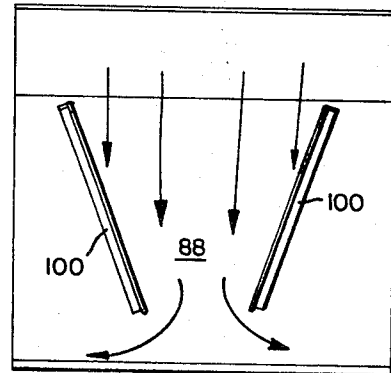


FIG. 12

FIG. 9

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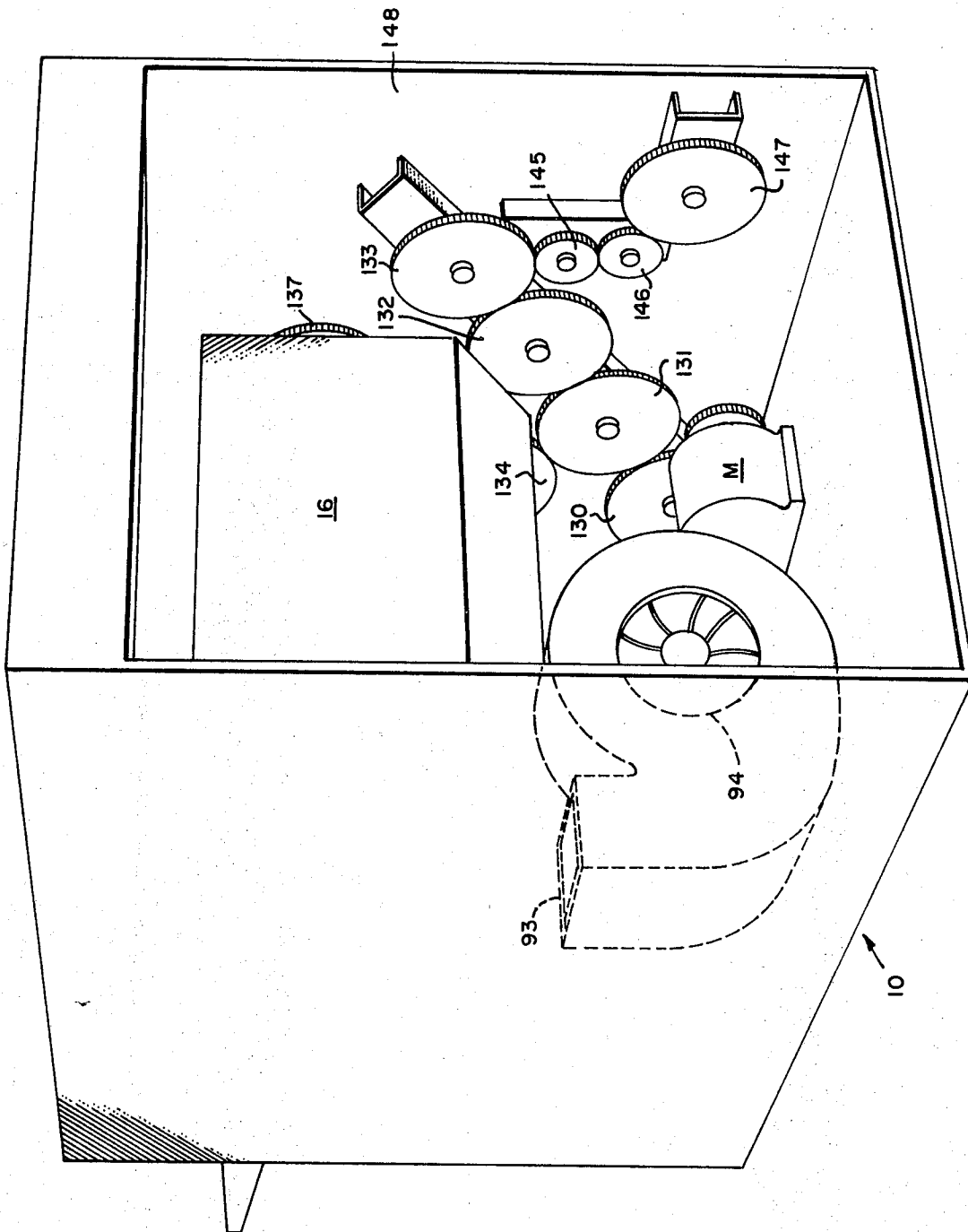


FIG. 13

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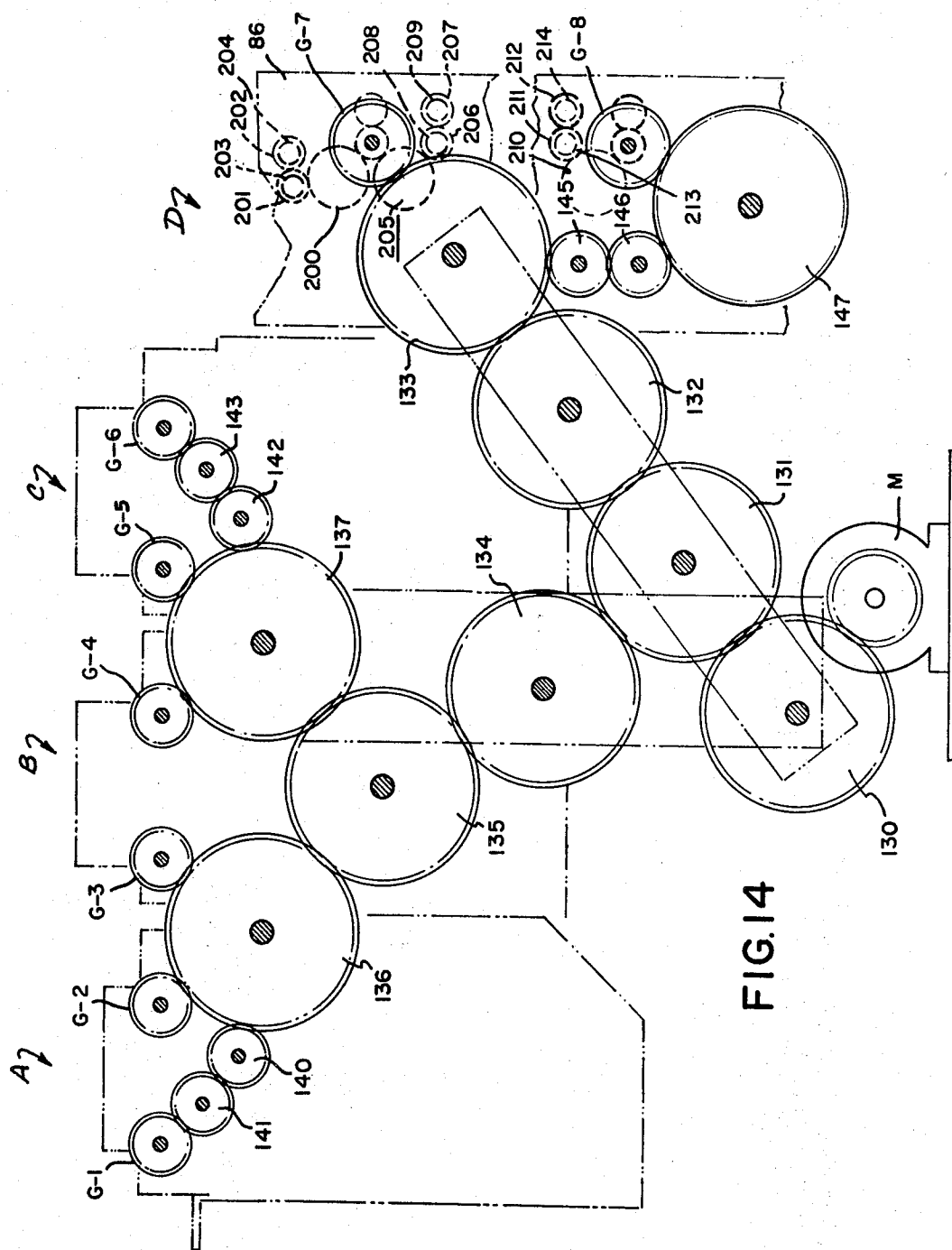
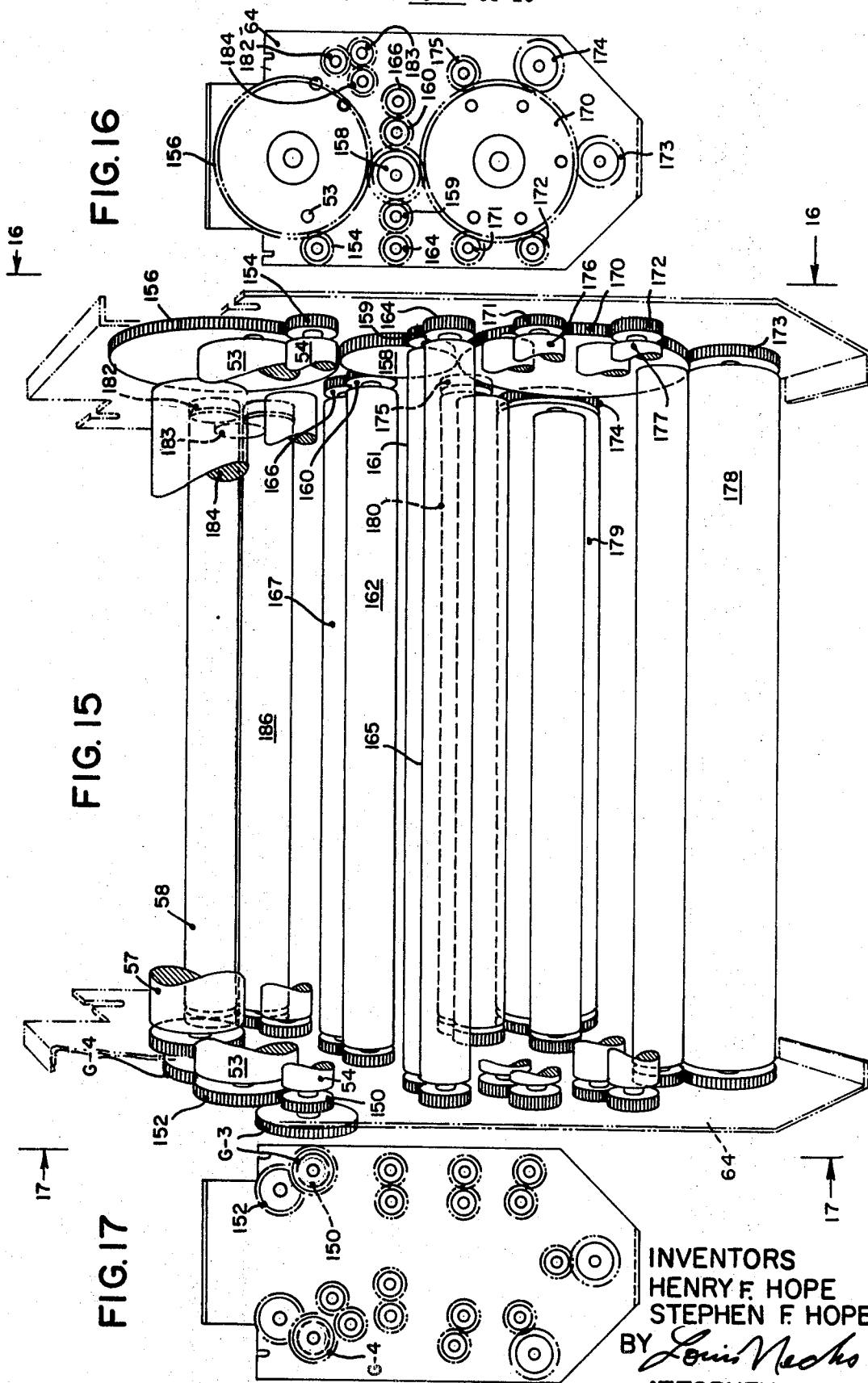


FIG. 14

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X-RAY FILM PROCESSING MACHINE

THE INVENTION

An X-ray developing machine includes a developing bath, a fixing bath, a washing bath and a dryer.

At one time, the still wet developed film was removed from the washing bath, to be provisionally read by the doctor, and was then hung up to dry on a frame in a room which was, or was not provided, with a drying medium. By way of improvement, machines have been proposed which included means for developing, fixing, washing and drying the film in a continuous process, but such machines were slow, especially in the drying process.

It is therefore an object of this invention to produce an improved machine whereby the entire operation from developing to drying is carried out in a very short time.

Radiologists have offices in high rent locations where space is at a premium, and it is therefore necessary that the machine be as compact as possible. Making a machine compact while providing adequate contact with the developing, fixing and washing liquids, and for adequate drying, has presented a problem which, as far as we are aware, has not as yet, been solved. This is partly due to the fact that the moving film is best moved in a straight, or on a large-radius curved path. Such paths necessarily resulted in a correspondingly extended machine.

It is therefore a still further object of the invention to produce an improved film-propelling mechanism which is compact, but which does not subject the film to any sharp bends.

It is necessary that a finished film be made accessible externally of the machine and as soon as it is ready, so as to make it unnecessary for the operator to time anything, or to open the machine to check its progress or to retrieve a film.

It is therefore a still further object to provide a drying unit which automatically ejects the finished film and stacks it in a hopper which is accessible from without the drying unit.

A machine of the type set forth includes a large number of rolls which are driven by intricately interrelated gears and other expedients and the conventional arrangement has been such that, if one element of the driving mechanism fails, the entire machine will be out of commission until the part is repaired. When the part which failed happens to be not readily accessible, extensive dismantling and total emptying of the machine may be needed.

It is therefore a still further object of the invention to provide an arrangement whereby the film is propelled through the developing tank by one roll assembly; through the fixing fluid by another roll assembly; through the washing compartment by another roll assembly; and through the drying compartment by still another roll assembly. Also, according to our invention, the roll assemblies are wholly unconnected with each other, and are actuated by a single driving mechanism. Another feature of the actuating mechanism is that placing a roll assembly, or unit, in position within the casing, automatically connects it, operationally speaking, with the common driving mechanism. Conversely, lifting a roll assembly out of the machine disconnects it from the driving mechanism without any effect on the remaining roll assemblies, or units.

Since failure of some part, or other, is inevitable, it is necessary that the "down" time of the X-ray machine be reduced and that the repair operation be simplified.

To this end, the roll assemblies used in the developing tank are made interchangeable, inter se, that is, any roll assembly of that type, picked at random will fit, and the roll assemblies used in the drying are made interchangeable in the same manner. For still further efficiency, roll assemblies B and C used in the fixing and washing compartments are made identical, so as to be interchangeable, one for the other.

Each of the roll assemblies mentioned involve a large number of relatively closely spaced rolls, and driving these rolls presents a problem because of limitations of space, weight and cost.

It is therefore a still further object of the invention to produce an improved driving system which permits all the rolls of all of units A, B, C and D, to be driven by a single motor and with the smallest number of gears.

Other features and advantages will become apparent from the following specification and the drawings in which:

FIG. 1 is a diagrammatic elevational view of an X-ray film-processing machine embodying the invention, the roll assemblies used in the development, fixing, washing and drying compartments being shown in phantom above the casing.

FIG. 2 is a top plan view of the same with the roll assemblies omitted.

FIG. 3 is an enlarged top plan view of the machine with the developing, fixing, washing and drying roll assemblies shown in position.

FIG. 4 is a sectional view looking in the direction of line 4-4 on FIG. 3.

FIG. 5 is a fragmentary, perspective view and shows the manner in which the treating liquids are circulated.

FIGS. 6 and 7 are enlarged, fragmentary views of the upper and lower portions of one of the units shown in FIG. 4, the better to show the path of movement of the film.

FIG. 8 is a perspective view of the dryer roll assembly.

FIG. 9 is a view, partly in section and partly in end elevation, of the dryer assembly shown in FIG. 9.

FIG. 10 is an enlargement of the lower portion of FIG. 9 and shows the manner in which a dried film is ejected and stacked.

FIGS. 11 and 12 are fragmentary views of the front and rear walls of the dryer unit and show deflections for directing the drying air in relation to the path of movement of the film.

FIG. 13 is a perspective view showing the end of the casing into which the dryer of FIGS. 8 and 9 is inserted, and shows the blower which supplies air to the dryer, and that part of the driving mechanism which actuates the dryer rolls.

FIG. 14 is a side elevational view of the driving mechanism.

FIG. 15 is a perspective view showing the driving mechanism of roll assembly which is used in the developing, fixing or washing tanks.

FIG. 16 is a right-hand elevational view of the same.

FIG. 17 is a left-hand elevational view of the same.

Generally speaking, the processing machine comprises a casing 10 partitioned to form a film developing compartment 12, a fixing compartment 14, a washing compartment 16 and a drying compartment 18. Compartments 12 and 14 are supplied with developing and fixing solutions respectively, and compartment 16 is supplied with running wash water by conventional means, not shown, leading from the corresponding sources also not shown.

According to this invention, the film is propelled into and out of developing compartment 12 by roll assembly, or unit A, into and out of fixing compartment 14 by roll assembly B, into and out of washing compartment 16 by roll assembly C and into and out of dryer compartment 18 by roll assembly D. These roll assemblies are shown in phantom above the casing in FIG. 1; and are shown in position within the casing in FIGS. 3 and 4.

It will be noted from FIG. 1 that the roll assemblies A, B and C are in the form of individual, self-contained units which can be removed from the casing by lifting them straight up, and which can be installed by lowering them, straight down. It will be seen from FIG. 13 that unit D is installed by sliding it horizontally into the open end of the casing and that it can be removed by withdrawing it in the opposite direction. As pointed out above, units B and C are interchangeable in that they will fit compartment B or C, and that units A and D are interchangeable in the sense that any roll unit A will fit in compartment 12 and any roll unit D will fit in compartment 18.

By reference to FIG. 4, it will be seen that the exposed film F to be processed is fed from platform P into the nip of a pair of orienting rolls 20, 21, which propelled the film in the direction of arrow 22, so that the leading edge of the film is guided, by plate 23, progressively into the nip of a pair of rolls

24, 25. The nip of this pair of rolls aligns, vertically, with the nips of as many additional pairs of rolls as desired, until the lowermost pair of rolls 26, 27, is reached. In other words, rolls 24, 25, and rolls 26, 27, and the rolls therebetween, define a straight line vertical path for the film, which is prevented from any deviation by guards 28. Below rolls 26, 27, which are the lowest pair of the vertically aligning rolls is another pair of orienting rolls 29, 30, which, in cooperation with lower guide plate 31, direct the film to the nip of cross-over rolls 32 and 33 which, in cooperation with guide plate 34, direct the film to the nip of lower orienting rolls 35, 36, and into the nips of successive pairs of rolls 35, 36; 37, 38; 39, 40; 41, 42; 43, 44; which propel the film upwardly over the large radius, sinuous path shown by solid black line 50 into the nip of discharge, orienting rolls 46 and 48 in FIG. 4. By this arrangement, when the leading edge of the film emerges from the nip of rolls 46 and 48, it will be aimed toward transfer guide plate 52 which directs it to the nip of inlet, orienting rolls 53, 54 of unit B, which correspond to rolls 20 and 21 of unit A.

Since, except for roll assembly A having two pairs of rolls 26, 27 and 41, 42, which merely lengthen the path of travel and which have no counterpart in roll assemblies B and C; the roll assemblies A, B and C are identical, it is thought that a detailed description of the rolls of assemblies B and C is unnecessary and that it is enough to point out that the film exits from compartment 14 through rolls 57, 58; that it enters compartment 16 through rolls 59, 60 and that it exits from compartment 16 to dryer compartment 18 through rolls 65, 67.

An upper pair of rolls of each roll assembly A, B and C is made of soft rubber so as to serve as a "squeegee" for minimizing the amount of liquid carried by the film as it passes from one compartment to the next.

In the interest of improved processing, the treating solutions in each of the compartments 12, 14 and the water in compartment 16, should be thoroughly agitated. According to this invention, this is accomplished by the mechanism which is shown in FIGS. 3 and 5. This mechanism includes a pump 61 which has an intake end 62 and a discharge end 63. It will be noted that the inlet end of the pump is at one end of the compartment, and that the discharge end 63 is at or beyond the center of the compartment, and that it discharges in the direction of the distal end of the compartment. In the preferred embodiment, each pump is located outside of its unit so as to conserve space and that end walls 64 and 66 of the compartment are spaced from the adjacent walls 68 and 69 of the casing and are provided with holes 70 so as to permit circulation of the liquid as generally indicated by the arrows in FIG. 5.

As shown in FIGS. 8 and 9, the dryer is formed of a large number of pairs of rolls, the uppermost pair 76, 77 of which receives a film from the exit pair of rolls 59, 60 of unit C in wash compartment 18, and the lowermost pair of rolls 78, 79 of which cooperates with guide plate 80 to direct the film to cross-over pair of rolls 81, 82, which are hereinafter further referred to. Except for the rolls which engage the driving mechanism and which will be hereinafter referred to, the remaining dryer rolls are conventional and are not described in detail. It is enough to point out that their nips define a sinuous path which lengthens the path of travel without sharply bending the film, FIG. 9.

The rolls of the dryer are enclosed in a housing formed of end walls 86, 87, front and rear walls 88, 89. End wall 87 of the dryer housing forms the inner wall of a duct or chute 90 which terminates in an intake nozzle 92. When the dryer roll unit is inserted into the end of casing 10, as in FIG. 4, intake nozzle 92 automatically registers with the discharge nozzle 93 of a blower 94 which delivers heated air into the duct 90. The air blown into chute 90 enters the dryer housing through openings 96 and 97 as shown by arrows 98 and 99. By this arrangement, air is blown horizontally and downwardly over the opposite faces of the film traveling downwardly between the rolls. As shown in FIGS. 9, 11 and 12, the front and rear walls of the dryer housing are provided with downwardly converg-

ing baffles 110 which direct the air to the center portion of the film. End wall 87 of the dryer housing 18 is provided with openings 102 through which the spent air is returned to the intake side of the fan to be heated and recirculated.

In order to stack the dried films in the hopper 108 so as to be accessible from without the dryer compartment, FIG. 10, we provide shaft roll 104 with axially spaced rings 114 which are provided with flutes 116 which extend axially of the roll. When a film emerges from rolls 104, 105, it passes through opening 106 and its leading edge climbs up inclined wall 111 of the hopper. As the trailing edge of the film emerges from rolls 104 and 105, it falls into a flute 116 and, as roll 104 turns, the film is moved to successive positions until it clears the rings as at 118, and falls onto inclined platform 120 on which it slides, in the direction of arrow 121 until it comes to rest on bottom wall 110 and leans against wall 111 of the hopper 108.

The driving mechanism is best shown in FIG. 14 from which it will be seen that motor M drives gear 130, which drives a gear train formed of gears 131, 132 and 133, and that gear 131 drives another gear train formed of gears 134, 135, 136 and 137. Gear 136 drives pinions 140 and 141; and gear 137 drives pinions 142 and 143. Gear 133 drives pinions 145 and 146, and it also drives gear 147. It should be noted that all of the gears and pinions thus far referred to in connection with FIG. 14 are carried by a side wall 148 of the casing 10, FIG. 13, and are all driven by motor M.

Gears G-1 and G-2 are carried by rolls 21 and 48 of unit A, respectively; gears G-3 and G-4 are carried by rolls 54 and 58 of unit B, respectively; and gears G-5 and G-6 are carried by rolls 60 and 67 of unit C, respectively. By this arrangement, when unit A is lowered into position, gears G-1 and G-2 will mesh with pinion 141 and gear 136, respectively; gears G-3 and G-4 will mesh with gear 136 and gear 137, respectively, and gears G-5 and G-6 will mesh with gear 137 and pinion 143, respectively. This means that the uppermost inlet and exit rolls of units A, B or C, will be automatically driven whenever the units are lowered to their operating positions.

The manner in which rotation is transmitted from rolls 21, 48, and 54, 58, and 60, 67, to the remaining roll of their respective units is identical and therefore a detailed description of one of the units such as unit B, FIGS. 15, 16 and 17, is thought to suffice.

As shown in FIGS. 15 to 17, Gear G-3 turns roll 54, the shaft of which carries gear 150 which meshes with 152 on the shaft of roll 53. The opposite end of roll 54 carries a gear 154 which is journaled in endwall 64. Gear 156 meshes with the gear 158 which is also journaled in end plate 64 and meshes with gears 159 and 160 on rolls 161 and 162, respectively. Gear 159 drives gear 164 which is on roller 165, and gear 160 drives gear 166 which is on roller 167.

Gear 158 also drives gear 170 which drives gears 171, 172, 173, 174 and 175 on rolls 176, 177, 178, 179 and 180, respectively.

Gear G-4 rotates roll 58 in the same manner in which gear G-3 rotated roll 54. On the right-hand end of roll 58, as viewed in FIG. 15, there is a gear 182 which meshes with pinion 183 which is journaled in wall 64 and which drives gear 184 to rotate roll 186.

The rolls of the drying unit D are driven as follows:

Gear 133 drives gear G-7 which, through pinion 200 drives gears 201, 202 on rolls 203 and 204, respectively. Gear G-7 through pinion 205 drives gears 206, 207 on rolls 208, 209. Gear 147 drives gear G-8 which through pinion 210 drives gears 211, 212, on rolls 213, 214, respectively.

It should be noted that gears 133, 145, 146 and 147 are carried by wall 148 of casing 10, and that the remaining gears and pinions are carried by the wall 86 of the roll unit concerned.

Generally speaking, the upper rolls are driven from gear G-7 and the lower rolls are driven from gear G-8.

From inspection of FIGS. 14 and 15, it will be noted that gears G-1, G-2; G-3, G-4; and gears G-5, G-6; are near the tops of their respective units A, B, and C, so that when the units are in their respective positions as shown in FIG. 4, all of

the gears will be above the level of the liquid in their respective compartments. This makes any packing around the stems of the gears where they pass through the end walls of the compartments unnecessary, and insures that the driving mechanism carried by wall 148 of the casing is kept wholly dry.

We claim:

1. A machine for processing X-ray film, said machine including:
 - a casing;
 - means partitioning said casing to form first and second vertical, substantially contiguous, open-top compartments for containing processing liquids;
 - a first, unitary roll assembly detachably and interchangeably insertable vertically, into either of said first or second compartments;
 - a second unitary roll assembly detachably interchangeably insertable into, and removable from, either of said compartments, in a vertical direction;
 - a third unitary dryer roll assembly detachably insertable into, and withdrawable from, said third compartment in a horizontal direction;
 - a driving mechanism carried by the exterior of each of said compartments;
 - a complementary driven mechanism carried by at least one of the rolls of each of said wall assemblies, and automatically engageable with a driving mechanism upon insertion of the corresponding roll assembly into a corresponding compartment;
 - a single driving mechanism for driving all of said roll assemblies, said mechanism comprising:
 - a first gear train detachably engageable with a roll of said first assembly roll;
 - a second gear train detachably engageable with said second assembly roll;
 - a third gear train detachably engageable with said third assembly roll; and
 - a single motor for simultaneously driving said three gear trains.
2. A machine for processing X-ray film or the like; said machine including at least one compartment;
 - a first set of pairs of rolls in said compartment for moving the film in a downward, substantially vertical path, from the inlet to the bottom of said compartment;
 - a second set of pairs of rolls in said compartment for moving the film from the bottom to the upper discharge end of said compartment;
 - said second set of rolls comprising:
 - a lower pair of rolls oriented to propel the film in a vertical path;
 - an intermediate pair of rolls which propel the film in a path which is inclined in the direction of said inlet; and
 - an upper pair of rolls which propel the film in a path inclined over or relatively large radius, in the direction of the discharge end of said compartment to direct the film towards the inlet end of an adjacent compartment.
3. A machine for processing X-ray film, said machine including:
 - a casing;
 - means partitioning said casing to form first and second vertical, substantially contiguous, open-top compartments

- for containing processing liquids, and a horizontal open end drying compartment;
- a first, unitary roll assembly detachably and interchangeably insertable vertically, into either of said first and second compartments;
- a second unitary roll assembly detachably and interchangeably insertable into, and removable from, either of said compartments, in a vertical direction;
- a third unitary dryer roll assembly detachably insertable into, and withdrawable from said third compartment in a horizontal direction;
- said third roll assembly comprising an outer wall which closes the open end of said third compartment when said third roll assembly is inserted into position in said third compartment;
- a single driving mechanism for driving all of said roll assemblies, said mechanism comprising:
 - a first gear train detachably engageable with a roll of said first assembly roll;
 - a second gear train detachably engageable with said second assembly roll;
 - a third gear train detachably engageable with said third assembly roll; and
 - a single motor for simultaneously driving said three gear trains.
- 4. The machine defined in claim 3, and a blower mounted in said third compartment and including an air discharge nozzle, and an intake chute carried by said housing and registerable with the discharge end of said blower when said third roll assembly is inserted into said third compartment.
- 5. An X-ray film processing machine including:
 - a plurality of tanks for containing film-treating liquids;
 - a drying chamber;
 - a storage hopper;
 - there being an opening, between said drying chamber and said hopper, for the passage of a dried film from said drying chamber into said hopper;
 - a roll assembly having a receiving end for receiving and propelling a film through the drying chamber;
 - a delivery end for propelling a dried film through said opening and into said hopper;
 - means co-operating with the discharge end of said roll assembly for stacking the dried films in said hopper with each film resting on its trailing edge on the bottom of said hopper;
 - said means including an auxiliary rotary roll means substantially contiguous with the delivery end of said roll assembly; and
 - said auxiliary roll means having at least one longitudinal groove for receiving the trailing edge of a processed film and for pushing said film forwardly and upwardly during a portion of a revolution of said roll means and dropping out of said groove during a subsequent portion of said revolution to cause the trailing edge of said film come to rest on the bottom of said hopper, with the film assuming a substantially vertical position in said hopper.
- 6. The structure recited in claim 5, and a guide plate adjacent the exit end of a compartment and oriented for engagement with only the leading edge of a film leaving said compartment.