United States Patent [19]

Foster

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[45] **July 24, 1973**

[54] **AUTOMATIC FILM PROCESSING SYSTEM AND APPARATUS FOR X-RAY FILM AND THE LIKE**

[76] Inventor: **Michael N. Foster,** 1409 Ruth Ave., Arlington, Tex. 76010

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[21] Appl. No.: **58,879**

[52] **U.S. Cl.** ..... **95/94 R,** 95/89 A, 271/51

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

[58] **Field of Search** ..... 95/94 R; 271/89 A, 271/51

[56] **References Cited**

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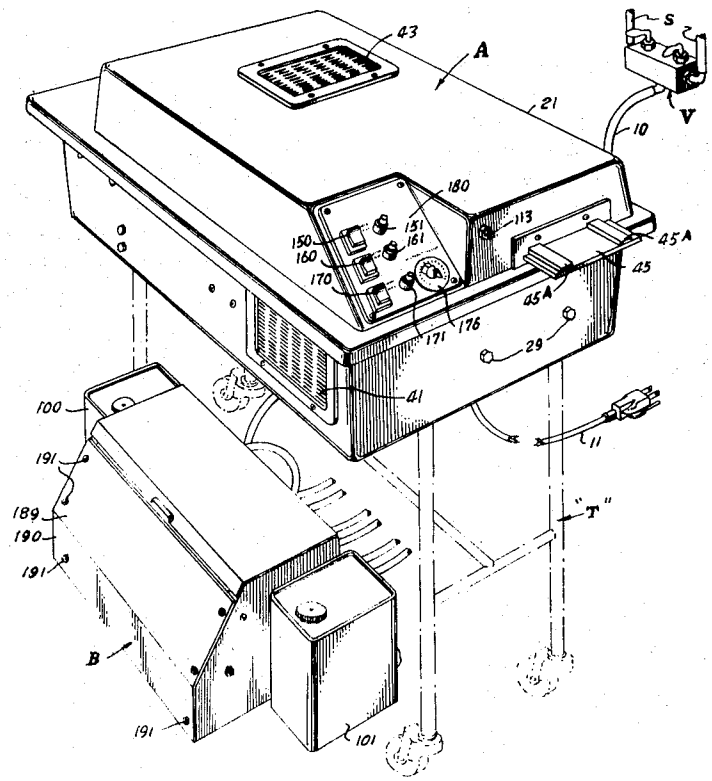
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Primary Examiner—Samuel S. Matthews
Assistant Examiner—Richard L. Moses
Attorney—E. Hastings Ackley

[57] **ABSTRACT**

An automatic positive roller transport system X-ray film developing, fixing, washing and drying unit, having film transporting roller systems for moving film through the developer tank, through the fixer tank, and through the wash tank, and then through a dryer, each of which transport systems is separately removable for cleaning or servicing of the transport systems and the tanks. Chemical circulating and supply systems are mounted separately in a separate housing from the developer and fixer tanks so that the chemical fumes are excluded from the pumps and motors used in circulating the chemicals and supplying additional chemicals to the tanks. A blower system vents the tank chamber to reduce corrosive action on the parts therein. The system is designed for continuous dry-to-dry cycle operation, but has stand-by availability, adapted for standard dental film and for larger panoramic type dental film. A daylight loader is also provided.

12 Claims, 19 Drawing Figures



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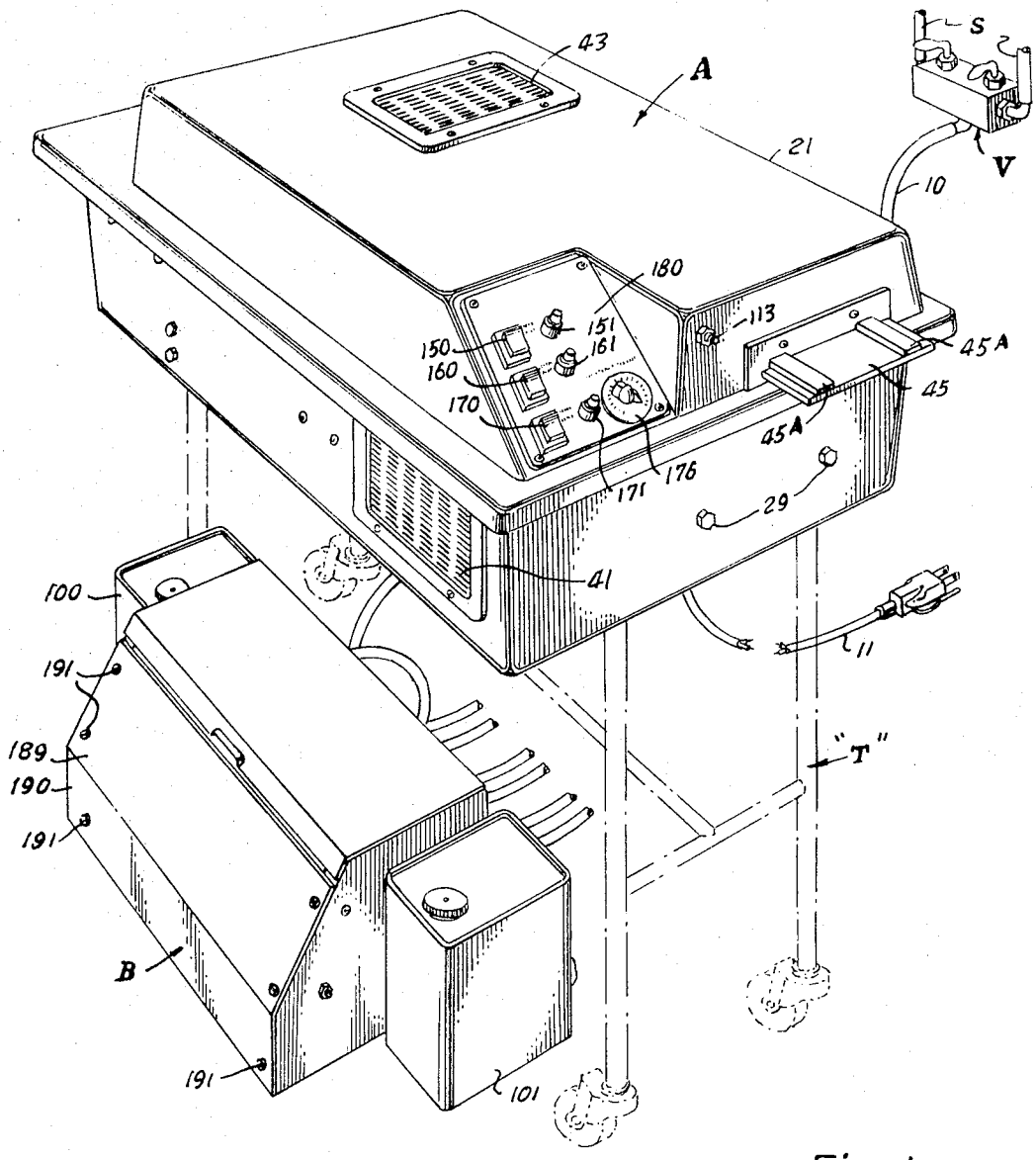


Fig. 1

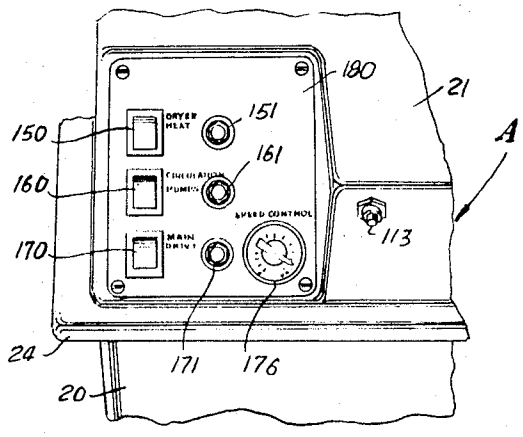


Fig. 2

INVENTOR
Michael N. Foster
BY
Eastines, Ackley
ATTORNEY

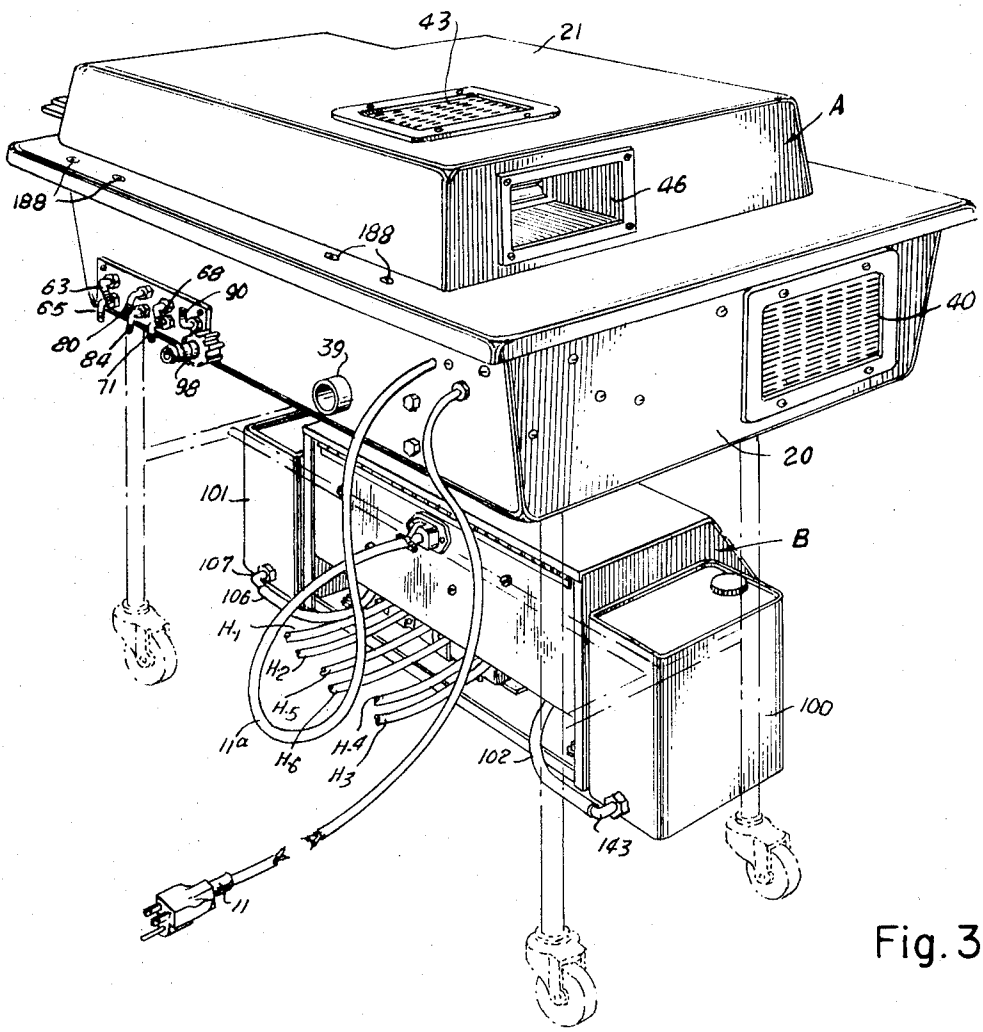


Fig. 3

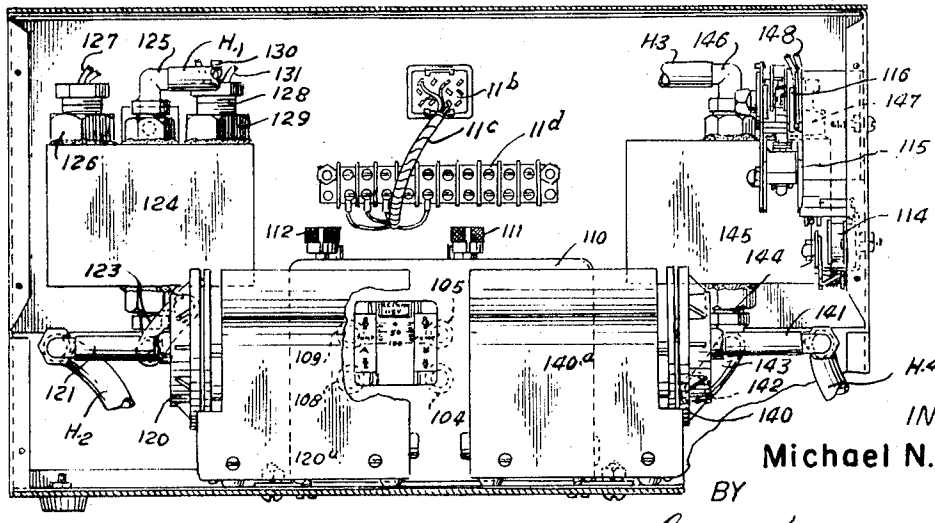


Fig. 4

INVENTOR
Michael N. Foster
BY
Estes Stinys Ackley
ATTORNEY

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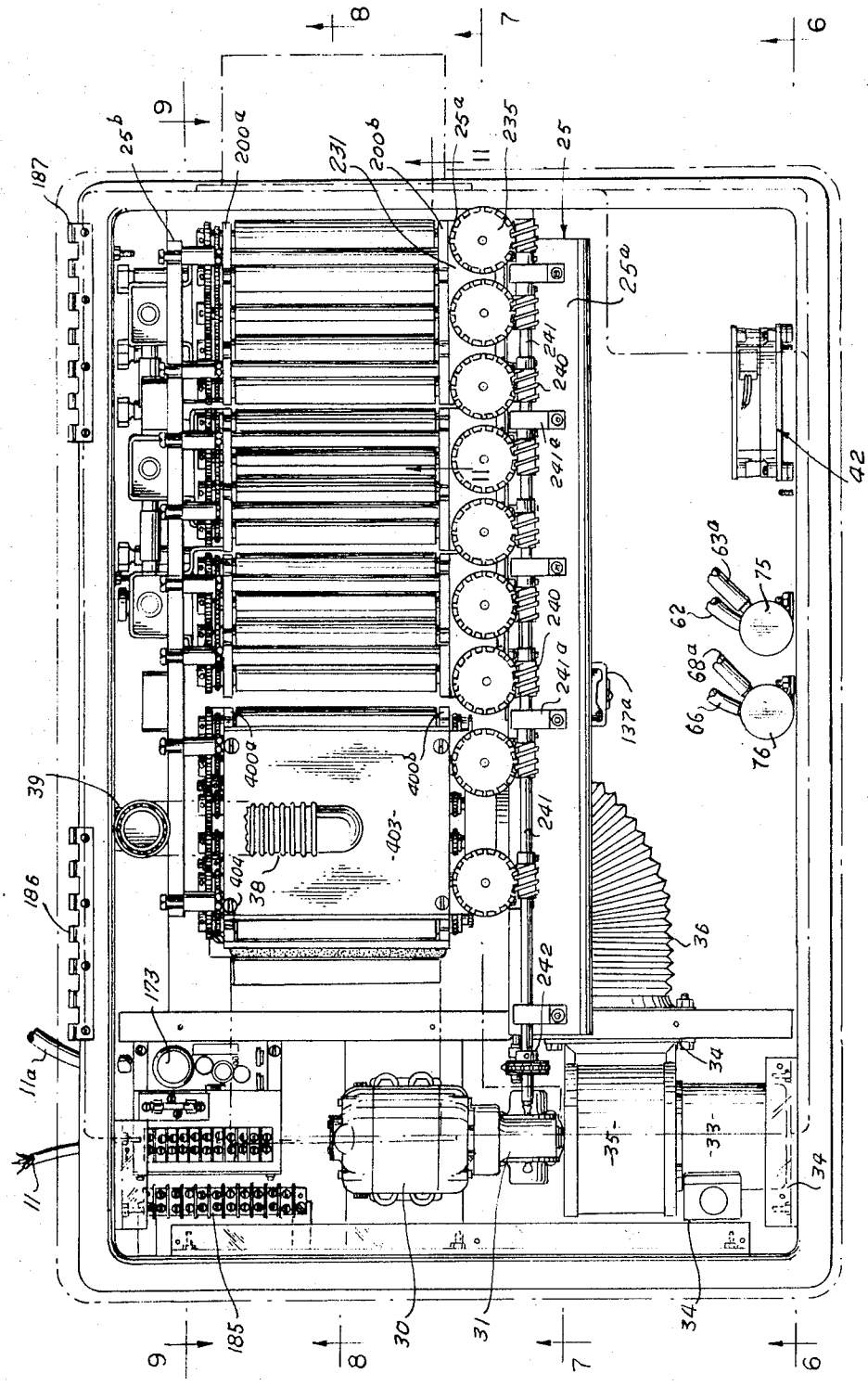


Fig.5

INVENTOR
Michael N. Foster
BY
Cestastings Ackley
ATTORNEY

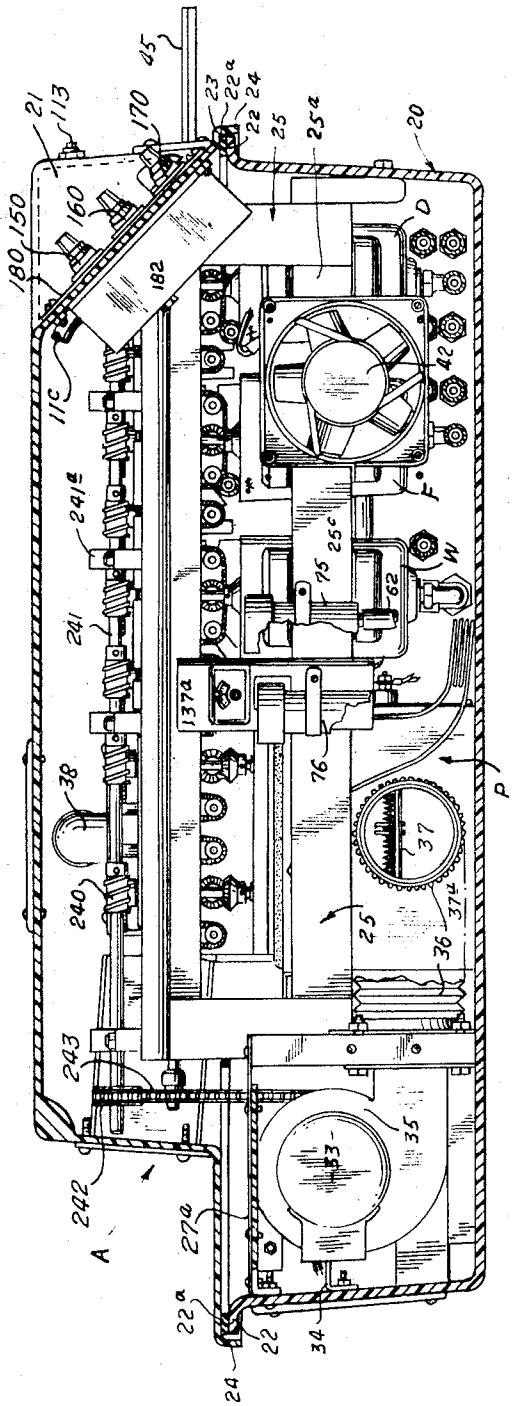


Fig.6

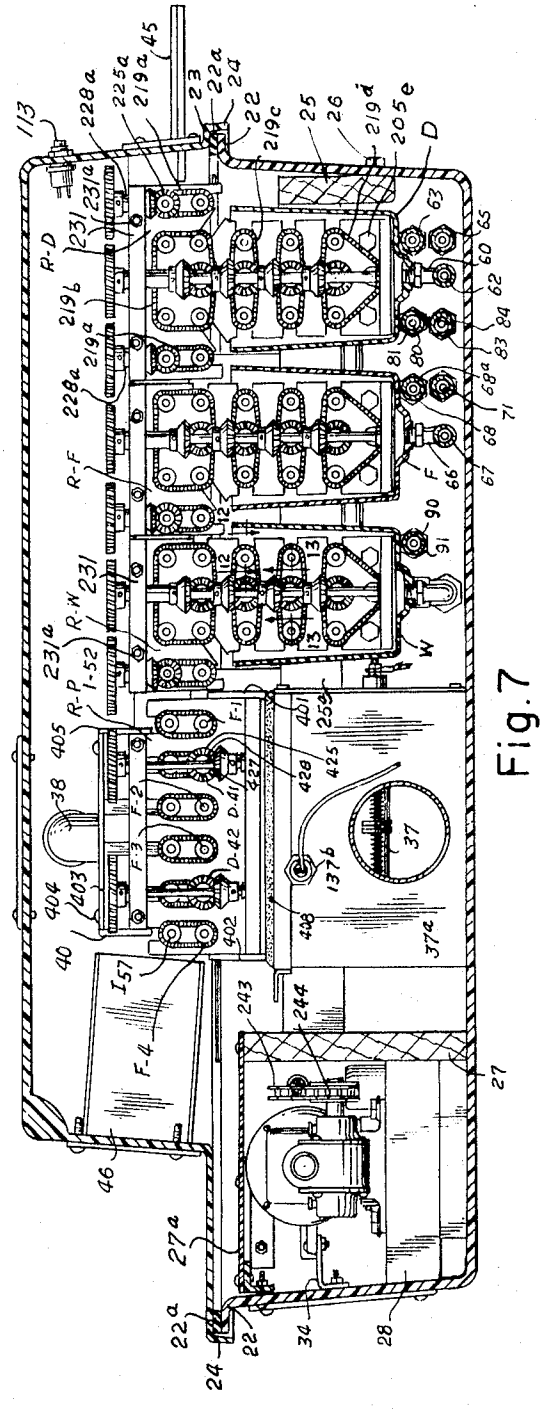


Fig.7

INVENTOR
Michael N. Foster
BY
Estastings Ackley
ATTORNEY

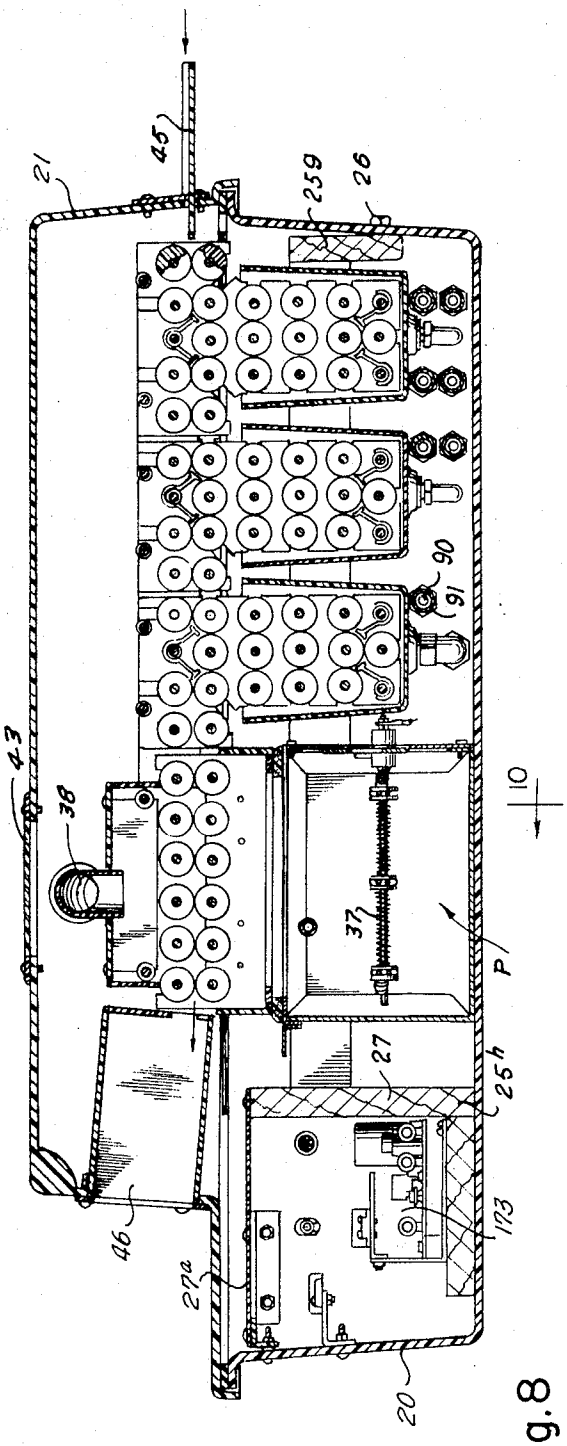


Fig. 8

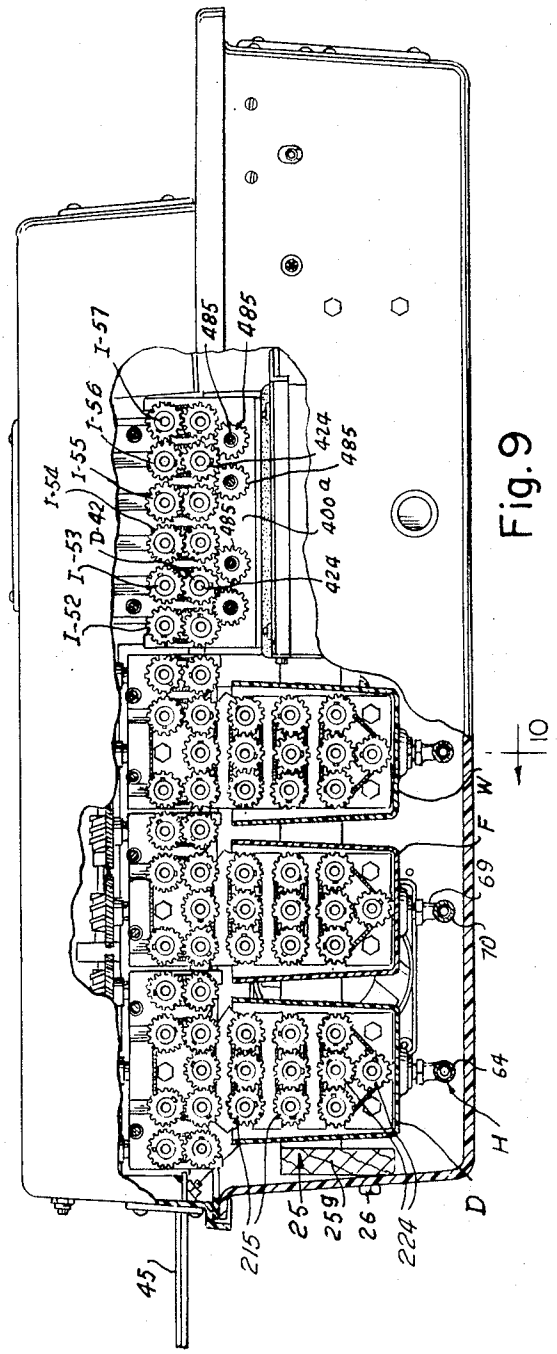


Fig. 9

INVENTOR
Michael N. Foster
BY
Estastings Ackley
ATTORNEY

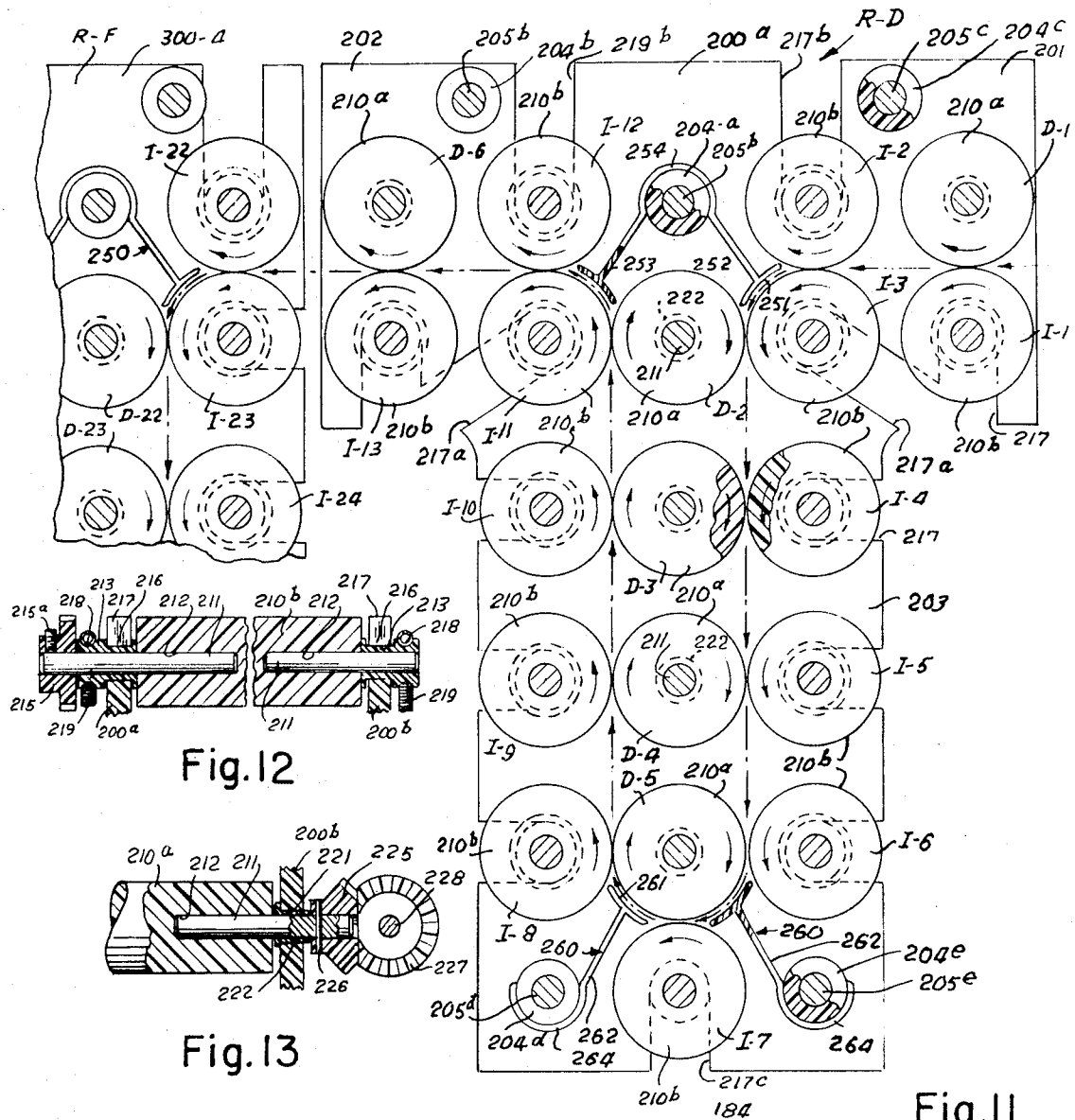


Fig.12

Fig.13

Fig.11

Fig.10

INVENTOR
Michael N. Foster
BY
Fastings Ackley
ATTORNEY

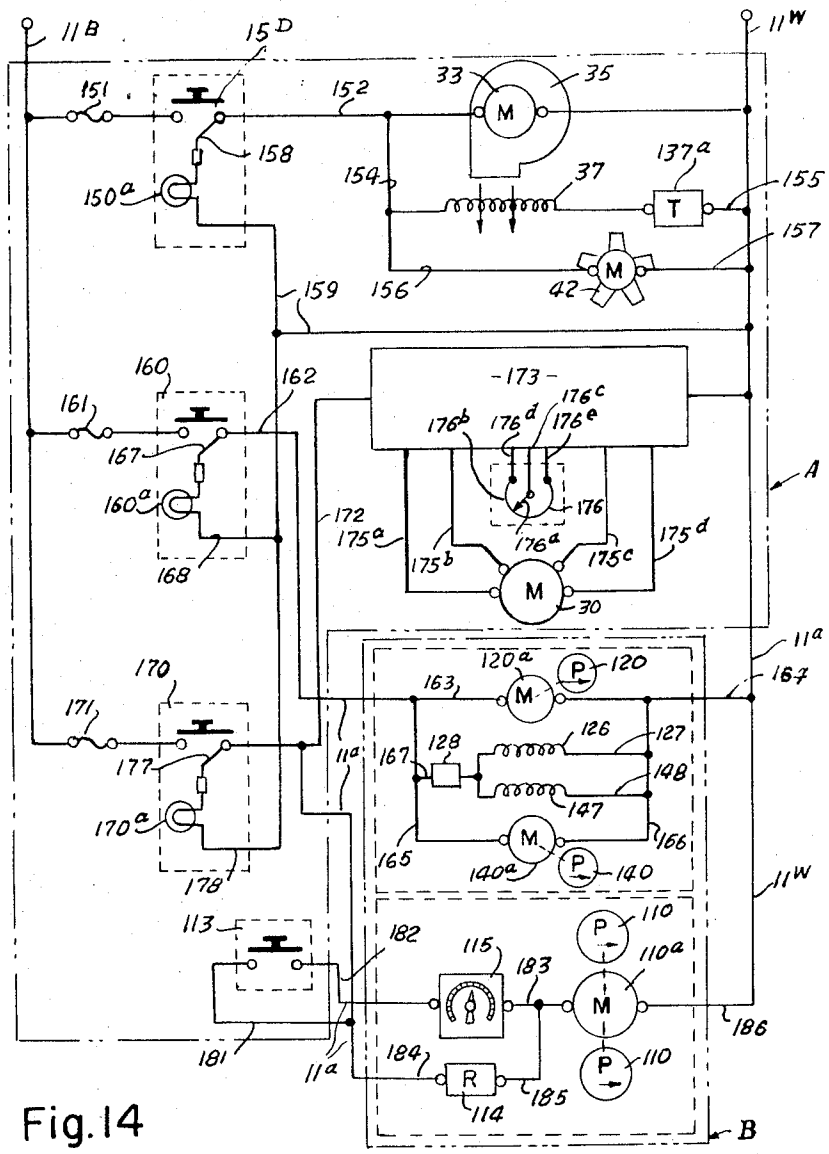


Fig. 14

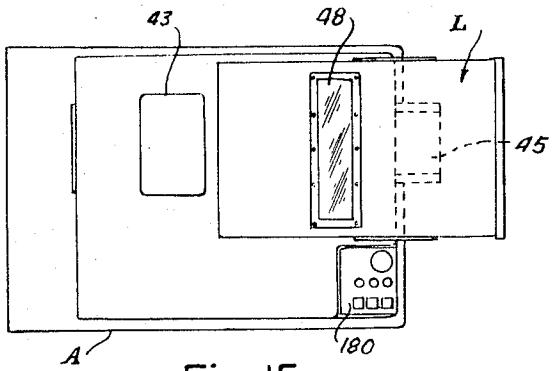


Fig. 15

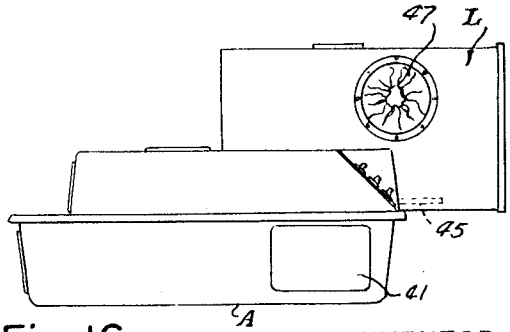


Fig. 16

INVENTOR
Michael N. Foster
BY
Eastman, Ackley
ATTORNEY

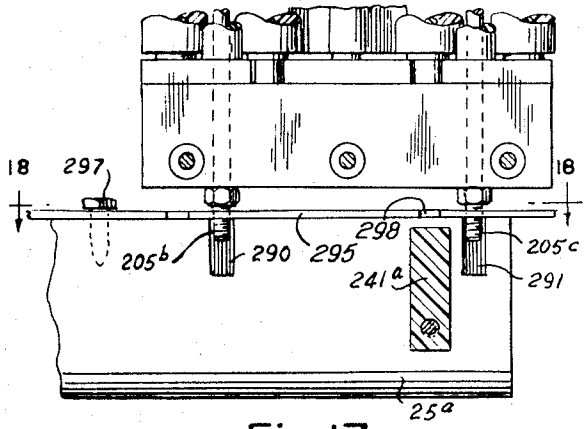


Fig.17

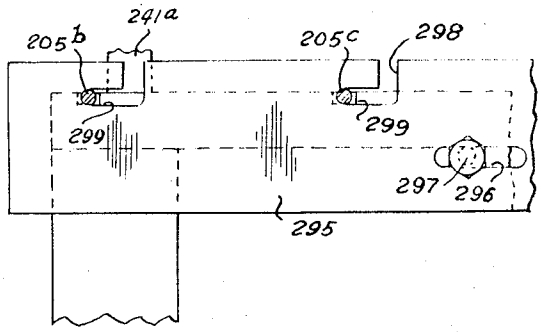


Fig.18

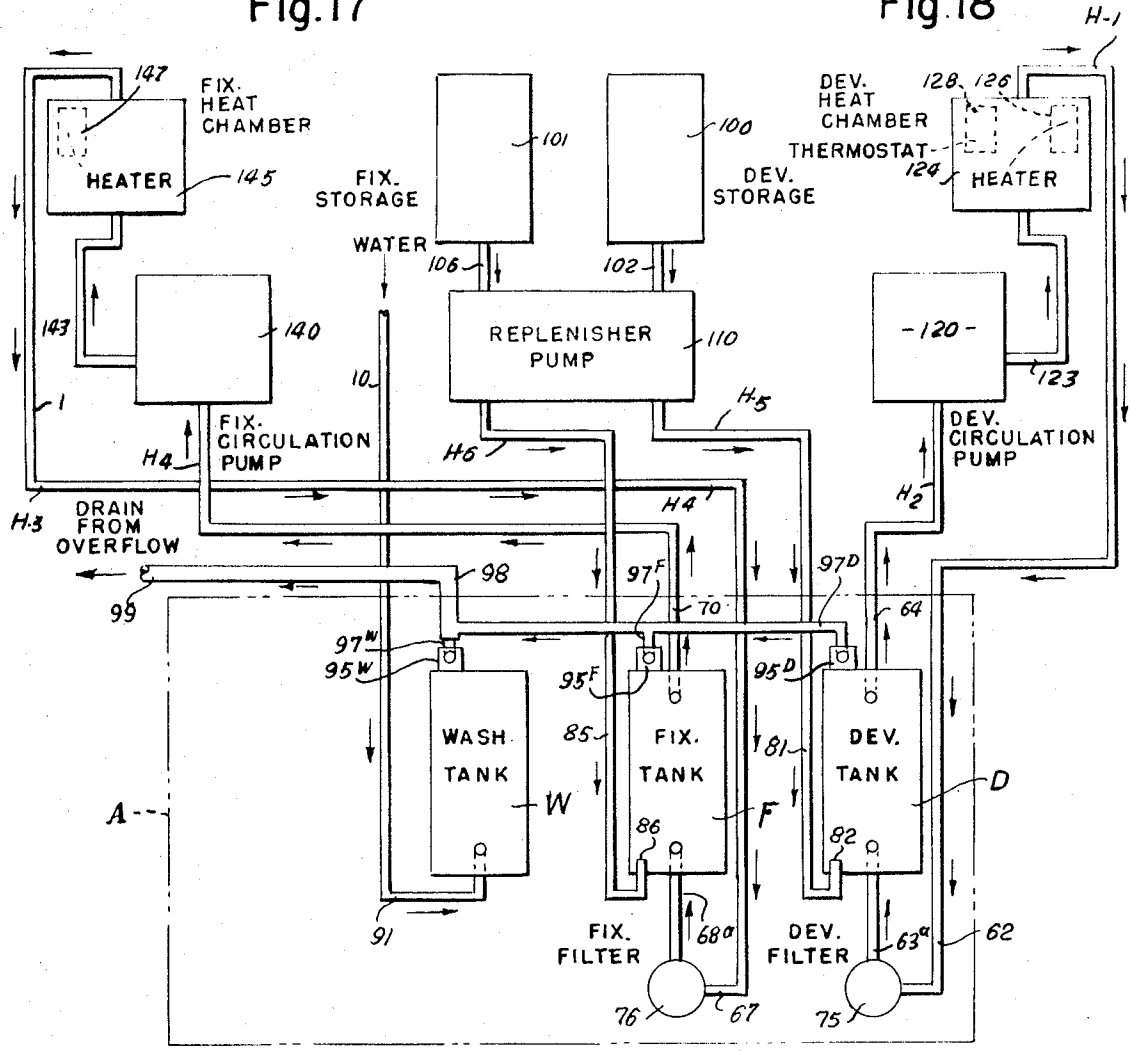


Fig.19

INVENTOR
Michael N. Foster
BY
Cressingtons Ackley
ATTORNEY

AUTOMATIC FILM PROCESSING SYSTEM AND APPARATUS FOR X-RAY FILM AND THE LIKE

This invention relates to processing apparatus for processing flexible film requiring chemical treatment, such as for developing, fixing, washing and drying cut X-ray film, more particularly dental X-ray film.

It is an object of the invention to provide an integrated processing system and apparatus for processing film from dry-to-dry condition automatically.

An important object of the invention is to provide an automatic film processing apparatus wherein the film transport components are modular and may be removed in modules from the several tank sections for cleaning, repair or adjustment of the transport system, and for cleaning or repair of the treating system or tanks.

Still another object of the invention is to provide a simple automatic film processing apparatus of the character described which is portable and which is economical and adapted for use in small offices as well as in larger clinics.

A particular object of the invention is to provide an improved film transport system wherein all film contacting elements are of non-corrosive material and wherein the cut film is directed through the system in a continuous predetermined path provided by means of a plurality of cooperating rollers and turning guides.

A further object of the invention is to provide a system wherein the transport sections are disposed in modules, for mounting in a developer tank, one for mounting in a fixer tank, and one for mounting in a washing tank, and wherein a drying conveyor is provided as a module likewise separately removable from the housing of the machine.

A further important object of the invention is to provide a film developing apparatus of the character set forth wherein the chemicals and the pumps for supplying and circulating the chemical, the heaters for heating the chemicals, and the replenishing mechanism, is contained within a separate housing connected to the film treating chamber by flexible flow conduits, to prevent the fumes from the chemicals acting on the pumps, motors and chemical heating elements, and their control elements.

Still another object of the invention is to provide a method and means for automatically picking up cut film segments or sections by a film transport system, conveying the cut film sections successively through the necessary tanks of developing and fixing solutions and washing water, and through a dryer, then automatically discharging the dry developed, fixed and washed film from the machine.

A further particularly important object of the invention is to provide in a film processing apparatus of the character set forth a transport system in which the film sections are moved through the apparatus by a succession of pairs of rollers arranged in modules, and wherein the rollers of each section are easily and readily removable from the supporting frame therefor for replacement, cleaning or the like.

Still another object of the invention is to provide a film processing apparatus of the character set forth wherein all parts which are exposed to chemicals in the film treating housing are formed of non-corrosive plastic material.

Still another object of the invention is to provide a drive for the rolls of the film transport system which

positively actuates each of the rolls throughout the system whereby damage to the film being transported by the transport system is avoided.

Still another object of the invention is to provide a film processing apparatus of the character described which has a daylight loading attachment whereby the device may be operated in an ordinary lighted room and it is not necessary that the film be processed in a dark room.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIG. 1 is a perspective view of the apparatus for processing film, showing the film handling and treating housing and a separate chemical and circulating pump system housing;

FIG. 2 is an enlarged elevational view of the control panel for the machine;

FIG. 3 is a perspective view similar to FIG. 1 showing the rear of the film processing apparatus;

FIG. 4 is a front view of the chemical supply and pump section of the apparatus with the cover removed;

FIG. 5 is a plan view of the film processing case or housing with the cover removed;

FIG. 6 is a longitudinal cross-sectional view taken on the line 6 — 6 of FIG. 5;

FIG. 7 is a longitudinal vertical sectional view taken on the line 7 — 7 of FIG. 5;

FIG. 8 is a longitudinal sectional view taken on the line 8 — 8 of FIG. 5;

FIG. 9 is a longitudinal side view, partly in section along the line 9 — 9 of FGG. 5, of the film processing chamber showing the roller drive assembly in elevation;

FIG. 10 is a vertical cross-sectional view taken on the line 10 — 10 of FIG. 9;

FIG. 11 is an enlarged sectional view, taken on the line 11 — 11 of FIG. 5, showing one film transport module;

FIG. 12 is a fragmentary sectional view taken longitudinally through one of the lateral or side rollers of the transport system;

FIG. 13 is a fragmentary sectional view of one end of one of the central drive rollers of one of the modules of the transport system;

FIG. 14 is a wiring diagram of the electrical system of the apparatus;

FIG. 15 is a top plan view of the apparatus showing a daylight loader attached thereto;

FIG. 16 is a side elevation of the film treating housing and daylight loader combination of FIG. 15;

FIG. 17 is an enlarged fragmentary sectional view showing the manner in which the transport modules are supported in the housing;

FIG. 18 is a view taken of the line 18 — 18 of FIG. 17; and,

FIG. 19 is a fluid circulation diagram of the system and apparatus.

In the drawings, FIGS. 1 and 3, is shown a film processing device constructed in accordance with the invention, which includes a film processing cabinet or case A and a separate chemical container or housing B. A hot and cold water mixing valve V from a suitable source of water supply S is connected to the processing cabinet A by a hose 10 and a source of electric power is connected to the cabinet by a conductor 11. The film

processing case A and chemical housing B may be mounted on a stand T, so as to be portable. Various chemical conductor hoses H extend from the chemical container or housing B to the film processing case A, each being connected thereto in a manner which will be hereinafter more fully described. In addition, an electrical conductor cord **11***a* extends from the film processing case A to the chemical housing B for supplying the various components in the chemical housing with electric power for operation, from the source of power to which the conductor **11** is connected.

The film processing case A comprises a hollow substantially rectangular base **20** and a cover **21**, each made of a plastic material such as "Fiberglass" glass fiber reinforced plastic material, or the like. The base has an outwardly projecting peripheral flange **22** at its upper end which provides a support, and an outwardly extending peripheral shoulder **23** on the lower edge of the cover **21**, below which a depending flange **24** extends, encloses the flange of the base in the cover. A suitable inert elastomeric seal **24***a* is secured, as by cementing, adhesives or the like, to the upper surface of the outwardly projecting flange **22** of the base and supports the shoulder **23** of the cover to form a seal with and a soft support for the cover.

Within the base **20** are located a developer tank D, a fixer tank F, a wash-water tank W, and a drier plenum P, all supported on a plastic-coated wooden frame **25** secured as by stainless steel bolts **26** to the upstanding end and side walls at one end and along one side of the base **20** and having supporting legs **27** at the other end resting on the bottom of the base and extending upwardly therefrom to carry a horizontal support **28** which is also bolted by stainless steel bolts **29** to the opposite end wall of the case base, and which supports a drive motor **30** having a reduction gear box **31** connected therewith for driving the film moving roller drive or conveyor systems, as will be hereinafter more fully described. A motor **33** supported by brackets **34** drives a blower fan **35**, which is connected by a flexible hose **36** to the plenum P, for blowing air over heating coils **37** in the plenum to provide a hot air drying section for the film being processed. The air is exhausted outwardly from the top of the plenum, after passing the conveyor roller system, through an exhaust conduit **38** which extends downwardly to an exhaust opening **39** in the side of the base **20**. A louvered air intake **40** is provided in the film delivery end wall of the case for entry of air drawn through the fan **35** and blown into the drier plenum. A plastic cover plate **27a** covers the drive motor, blower and other parts in this end portion of the base.

A further louver covered inlet **41** for air into the chamber is provided in the side wall of the base and a cooling fan **42** draws air into the base through such inlet and blows it through the case over the tanks and plenum to cool the same, then outwardly through a louvered exhaust or outlet opening **43** in the top of the cover **21**.

Film segments to be processed are placed on an entrance feeding tray or plate **45** and slid into the case through a slot in the case. The film enters the several film roller conveyor modules between the rollers thereof, as shown in FIG. **11**, and progresses through the processing tanks and drying plenum in the case, being moved by means of the film roller conveyor modules to exit in a completely processed dry condition through a delivery chute **46** at the opposite end of the cover. The apparatus, therefore, processes the film in a continuous dry-to-dry cycle, so that the exposed film enters the entrance feeding table or chute **45** in a dry state, passes through the several processing tanks in a wet state, enters the drying chamber or plenum where it is dried, and then comes out the film exit box or chute **46** dried and ready for viewing or use.

It is readily apparent that a day-light loader L, as shown schematically in FIGS. **15** and **16**, may be used in the usual and well known manner to insert the exposed film into the case through the inlet feeding tray or plate **45**. Openings with cuffs **47** are disposed on each side of the loader and a filter glass viewing window **38** is provided in the top of the loader for use by the operator in inserting the exposed film through the loader L into the loading chute **45**. The entire apparatus is, therefore, adapted for use outside a dark room, since the entire film processing equipment is contained within the Fiberglass case where it is not exposed to damaging light during the processing of the film.

After the exposed film has been placed on the entrance feeding tray **45** and inserted through the inlet slot into the conveyor modules, it progresses between the rollers of the roller conveyor systems through the developer tank D, out of the developer tank D into the fixer tank F, out of the fixer tank F into the wash-water tank W, and out of the wash-water tank W into the dryer plenum P. From the drier plenum, the film is conveyed to the plastic delivery chute **46** where it is delivered in the dry state.

The tanks and roller conveyor modules are supported by the frame **25**, which is formed in two laterally spaced side sections **25***a* and **25***b* as will best be seen in FIG. **10**, each side having a lower horizontal runner or support member **25***c* and **25***d*, respectively, and an upper horizontal runner or support member **25***e* and **25***f*, respectively. The end cross member **25***g* is secured by the bolts **26** to the entrance end wall of the base member of the case. The upright **25***h* at the opposite end of the case is supported on the bottom of the case base and extends upwardly therefrom, as best shown in FIG. **8**.

The developer, fixer and wash tanks are each substantially rectangular in configuration, and each has a pair of transverse grooves **51** and **54** formed on opposite sides thereof for receiving the longitudinal runners **25***c* and **25***d*. The groove **51** for receiving the horizontal support runner **25***c* is formed between a pair of transverse bulges or protuberances **52** and **53** on one side of each of the tanks and the groove **54** on the opposite side of the case for receiving the support runner **25***d* is formed by a pair of bulges or protuberances **55** and **56** in the opposite side of each of the tanks. The tanks will therefore be completely supported by the horizontal runners **25***c* and **25***d* of the frame **25**.

The developer tank D has a chemical fluid inlet fitting **60** and a similar outlet fitting **61** connected in its bottom, whereby developing fluid may be pumped into and circulated into and out of the tank, as will be explained. The developer tank inlet fitting is connected by a tube **63***a* to a filter **75**, and a conductor tube **62** leads from the filter to a fitting **63** secured in the sidewall of the base. The fitting **63** is also connected to the developer supply hose H-1 from the chemical container B. Similarly, the outlet fitting **61** is connected by means of a hose or tube **64** with a fitting **65** in the wall of the

base which is connected to a developer return tube H-2 leading to the chemical container B. The fixer tank has an inlet fitting 66 connected to its bottom and connected by a conductor tube 68*a* to a filter 76, and a conductor tube 67 leads from the filter 76 to a fitting 68 on the side of the case base. The fitting 68 is also connected to a flexible fixer supply conductor tube H-3 leading to the chemical container B. A return or outlet fitting 69 is provided in the bottom of the fixer tank and is connected to a return tube 70 which leads to a fitting 71 in the side of the base, and this fitting is connected to a fixer return conductor hose 11-4 leading to the chemical container. Thus, each of the inlets into the developer tank and the fixer tank is connected to a filter, so that developer fluid supplied from the chemical container through the developer supply conductor H-1 to the fitting 63 passes through the tube 62 to the developer filter 75, thence from the filter 75 through the tube 63a to the inlet fitting 60 and into the developer tank. Similarly, the fixer supply tube H-3 from the chemical container B leads to the fitting 68 and through the supply tube 67 to the fixer filter 76 from which the fixer is conducted through the inlet tube 68*a* to the inlet fitting 66 and into the fixer tank. Thus, it is assured that clean, pure developer is supplied to the developer tank D and clean fixer to the fixer tank at all times.

A developer replenisher fitting 80 in the side wall of the base 20 is connected by the tube H-5 to the chemical container B for supplying new developer chemical to the developer tank D. A tube or conductor 81 leads from the fitting 80 to a hook fitting 82 disposed over the upper end of the developer tank through which additional new chemical developer is supplied to the tank as needed. Similarly, a fixer replenisher fitting 84 is provided in the side wall of the case and receives fixer chemical from the supply conduit or tube H-6, and a tube 85 leads from the fitting 84 to a hook type or J-type fitting 86 which hooks over the upper end of the fixer tank side wall and delivers a new supply of fixer chemical in the fixer tank F when needed.

A water supply fitting 90 in the side wall of the case has the water hose 10 connected thereto for conducting water from the mixing valve V to the supply fitting 90, from which the water is conducted by means of a conductor tube 91 to an inlet fitting 92 in the bottom of the wash water tank W for continuously supplying fresh wash water to the wash water tank. An exhaust drain trap 95-W is formed in the upper side wall of the wash water tank, and a drain fitting 96 is connected to the bottom of the trap and leads downwardly through a drain conductor 97-W to an exhaust or outlet fitting 98 in the side wall of the case base to which a drain hose 99 may be connected for disposing of the water to a sewer or other drain in the building.

Similar exhaust or drain traps 95-D and 95-F are formed in the upper end of a side wall of the developer tank D and the fixer tank F, and drain conductors 97-D and 97-F lead to the outlet fitting 98, whereby excess fluids, the developer and fixer tanks may overflow into the drain traps 95-D and 95-F, respectively, and flow through the appropriate drain conductors to outlet 98 and drain hose 99.

It will thus be seen that each of the developing tank D and the fixing tank F is provided with a circulation system for circulating and filtering the developing chemicals and the fixing chemicals, respectively, in those tanks. Also, it will be seen that replenishing conductors have been provided for the developer tank and for the fixer tank to add new chemicals to the tanks as needed, and that excess fluids may overflow into the drain traps and then to the sewer or other outlet, as will be hereinafter more fully explained. Also, it will be seen that the water for the wash tank W is supplied continuously from the mixing valve V to the wash water tank, and that the water in the tank will drain outwardly therefrom through the overflow trap at the upper end of the tank from which it is conducted to a drain. Thus, a continuously circulated and a continuously replenished supply of wash water is maintained in the wash water tank. Also, a continuously circulated supply of developer and fixer chemicals is maintained in their respective tanks, each of which can be supplied with additional fresh or new chemicals as needed or desired.

For circulating the chemicals in each of the developer tank and the fixer tank and for replenishing the chemicals as they are used in the tanks, the separate chemical container B is provided. The conainer includes a fixer storage tank 100 secured to one end of the housing for the container B and a developer storage tank 101 secured to the opposite end of the housing. A conduit 102 leads from a fitting 103 in the lower portion of the fixer tank 100 into the container case B and to a replenisher pump 110, which may be a variable stroke dual diaphragm metering pump of the well known type, such as is manufactured by Gorman-Rupp. As shown, the output of the metering pump is variable between a volume of 0 to 100 ccs per minute from each of the two separate diaphragm pumps. The conductor 102 from the fixer storage tank is connected by a fitting shown in dotted lines at 104 on the pump, through which the fixer chemicals are directed into the pump and thence outwardly through an outlet or delivery fitting 105 to the conductor tube H-6 which leads to the fitting 84 on the processing case base 20. Similary, a conductor tube 106 is connected to a fitting 107 in the bottom of the developer storage tank 101 and leads inwardly into the chemical case B and to the input fitting 108 for the opposite diaphragm pump of the dual diaphragm metering pump 110, where the developer fluid passes through the pump and is forced outwardly through an outlet fitting 109 communicating with the developer replenisher supply tube H-5 which leads to the fitting 80 on the base of the processing case A and thence into the developer tank therein.

The motor for the dual diaphragm metering pump 110 drives both diaphragms from a common shaft in the well known manner, and the length of the stroke transmitted by the shaft to the diaphragm is controlled by means of adjusting screws 111 for the fixer diaphragm pump and adjusting screws 112 for the developer diaphragm pump so that the diaphragms of the pumps may be adjusted to deliver a predetermined desired amount of chemical to the tank. The pump 110 is energized to supply a fresh or additional fresh supply of chemicals to the processing tanks each time a film segment is inserted into the machine. A push button switch 113 on the entrant end of the cover 21 of the case A is pushed as the film segment is inserted into the machine through the tray 45 to energize a control relay 114 which closes a circuit and starts a variable elapsed time re-set timer 115 having a microswitch 116, for controlling the supply of power to the motor for the pump 110, to operate the pump 110 for a predeter-

mined period of time to supply a predetermined amount of chemical to the processing tanks. The quantity of chemical delivered by the replenishing pump is therefore variable in two manners, by varying the stroke of the pumps and by varying the time that the pumps are operated. Thus, a rather wide range of control of volume of chemicals injected into the processing tanks can be effected by varying the time of operation of the pump motor and by varying the stroke of the pumps. It will also be seen that the stroke of each pump is adjustable separately from that of the other pump to vary the amount of each chemical which is injected during the period of time the pumps are in operation by the motor as controlled by the timer.

The developer tank and fixer tank are each filled manually with the desired quantity of chemical at the start of the operation of the machine. Chemicals injected into the tanks after the machine has been placed in operation will cause a substantially corresponding amount of used chemical to flow outwardly through the overflow drain **95-D** for the developer tank and the drain **95-F** for the fixer tank, and such overflow fluids will flow downwardly through the drains **97-D** and **97-F** to the common disposal outlet drain **98** and the hose **99** to the sewer or other drain for disposal. After the tanks have been filled with chemicals, the chemical is circulated to agitate the chemicals in the tanks to maintain a substantially uniform concentration of chemicals throughout the tanks, and to maintain a substantially constant temperature in the tanks at all times. A developer circulating pump **120** of the motor driven vane type, driven by an electric motor **120***a*, has an intake fitting **121** which is connected to the return tube H-2 from the processing case base **20**, which is connected to the return hose or conduit H-2 from the developer tank in the processing case A. The conduit connects to the intake of the pump **120** where the fluid is then circulated outwardly through an output conduit fitting **122** through a hose **123** to a fitting at the lower end of a heating tank or chamber **124** which has an outlet fitting **125** at its upper end connected with the supply hose H-1 leading to the processing chamber A and to the developer tank therein. Within the heating chamber **124** is a heating member, such as a heating rod of any well known type having an inert or stainless steel covering, supported in the tube by a fitting **126** and having electrical energy supply wires **127** connected thereto. A thermostat **128** is supported in the tank by a fitting **129** and has an adjustment **130** at its upper end for setting the temperature at which the developing chemicals are to be maintained. Conductor leads **131** lead from the thermostat to the supply of power through the conductors **127** to the heater for controlling the operation of the heater.

Similarly, a vane type power driven fixer circulating pump **140**, driven by an electric motor **140a**, is connected to an input conductor **141** which is connected to the fixer return line H-4 from the processing housing or case A and the fixer from the tank F in the housing travels through the return hose H-4 to the input conductor **141** and into the vane type circulating pump where it is forced outwardly through an outlet **142** to a conductor **143** leading to a fitting **144** in the bottom of a heating tank or chamber **145** for heating the fixer chemical. A fitting **146** is connected to the upper end of the tank and to the fixer supply hose conductor H-3 leading to the processing chamber or case A and into the fixer tank therein. The temperature of the chemicals in the fixer heating chamber **145** is controlled by the thermostat **128** in the developer heating chamber.

The heating element **147** in the fixer heating tank and the heating element **126** in the developer heating tank are connected in parallel and the thermostat **128** is connected in series with the supply to those heating elements, so that each of the elements is energized to maintain a temperature controlled by the thermostat in the developer heating tank and no thermostat is necessary in the fixer tank. The temperature of the developer fluid is more critical than that of the fixer, hence the temperature is controlled at the developer heating tank.

The electrical conductor **11**a is connected to a fitting **11***b* on the rear wall of the chemical container B and suitable electrical conductors **11***c* are connected with a connector bar or strap **11***d* to which all of the electrical elements in the chemical container B are connected for energization from the source of electrical power.

It will thus be seen that the chemical container B contains a circulation pump for developer fluid for circulating the developer fluid through a heating chamber controlled by the thermostat and constantly stirring the chemicals present in the developer tank D in the processing chamber A. It will also be seen that the fixer chemical in the fixer tank F in the processing chamber A is constantly circulated by means of a circulating pump **140** connected with a heating tank **145**, which is also thermostatically controlled to produce a desired temperature in the fixer fluid. Thus, the chemicals are constantly circulated in the system to maintain a uniform density or concentration of chemicals in the developer tank and in the fixer tank and to maintain the chemicals at a predetermined desired temperature controlled by the more sensitive chemical, the developer fluid. Also, it will be seen that additional amounts of chemicals are supplied to the developer tank and to the fixer tank by means of a variable dual diaphragm replenishing pump supplying fresh chemicals from a storage tank for such chemicals through the pump into the respective processing tanks in the processing chamber or case A, and that the added chemical in the tanks will displace the used chemical therefrom through the drains out of the container into a sewer or other place of disposal.

It will particularly be noted that the circulating pumps, the replenishing pumps, the controls for the pumps, the heating elements and the adjustment for the replenishing pumps, all of which may be subject to damage by chemical fumes or liquids, are contained within the separate chemical container B and are not subjected to the fumes present in the film processing chamber or case A. Thus, the critical controls for circulating the fluids and for replenishing the fluids in the chemicla treating tanks are relatively free from damage due to chemical fumes or spilled liquids.

A schematic illustration of the flow of chemicals in the system is shown in FIG. **19**, wherein the processing tank A is shown is dotted lines as enclosing the developer tank D, the fixer tank F and the wash water tank W. The developer storage tank **100** is connected by the conductor **102** to the replenishing pump **110** from which it is conducted by the developer replensher hose H-5 through the hook fitting **82** to the developer tank D. The fixer chemical from the fixer storage tank **101** is conducted by means of the conductor **106** to the re-

plenisher pump 110 from which it is directed through the fixer replenisher hose or conductor H-6 through the hook fitting 86 to the fixer tank F.

Chemicals in the developer tank are circulated therein by means of the developer circulating pump 120 which has its input connected with the return hose H-2 from the developer tank D in the processing chamber or case and its output connected by means of the conductor 123 to the developer heating chamber 124 having the heater element 126 and the thermostat 128 mounted therein for controlling the temperature of the developer. From the developer heating chamber the conductor H-1 leads to the developer filter 75 through the conductor 62, and from the filter by the conductor 63a to the developer tank D.

Similarly, the fixer fluid in the fixer tank F is conducted from the tank by way of the fixer return hose H-4 to the fixer circulating pump 140 from which the fluid is circulated through the conductor 143 to the fixer heater chamber 145 having the heater element 148 therein for heating the developer to maintain a desired temperature. From the heating chamber 145 the heated fixer chemical is conducted by means of the fixer supply conductor H-3 and the conductor 67 to the fixer filter 76, and from the filter by way of the conductor 68*a* to the fixer tank to provide a circulation system for fixer in the tank F.

In the replenisher system, the drain 95-D at the upper end of the developer tank is connected with a drain 97-D, while the overflow drain or sump 95-F is connected by a drain 97-F, to a common drain 98 leading to the sewer through the conductor or hose 99.

The wash water tank is supplied with water through the supply pipe 10 and the conductor 91 leading to the wash water tank W. The overflow into the drain 95-W at the upper end of the tank flows through the drain 97-W to the common drain 98 and the hose 99 leading to the sewer or other place of disposal.

The electrical system for controlling the operating the apparatus is illustrated in the diagram of FIG. 14. The main power supply line 11, consisting of conductors 11*b* and 11*w*, supplies energy to the entire electrical system. One conductor 11b is connected through a fuse 151 with a push-on - push-off illuminated switch button 150, which is in turn connected by a conductor 152 to one side of the motor 33 for the drier blower 35 and the other side of the motor is connected with the conductor 11*w* by a conductor 153, whereby the motor is energized when the switch 150 is closed. In parallel with the motor, the heating element 37 is connected by means of a conductor 154 to the conductor 152 and in series to the thermostat 137*a* having its probe 137*b* exposed in the dryer plenum P, for controlling the temperature of the air in the plenum P. A conductor 155 connects the thermostat with the conductor 11*w*. The ventilating or cooling fan 42 for the processing case A is connected by means of a conductor 156 to the conductor 154 and by a conductor 157 to the main line conductor 11*w*, so that when the switch 150 is closed, the motor is energized to drive the heater blower fan, the heater 37 is energized to heat the plenum, controlled by the thermostat 137*a*, and the ventilating and cooling motor fan 42 is energized, all simultaneously. Thus, the drying plenum P is heated by the element 37, the interior of the case on the outside of the plenum is ventilated and cooled by the ventilating and cooling fan 42, and the cooling fan 42 is turned on each time the heating element 37 is turned on or energized.

The signal or indicator light 150*a* in the switch 150 is connected by a conductor 158 to the conductor 152 and the conductor 159 to the main conductor 11*w* so that the signal light remains on as long as the switch is on, to indicate that the circuit is closed and the heater, blower motor and ventilating fans are running. The fuse 151 is a signaling fuse which indicates when it has been burned out to call attention of the operator to that fact for replacement of the fuse.

A second push-on - push-off illuminated switch 160 is connected through a fuse 161 with the supply line 11*b* and through a conductor 162 with the connecting conductor 11*a* which leads to a conductor 163 connected to the motor 120*a* of the developer circulating pump 120. The other side of the motor is connected by a conductor 164 with the main supply conductor 11*w* through the connecting conductor 11*a*. The motor 140*a* of the fixer circulating pump 140 is also connected by a conductor 165 to the conductor 163 and by conductor 166 to the conductor 164, so that the two motors are connected in parallel and are both energized when the switch 160 is closed. Also connected in parallel to the conductor 165 by a conductor 167 is the thermostat 128 which is connected by means of a conductor 168 to each of the heating elements 126 and 147 for the developer heating chamber 124 and the fixer heating chanber 145, respectively. The heating elements are connected by means of the conductors 127 and 148 to the conductor 166 and are thus connected in parallel with the motors for driving the pumps. Thus, the circulating systems for both developer and fixer fluids are controlled by the switch 160. The switch signal light 160*a* is connected by a conductor 167 to the conductor 162 and by a conductor 168 to the conductor 159 to indicate when the switch is closed and the circuit to the circulating pumps is operative. The fuse 161 is an indicating fuse which signals its failure so the operator can replace it.

A third illuminated push-on - push-off switch 170 is connected to the conductor 11*b* through a fuse 171 and by a conductor 172 to an electronic solid state motor speed control and AC-DC converter 173 which is connected by a conductor 174 to the main power supply line 11*w*. The DC main drive motor 30 is connected by conductors 175*a*, 175*b*, 175*c* and 175*d* with the converter control 173. The rheostat for controlling the speed of the motor is indicated at 176 and includes a variable potentiometer for adjusting the speed of the motor from 0 to 100 percent of its capacity. The movable contact 176*a* moves along the usual resistance 176*b* betweeen the two conductors 176*d* and 176*e* in the usual manner for controlling the power supplied to the motor and thus controlling the speed of the motor.

The switch signal light 170*a* is connected by a conductor 177 to the conductor 172 and by a conductor 178 to the conductor 159 and signals when the switch is closed the the main drive motor is operative. The fuse 171 is of the same signaling type as the fuses 151 and 161 previously described and functions to signal its failure, when such occurs so the operator can replace it and place the system back in operation or repair any electrical misfunction in the system.

The replenisher switch 113 is connected by means of a conductor 181 to the electrical connector conductor cord 11*a* on one side and by means of a conductor 182

which also is a part of the connector conductor 11*a* to the variable timer 115, and to the relay 114 having the contacts 116 therein, which is connected by a conductor 183 to the motor 110*a* of the proportioning replenishing pump 110 for driving the dual pumps thereof. A conductor 184 connects the relay 114 to the connector conductor 11*a* which is connected to the conductor 181 which leads from the switch 113, and a conductor 185 from the relay leads to the conductor 183 from the timer switch to the motor 110*a*, so that when the relay is energized by closing the switch 113 the timer 115 is energized and the motor 110*a* is energized to drive the pumps 110.

When the timer has mover through the prescribed time interval, the contacts 116 of the timer are opened to break the circuit and open the relay 114 and stop the replenisher pump motor 110*a* and the pumps 110 from circulating. The motor 110*a* is connected by conductor 186 to the connecter conductor 11*a* and thence to supply line 11*w*.

The swtches 150, 160 and 170, the signaling fuses 151, 161 and 171, and the speed control potentiometer 176 are all mounted on an inclined control panel 180 mounted on the upper entrant end of the cover 21. The main supply line 11 is connected to the switches, fuses, and potentiometer, mounted under the instrument panel 180, through a cover box 182 which is secured, as by bolt 183, to the rear of the panel and has a seal 184 around its periphery for sealing against entry of corrosive chemical fumes or the like through the cover 182 to act on the switches, etc. A conductor 11*c* comprises the power supply line 11 consisting of the conductors 11*w* and 11*b*, and also all conductors from the switches and potentiometers and other controls on the panel 180, leads back to a bus 185 at the outlet end of the base 20 adjacent the main drive motor 30 and the electronic solid state motor speed control and AC-DC converter 173, and from the bus 185 to the connector cable 11*a* which leads to the auxiliary or chemical container B.

The cover 21 is hinged as at 186 and 187 to the base 20, the hinges being secured by rivets 188 to the cover and to the base 20. The chemical container B has cover plates 189 and 190 which are secured by screws 191 to the face of the container to enclose the same.

From the foregoing, it will be seen that the electrical controls are mounted on the panel 180 accessible to the operator of the device who will be standing near the entrance or feeding chute 45 for inserting film into the system for processing therein. All controls are handy to the operator for controlling operation of the machine. The replenisher button 113 is exposed within the daylight loader L for actuation when the film segments are inserted through the loading chute 45 and all other controls are readily accessible exteriorly of the loader.

A particularly important feature of the invention is the modular roller conveyor systems for the processing system. A separate roller conveyor module is provided for conveying the film through each of the tanks and the dryer plenum. The developer conveyor roller module R-D is separate from the conveyor roller module R-F for conveying the film through the fixer tank. Similarly, the roller conveyor module R-W is separate from the developer module R-D and the fixer module R-F, and from a separate drier roller conveyor module R-P which is mounted in the dryer plenum. Each of the roller conveyor modules may be lifted separately out of the case base, out of the tanks or plenum for drying, cleaning, repairing or adjusting as desired. Also while the roller conveyor modules are removed from the tanks the tanks may be cleaned and chemicals removed and replaced, if desired.

The roller conveyor module R-D for the developer tank D is shown in FIG. 11, and includes a frame 200 having two spaced side frame members 200*a* and 200*b*, each is substantially the shape of a T having transverse arms 201 and 202 extending laterally from the stem 203. The side members 200*a* and 200*b*, as shown in FIG. 5, are spaced from each other by spacer members 204*a*, 204*b*, 204*c*, 204*d* and 204*e*, all made of nylon or other inert, non-corrosive, non-conductive material. Stainless steel or nylon bolts 205*a*, 205*b*, 205*c*, 205*d* and 205*e* extend through openings in the side frame members 200*a* and 200*b* and are threaded into axial threaded openings in the opposite ends of each of the spacer rods 204*a* through 204*e*, inclusive, and holds the side frame members in rigid parallel spaced relationship.

A plurality of pairs of cylindrical drive rollers, which are made of phenolic plastic material, nylon, or other similar rigid suitable inert non-conductive, non-corrosive material, preferably providing a rigid non-resilient surface, are mounted on stub shafts 211 of stainless steel pressed into axial apertures in each end thereof and have nylon bearing bushings 213 on their projecting ends abutting the ends of the phenolic rollers, as shown in FIGS. 12 and 13.

Shown in FIG. 12 is an idler follower roller while a drive roller is shown in FIG. 13. Each of the rollers is constructed of the same material and has the stainless steel shaft 211 pressed into the axial apertures 212 in its opposite ends. The follower rollers have the bushings 213 on each of the projecting shafts 211 abutting the roller cylinder 210 at its opposite ends. On one of the shafts 211 is mounted a spur gear 215 for driving the roller, as will be hereinafter more fully set forth. The spur gear 215 is secured on the shaft 211 by a set screw 215*a*. The bushings 213 have external annular bearing recesses 216 formed in their inner portions and these bearing recesses are engaged in slots, shown generally as 217 in FIG. 12, formed in the side plates 200*a* and 200*b* of the module for supporting the roller between the side plates. The recesses or slots 217 have semi-circular inner ends for limiting movement of the rollers and properly positioning the same with respect to each other and providing, with the bushing, a bearing for rotation of the roller in the frame. Outwardly from the annular recesses 216 the bushings 213 are provided with semi-circular annular grooves 218 which are adapted to receive helical coil springs or garter springs 219, made of stainless steel or other suitable non-corrosive material, for biasing adjacent rollers toward each other as will be hereinafter more fully explained.

The drive roller 210*a* has the shaft 211 fitting in the aperture 212 extending outwardly through a thimble bushing or bearing 221 which is pressed into an aperture 222 formed in the side frame member 200*b* and a similar bushing or bearing 221 is mounted in an aperture 222 formed in axial alignment therewith in the side plate 200*a*, whereby the shaft is positively held in a fixed position between the two side plates for rotation about the axis of the shafts 211 at its opposite ends. A beveled gear 225 is secured by pins 226 on the shaft

211 at one end of the drive roller and meshes with a complementary beveled gear 227 carried on a vertical shaft 228 carried by the frame 200*b*.

The shaft 211 at the opposite end of the drive roller extends through a bearing bushing 221 in the side frame 200*a* and projects outwardly therefrom a sufficient distance to receive a spur drive gear 224 which is pinned or secured by a set screw 224*a* to the outer end of the shaft 211 in vertical alignment with the spur gears 215 of the driven rollers, so as to mesh therewith for driving the driven rollers (See FIG. 10). The drive roller 210*a* is thus held in position for rotation between the frame side plates 200*a* and 200*b* against longitudinal axial movement by the bushings or bearings 221, and the beveled gear 221 at one end of the drive roller is held in meshed engagement with the beveled gear 227 on the vertical shaft 228 while the sprocket gear 224 at the opposite end of the drive roller is held in position to mesh with the spocket gears 215 on the driven rollers 210*b*.

The lower end of the shaft 228 fits into a bearing bushing 229 similar to the bushing 221 supported by a laterally extending supporting member 230 secured by adhesive or in any other suitable manner to the lower end of the side frame 200*b*. A similar laterally projecting supporting member 231 is secured to the upper end of the side frame member 200*b* by means of the transverse bolts 205*a* and 205*b* which extend through suitable openings in the supporting member and have nuts 232 on their threaded outer ends for securely clamping the supporting member 231 to the side frame. A bearing bushing 233 is pressed into a vertical aperture in the side frame vertically aligned with the bearing bushing 229 therebelow, and the shaft 228 extends upwardly through the bushing 233 to a point thereabove and has a pinion wheel gear 235 secured thereon by a set screw or cross pin 236 or any other suitable means, whereby the shaft 228 may be rotated by the pinion gear when the pinion gear is rotated. Each of the beveled gears 227 is secured by set screws or pins to the shaft 228 in position to engage the corresponding beveled gear 225 on the shafts 211 of the drive rollers.

The hub of the pinion wheel gear 235 rests upon the upper flanged end of the bearing bushing 233 and supports the shaft 228 in position for the beveled gears 225 and 227 to mesh as shown in FIG. 10. A spacer bushing 237 is mounted on the shaft 228 between the hub of the upper beveled gear 227 and the underside of the lateral supporting member 231 to prevent the shaft from riding axially upwardly as the beveled gears mesh and are driven by the pinion wheel gear 235. A plurality of worm gears 240 are secured on a main drive shaft 241 which is supported in bearings 241*a* carried by the frame side section 25*a* and is driven by a chain and sprocket drive consisting of an upper stainless steel sprocket 242 on the drive shaft 241, a stainless steel chain 243 extending downwardly from the upper sprocket 242 to a lower stainless steel drive sprocket 244 on the drive shaft of the reduction gear drive 31 driven by the main drive motor 30. Thus, when the main drive motor is actuated, the reduction gear drive turns the lower sprocket gear 244 and drives the chain 243 to turn the upper sprocket gear 242 and rotate the drive shaft 241 to turn the worm gears 240 thereon for driving the pinion wheel gears 235, thus driving the shafts 228 and all the beveled gears fixed thereon. Thus, when the drive motor 30 is energized, all the vertical shafts 228 are rotated to drive all of the drive rollers having beveled gears meshed with the beveled gears on the vertical shafts.

The bearing bushings 213 at each end of each of the driven rollers 210*b* are slidable in the slots 217 in the frame 200*a* and 200*b*, and the slots extend radially inwardly toward the axis of the adjacent drive rollers 210*a* mounted in the frame. The slots 217*a* formed in the underside of the laterally projecting or transverse arms 201 and 202 of the frame members extend inwardly at an angle of approximately 45 degrees with the vertical and horizontal, and are directed equally between the axis of the upper central drive roller D-2 and the opposing idler roller I-2 in the slot 217*b* formed in the upper portion of the arm. Similarly, a slot 217 *c* formed in the lower end of the frame extends radially inwardly toward the lower drive roller D-5 so that the driven roller I-7 is movable toward and away from such lower drive roller. The driven rollers I-3 and I-11 in the angularly disposed slots 217*a* move inwardly to engage the upper central drive roller D-2 and the idler rollers I-2 and I-12, respectively, in the vertical downwardly extending slots 217*b* in the upper end of the arm frame. The helical coil tension springs 219 press the idler rollers toward the drive rollers in each case. As will be seen in FIG. 7 in the developer module R-D, the helical coil spring 219 mounted in the recesses 218 draws the idler roller I-2 toward the drive roller I-1. Four drive rollers I-3, I-4, I-5 and I-6 are mounted centrally of the vertical stem of the frame members 200*a* and 200*b* and are spaced apart vertically to dispose the peripheral portions of the rollers tangent to a vertical plane on either side of the rollers in positions in which the distance between such peripheral portion of adjacent pairs of rollers is less than the narrowest dimension of the film segments being processed, so that film moving through the conveyor module R-D will still be in engagement with one of the drive rollers when it is moved into engagement with the next subsequent roller. Idler rollers I-1 through I-13, inclusive, are disposed in the slots 217, 217*a*, 217*b* and 217*c* in the frame members and move radially toward the adjacent drive rollers. The helical coil spring 219 engaged in the grooves 218 in the bushings 213 on each end of the idler roller I-1 and in a similar recess 218 formed in bushings disposed on the projecting shafts 211 of the drive roller D-1 between the beveled gear 225 and the spur gear 224 and the bearing bushings 221, whereby the idler roller I-1 is drawn toward the drive roller D-1. The size of the bevel gear 225 on this drive roller D-1 and the spacing of the same from the side wall frame member 200*b* is such that the bushing may be interposed between the beveled gear and the bearing bushing 221. Thus, the idler roller I-1 is biased into engagement with the drive roller D-1 and the meshing of the sprocket gears 224 and 215 on the ends of the rollers causes the rolers to drive in exact unity of peripheral speed. The idler roller I-2 and the idler roller I-3, the idler roller I-11 and the idler roller I-12, are biased toward each other and toward the drive roller D-2 by a helical coil spring 219b which engages in the annular recesses 218 in the bushings 213 on the ends of the idler roller shafts. As will be seen in FIG. 7, the idler rollers I-3 and I-11 are drawn inwardly toward the drive roller D-2, while the idler rollers I-2 and I-12 are drawn toward the idler rollers I-3 and I-11, respectively. The spur gears 215 on the ends of the idler rollers I-2 and I-3 mesh with each other, as do the spur

gears on the idler rollers I-12 and I-11. The spur gears on the idler rollers I-3 and I-11 mesh with the spur gear 224 on the drive roller D-2 and are driven thereby, so the rollers all turn in exact unison.

In the same manner, the idler rollers I-4 and I-10 are biased toward the drive roller D-3 by the helical coil spring 219*c*, and the spur gears on the ends of these idler rollers mesh with the spur gear 224 on the end of the drive roller D-3 to cause the three rollers to turn in unison. Similarly, the idler rollers I-5 and I-9 are biased toward the drive roller D-4 by a spring 219*c*, and the spur gears on the idler rollers mesh with the spur gear on the drive roller to cause the rollers to move in unison. The idler rollers I-6, I-7 and I-8 are all biased radially inwardly toward the axis of the drive roller D-5 by a helical coil spring 219*d* which engages over the bushings 213 at each end of the idler rollers to bias the idler rollers toward each other and toward the drive roller D-5, so that the surfaces of the rollers contact and the spur gears 215 on the idler rollers engage and mesh with the spur gear 224 on the drive roller to cause all the rollers in this group to move as a unit. In addition, the transfer or cross-over rollers D-6 and I-13 are biased toward each other by a helical coil spring 219*a* which is engaged in bushings on the opposite ends of the idler roller and the drive roller in the same manner as the spring 219*a* of the entrance rollers B-1 and I-1, so that the idler roller I-13 is biased toward the drive roller D-6 to mesh the spur gear 215 on the idler roller with the spur gear 224 on the drive roller to cause those two rollers to move in unison. Each of the entrance drive roller D-1 and the cross-over or transfer drive roller D-6 is driven by a beveled gear 227*a* mounted on a stub shaft 228*a* and meshing with the beveled gear 225*a* on the drive rollers D-1 and D-6. A worm gear 240 drives the shaft 228*a* at the same speed that the shafts 228 are rotated and, since the beveled gears 225*a* and 227*a* are identical in size, the speed of rotation of the drive rollers D-1 and D-6 is the same as that of the other drive rollers. As will be seen in FIG. 11, the film segments will enter between the entrance rollers D-1 and I-1 and be moved along the path shown by broken lines and arrow heads, between the entrance rollers D-1 and I-1 to the rollers I-2 and I-3. The distance between the contacting surfaces of the rollers is less than the minimum dimension, width or length, of the film segment being processed, so that the film will move from one set of rollers to the other readily. After the film has entered between the rollers I-2 and I-3 it moves outwardly from therebetween to engage a concave guide surface 251 on a turn-around or guide member 250 having a pair of divergent arms 252 and 253 extending downwardly from a substantially semicircular central clamping portion 254. The turn-around is formed of polyvinyl chloride or other suitable inert plastic which is sufficiently rigid to hold its shape under the conditions of use set forth. The concave guide surface 255 on the arm 253 is identical to the concave surface 251 on the arm 252. The central clamping section 254 comprises a greater than a semi-circular configuration so that it will snap over the spacer rod 204*a* and be held securely in place thereon. The lateral length of the turn-around member is equal to the width of the rollers, so that the concave surfaces 251 and 255 overlie the cylindrical surface of the roller I-3 and the cylindrical surface of the roller I-11, respectively, as shown in FIG. 11, and are disposed closley adjacent the surfaces of the rollers so that the film passing between the rollers will engage the concave surface and be flexed about the roller I-3 to enter between the roller I-3 and the drive roller D-2 and pass downwardly therefrom between the idler roller I-4 and the drive roller D-3, the idler roller I-5 and the drive roller D-4, and between the idler roller I-6 and the drive roller D-5 to engage a concave guiding surface 261 of a single turn-around or guide member 260 having a hook shaped clamping member 264 on its end supporting the arm 262 in position to dispose the concave guide surface 261 closely adjacent the cylindrical surface of the drive roller D-5 for contacting film passing from between the idler roller I-6 and the drive roller D-5 and flexing the same around the drive roller D-5 to enter between the idler roller I-7 and the drive roller D-5. As the film passes from between the idler roller I-7 and the drive roller D-5, it engages the concave surface 261 an identical but oppositely disposed guide or turn-around member 260 having the hook clamping member 264 engaged around and gripping the spacer bar 204*d* for positioning the arm 262 of the turn-around member at a position to dispose the concave guide surface 261 to be engaged by the film passing from between the idler roller I-7 and the drive roller D-5 to flex the film about the exterior cylindrical surface of the drive roller D-5 to cause the film to enter between the idler roler I-8 and the drive roller D-5, to be moved upwardly therebetween. The film will then pass between the idler roller I-9 and the drive roller D-4, between the idler roller I-10 and the drive roller D-3, and between the idler roller I-11 and the drive roller D-2. As the film passes from between the idler roller I-11 and the drive roller D-2, it engages the concave guide surface 255 on the arm 253 of the turnaround member 250 and is flexed around the idler roller I-11 to enter between the idler roller I-11 and the idler roller I-12 and be moved thereby along the path of flow indicated by the broken lines and arrows to pass between the drive roller D-6 and the idler roller I-13, which comprises cross-over or transfer rollers from the developer roller conveyor module R-D to the idler rollers I-22 and I-23 of the fixer roller conveyor module R-F.

There are no entrance rollers on the fixer roller conveyor module R-F, since the cross-over transfer rollers D-6 and I-13 of the developer module R-D will feed the film between the idler rollers I-22 and I-23 for movement through the fixer roller conveyor module R-F in the same manner as the film was moved through the module R-D. A pair of exit or cross-over rollers corresponding to the drive roller D-6 and the idler roller I-13 are provided on the fixer roller conveyor module R-F for transferring the film from the fixer conveyor module to wash water conveyor module R-W. The rollers of the fixer module, other than not having the entrance rollers of the developer module, corresponds identically with those of the developer module. Similarly, the rollers of the wash water module correspond identically with those of the fixer module and are interchangeable with the elements of the other modules. The side frame plates 300*a* and 300*b* of the fixer and wash water modules are therefore slightly different from the side frames 200*a* and 200*b* of the developer module, since the transverse arm of the frame side members which would carry the entrance rollers is omitted from the frame of the fixer roller conveyor module R-F and the wash

water roller conveyor module R-W. All of the other elements, however, are identical.

As will be seen in FIG. 7, the end of the transverse arm 201 of the developer module disposes the entrance rollers D-1 and I-1 closely adjacent the surface of the entrance feeding table 45, so that the film slid along the table will enter between the rollers readily. Similarly, the arm 202 is disposed closely adjacent the vertical edge of the upright portion of the frame members 300*a* and 300*b* of the fixer module, so that the film will pass from the transfer or cross-over rollers D-6 and I-13 to the rollers I-22 and I-23 of the fixer module.

Also, the transfer or cross-over rollers of the fixer roller conveyor module R-F are disposed closely adjacent the vertical upright edge of the wash water roller conveyor R-W so that the film from the fixer module will enter between the rollers of the wash water module and travel therethrough, in the manner just described, to pass the film through the wash water tank W in the same manner that the film was passed through the developer chemical in the developer tank D and the fixer chemical in the fixer tank F.

The roller conveyor module in the drier plenum R-P includes a pair of spaced upright frame members 400*a* and 400*b* which are generally rectangular in configuration and which provide side walls for the upper portion of the plenum. A lower gate 401 on the entrance end of the module and a lower gate 402 on the exit end of the module overlies the vertical walls of the heating coil section 37*a* of the plenum D therebelow and a cover 403 is secured by screws 404 to the upper ends of the side members. Upper gates 405 and 406 at the entrance and exit ends of the conveyor module further enclose the plenum above and below the rollers to contain the heat therein to the fullest extent possible consistent with passing the film through the drying plenum. The exhaust conduit 38 is secured centrally of the cover 203 for the plenum. A suitable seal 408 is provided between the lower ends of the side walls and the lower gates of the conveyor module R-P to contain as much heat as possible within the plenum formed by the heater chamber 37*a* and the roller conveyor module R-P.

A plurality of fixed rollers F-1, D-41, F-2, F-3, D-42 and F-4 are rotatably secured mounted in bearing bushings 221 pressed into the side frame members 400*a* and 400*b* of the drier conveyor module. Idler rollers I-41, I-42, I-43, I-44, I-45 and I-46, identical to the idler rollers of the form first described, are disposed in vertically extending slots 417 in vertical alignment with the axis of the fixed rollers, so the idler rollers can move radially toward engagement with the fixed rollers for conveying the film through the drying plenum. Pinion wheel gears 235 drive vertical shafts 428 on which beveled gears 427 are mounted for driving the beveled gears 425 on the drive rollers D-41 and D-42, respectively. The drive rollers D-41 and D-42 are rotated at the same speed as all the other drive rollers in the several modules. As will be seen in FIG. 9, each of the fixed rollers F-1, F-2, F-3 and F-4 has a spur gear on one end of its shaft which is disposed to mesh with one of the idler spur gears 485 mounted on stub shafts or bolts 486 carried by the side plate 400 *a* of the module, and these idler gears mesh with spur gears 424 on the drive rollers D-41 and D-42 to provide means for transferring rotation from the drive rollers D-41 and D-42 to the fixed rollers F-1, F-2, F-3 and F-4, which in turn transfer rotation to the idler rollers I-52 through I-58, inclusive. Thus, the idler rollers I-52 through I-57, inclusive, will be rotated by the idler gears 485 which are driven by the drive gears 424 on the drive rollers. The idler rollers are biased toward the fixed rollers F-1, F-2, F-3 and F-4, and the drive rollers D-41 and D-42 to cause the spur gears to mesh and bias the rollers into engaging contact with each other for transporting the film through the module.

From the fixed roller F-4 and the idler roller I-57 the developed, fixed, washed and dried film segment will pass into the delivery chute 46, from which it may be taken by the operator when desired.

The entrance table or feeding table 45 is preferably formed of a non-corrosive, inert, non-conductive material, such as Plexiglass, having side guide ribs 45*a* on each side thereof for guiding the film through the slot between the upper surface of the table 45 and the lower edge of the gate 45*b*. This material prevents static electrical discharges and exposure of the X-ray film as a result of such static electricity which has been generated on the film during handling or processing of the film before and after it has been exposed and before it is run through the developer. When the static charge has been built up on the film and it is placed on a metal surface, there is often a discharge, and the film would be affected by streaking of the film as a result of the electrical discharge.

In FIGS. 17 and 18 are shown means for securing the several roller conveyor modules on the supporting frame 25 in the processing housing or case A. The outer ends of the spacer bolts or rods 205*b* and 205*c* at the upper ends of the modules fit in transverse recesses 290 and 291 in the upper surfaces of the frame members 25*a* and 25*b*. A sliding locking plate 295, which is made of plastic or stainless steel has a plurality of slots 296 formed therein for receiving plastic or stainless steel screws 297 which extend through slots 296 into the wood or plastic of the frame members 25*a* and 25*b* to hold the locking plate in place thereon. J-slots 298 and 299 are formed to engage the projecting ends of the bars or rods 205*b* and 205*c* of the conveyor modules, and the sliding locking plate 295 may be moved to engage the horizontal portion 299 of the slot 298 over the bars to prevent displacement of the bars or rods from the recesses 290 and 291. When it is desired to remove the module, the plate 295 is slid, to the left in FIG. 18, to disengage the horizontal portion 299 of the slot from the rods or bars 205*b* and 205*c*, and the module may then be lifted upwardly through the vertical portions of the slots 298 to remove the modules from within the tanks nad the processing housing or case.

It will readily be seen that the conveyor modules are quickly and easily removed from within their respective tanks or plenum for servicing, repair, cleaning or the like, when desired. It will also be seen that the conveyor module for each of the tanks may be separately moved from that of the other tanks or the plenum, and that the removal of the conveyor modules makes the tanks available for cleaning.

It will be noted that all parts of the machine in which the chemicals are handled are made of inert plastic material or non-corrosive metal such as stainless steel, Monil or the like. It will also be seen that the rollers are made of rigid phenolic plastic or similar material which is inert and non-corrosive and which will not damage

the film as it is moved through the system. Also, the rollers all move at an identical speed so that the emulsion on the film is not damaged as it is passed through the conveyor rollers.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A film processing apparatus for processing light sensitive film comprising: a processing case having an openable top providing a darkened processing chamber; a plurality of open topped tanks mounted within said case in close parallel series relationship; roller conveyor means disposed in said housing and comprising a plurality of separate modules, one extending downwardly into each of said tanks and having a plurality of sets of rollers for moving film segments from module to module through said tanks; a drier plenum in alignment with said series of tanks; a roller conveyor module in said drier plenum for receiving film from the tank conveyor modules and conveying said film through the drier; an entrance opening into the case into the conveyor modules of the first tank; an exit chute in the case in alignment with the roller conveyor of the drier plenum; each of the said roller conveyor modules being independently movable into and out of each of said tanks and out of said plenum; means for releasably securing said roller conveyor modules in position in said tanks and in position in said plenum and in conveying communication with respect to each other; each of said roller conveyor modules of said roller conveyor means comprising: a frame having a vertically aligned medial row of a plurality of vertically spaced central drive rollers rotatably secured thereto, a pair of vertically aligned lateral rows of a plurality of vertically spaced driven rollers, one vertical row of driven rollers being disposed on each side of said vertical row of drive rollers with each of the driven rollers of each vertical row of driven rollers being disposed in the same horizontal plane with and on diametrically opposite sides of one of the drive rollers and movable toward and away from the drive rollers, means biasing the driven rollers toward the drive rollers to contact the same, drive means for positively driving the driven rollers at the same speed as the drive rollers contacted thereby, a driven turn roller below the lowermost drive roller resiliently biased upwardly toward said drive roller and having drive means for positively driving it at the same surface speed as the lowermost drive roller, concave turn members disposed adjacent and extending in close parallel spaced relationship around the lowermost drive roller between said turn roller and each of the pair of driven rollers disposed in the same horizontal plane with and contacting said lowermost drive roller for turning film around said lowermost drive roller in contact with said lowermost drive roller between said driven rollers, and concave turn means on opposite sides of the uppermost drive roller disposed adjacent and extending in close parallel spaced relationship around the driven rollers in the same horizontal plane as and on opposite sides of said upper drive roller comprising first turn means for engaging film segments entering said module to turn the same downwardly between said upper drive roller and the upper one of the driven rollers on the entrance side of and in the same horizontal plane as the upper drive roller which it engages to direct said film segments downwardly in a vertical path between the rows of drive rollers and driven rollers disposed below said upper drive roller and upper driven roller to said first mentioned concave turn members adjacent the lower drive roller, and second turn means disposed to turn film leaving the module from between the uppermost drive roller and the upper driven roller on the exit side of and in the same horizontal plane with said upper drive roller around said upper exit side driven roller to pass horizontally outwardly from the module, each of said rollers of said module being of identical diameter and so spaced that the space between adjacent rollers of each vertical row is less than the diameter of the rollers so that at least two pairs of adjacent drive rollers and driven rollers contact film segments moved by the module at all times and the drive rollers and driven rollers rotating toward each other on opposite sides of the path of movement of the film segments through the module provide the sole guide for the film segments during the vertical movements thereof between the vertical rows of rollers, and the concave turn members and lower driven turn roller guide the film segments around the lowermost drive roller from a downward vertical path to the upward vertical path between the vertical rows of rollers in the module, said film segments contacting at least one driven roller at all times during the change of direction of movement of the film segments through the module; and means for conducting developer fluid to and for circulating developer fluid in said first tank, for conducting fixer fluid to and for circulating fixer fluid in said second tank, and for conducting wash water to the third tank for processing the film moved therethrough.

2. A film processing apparatus of the character set forth in claim 1 wherein all parts of the processing apparatus contacting the film are formed of a substantially rigid non-conductive inert plastic material not subject to corrosion.

3. A film processing apparatus of the character set forth in claim 1 wherein the roller conveyor modules each have rollers formed of a substantially rigid, inert, non-conductive plastic material, and pairs of said rollers are biased toward each other into engaging contact for transporting film segments therebetween through the module; and said means for driving said rollers positively drives all rollers of each of the modules at a uniform speed to move the film through the modules between the rollers without a wiping action on the emulsion on the film.

4. A film processing apparatus of the character set forth in claim 1 wherein the means for conducting fluids to and circulating fluids in said developer and fixer tanks comprises: circulating pump and heating means for said developer fluid; circulating pump and heating means for said fixer fluid; replenisher pump means and supply storage means for fixer fluid; temperature sensing means in said developer heating means for controlling the heat applied to said developer heating means and for controlling the heat applied to the fixed heating means; a container enclosing all said pump, heating and temperature sensing and controlling means separately from said processing chamber of said processing case; and conductor means for conducting fluids from the pumps in the separate container to the tanks in the pro-

cessing chamber, and from said tanks to the circulating pump is said separate container.

5. A conveyor system for a film processing apparatus for processing light sensitive sheet film material having a housing with a cover providing a darkened processing chamber, a developer fluid tank, a fixer fluid tank, a wash water tank and a drier plenum disposed in sequential alignment in said housing; said conveyor system comprising a roller film conveyor module for said developer tank, a separate roller film conveyor module for said fixer tank, a separate roller film conveyor module for said wash water tank, and a separate roller film conveyor module for said drying plenum, each of said developer, fixer and wash water conveyor modules including: a pair of spaced parallel side frame members having parallel vertical side edges; a vertical row of a plurality of vertically spaced drive rollers rotatably mounted in shafts at fixed points medially between the side edges of said side members and having drive gears on the outside of the side members connected on the shafts of each of said drive rollers for driving said drive rollers; a pair of vertical rows of vertically spaced idler rollers rotatably mounted on shafts on opposite sides of and parallel to said row of drive rollers and each movable laterally horizontally toward and away from adjacent drive rollers, one row of said pair of rows of idler rollers being each disposed on diametrically opposite sides of said row of drive rollers with one roller of each vertical row of idler rollers disposed in a common horizontal plane with each drive roller; an idler turn roller rotatably mounted on said frame member below and movable vertically toward and away from the lowermost drive roller; an idler guide roller rotatably mounted on the frame members vertically above and movable vertically toward and away from contact with the uppermost idler roller of each vertical row of idler members disposed in a common horizontal plane with the uppermost drive roller of said vertical row of drive rollers and movable vertically into engagement with said uppermost idler roller; at least one pair of guide rollers comprising a drive roller and an idler roller one rotatably mounted in a fixed position between said side frame members and the other rotatably mounted on said side members and movable vertically thereon into and out of engagement with said one fixed position roller, said pair of guide rollers being mounted one in the same horizontal plane with the upper drive roller of said row of drive rollers and the other in the same horizontal plane with said idler guide roller mounted vertically above the uppermost of each of the vertical rows of idler rollers on opposite sides of said vertical row of drive rollers; means biasing all said idler rollers toward the adjacent fixed drive rollers and idler rollers with which they are movable into contact to resiliently hold said idler rollers in engagement with the adjacent drive rollers and idler rollers; upper guide means fixedly secured between the side frame members and having concave turn members thereon disposed on opposite sides of the uppermost drive roller and extending in close parallel spaced relationship about the uppermost idler roller of said vertical row of idler rollers lying in the same horizontal plane with said uppermost driven roller and disposed to engage film segments passing between said idler guide roller above said uppermost idler roller to turn the same around the surface of said uppermost idler roller to engagement between said idler roller and the next roller in engagement therewith; turn means having concave surfaces thereon disposed adjacent and extending in close parallel spaced relationship around the lowermost drive roller of said vertical row of drive rollers between the lowermost idler roller lying in the horizontal plane with said lowermost drive roller and the idler turn roller rotatably mounted below said lowermost drive roller for engaging and turning film segments around the surface of said lowermost drive roller between the lowermost idler roller of one vertical row of idler rollers and the idler turn roller below the lowermost drive roller and between said idler turn roller and the lowermost idler roller on the opposite side of said lowermost drive roller; means positively driving each of said idler rollers about their axes at the same surface speed as the drive rollers, said rollers contacting each other rotating in the same surface direction at the point of contact to provide guide surfaces guiding film segments therebetween and with the concave surfaces of said guide members and said guide means defining a path of movement of film segments through the module, the rotating drive rollers and idler rollers providing the sole guide for the film segments during horizontal and vertical movements of the segments between the rollers, and the concave turn surfaces directing said segments in a path in contact with the roller adjacent which they are disposed in close parallel relationship for turning the film segments between horizontal and vertical paths of movement; whereby the rollers and guide turn members define a path of movement of film through the module in first a horizontal path, then in a downward path on one side of the drive rollers, then a reverse turning path around the lowermost drive roller, then in an upward vertical path on the other side of the row of drive rollers, and then in a horizontal exit path; said guide means and turn means being detachably secured between the side frame members; drive means carried by one of the frame members for positively rotatably driving the drive rollers; each of said drive rollers and idler rollers having gear means outside the side frame members on one end of their shafts meshing with gear means of another roller for causing simultaneous rotative movement of all the rollers in the module at identical surface speed.

6. A film processing apparatus of the character set forth in claim 5 wherein all parts of the processing apparatus contacting the film are formed of a substantially rigid non-conductive inert plastic material not subject to corrosion.

7. A film processing apparatus including: a case providing a darkened processing chamber; a developer tank in said chamber; a fixer tank in said chamber; a wash water tank in said chamber; a drier plenum in said chamber; an entrance opening into said case adjacent the developer tank; an exit opening in the case adjacent the drier plenum; a roller conveyor module in said developer tank having conveyor rollers thereon for receiving film from the entrance opening into the case and conducting it through the developer tank for developing therein and delivering it to the fixer tank; a roller conveyor module in said fixer tank for receiving the film from the developer conveyor module and moving the film through the fixer solution in the fixer tank and delivering the film to the wash water tank; a roller conveyor module in the wash water tank for receiving the film from the fixer tank conveyor module and conducting it through the wash water in the wash water tank

and delivering it to the drier plenum; a roller conveyor module in the drier plenum for receiving the film from the wash water tank conveyor module and conducting it through the drier plenum for drying therein and delivering it to the exit opening; means for circulating heated developer fluid in the developer tank; means for circulating heated fixer fluid in the fixer tank; means for supplying a flow of water under controlled temperature in the wash water tank; means for blowing heated air through the drier plenum; means for supplying additional developer fluid to the developer tank and supplying additional fixer fluid to the fixer tank; and drive means for driving each of the separate roller conveyor modules from a common source of power, each of said developer, fixer and wash water tanks including: a pair of spaced parallel side frame members having parallel vertical side edges; a vertical row of a plurality of vertically spaced drive rollers rotatably mounted in shafts at fixed points medially between the side edges of said side members and having drive gears on the outside of the side members connected on the shafts of each of said drive rollers for driving said drive rollers; a pair of vertical rows of vertically spaced idler rollers rotatably mounted on shafts on opposite sides of and parallel to said row of drive rollers and each movable laterally horizontally toward and away from adjacent drive rollers, one row of said pair of rows of idler rollers being each disposed on diametrically opposite sides of said row of drive rollers with one roller of each vertical row of idler rollers disposed in a common horizontal plane with each drive roller; an idler turn roller rotatably mounted on said frame member below and movable vertically toward and away from the lowermost drive roller; an idler guide roller rotatably mounted on the frame members vertically above and movable vertically toward and away from contact with the uppermost idler roller of each vertical row of idler members disposed in a common horizontal plane with the uppermost drive roller of said vertical row of drive rollers and movable vertically into engagement with said uppermost idler roller; at least one pair of guide rollers comprising a drive roller and an idler roller one rotatably mounted in a fixed position between said side frame members and the other rotatably mounted on said side members and movable vertically thereon into and out of engagement with said one fixed position roller, said pair of guide rollers being mounted one in the same horizontal plane with the upper drive roller of said row of drive rollers and the other in the same horizontal plane with said idler guide roller mounted vertically above the uppermost of each of the vertical rows of idler rollers on opposite sides of said vertical row of drive rollers; means biasing all said idler rollers toward the adjacent fixed drive rollers and idler rollers with which they are movable into contact to resiliently hold said idler rollers in engagement with the adjacent drive rollers and idler rollers; upper guide means fixedly secured between the side frame members and having concave turn members thereon disposed on opposit sides of the uppermost drive roller and extending in close parallel spaced relationship about the uppermost idler roller of said vertical row of idler rollers lying in the same horizontal plane with said uppermost driven roller and disposed to engage film segments passing between said idler guide roller above said uppermost idler roller to turn the same around the surface of said uppermost idler roller to engagement between said idler roller and the next roller in engagement therewith; turn means having concave surfaces thereon disposed adjacent and extending in close parallel spaced relationship around the lowermost drive roller of said vertical row of drive rollers between the lowermost idler roller lying in the horizontal plane with said lowermost drive roller and the idler turn roller rotatably mounted below said lowermost drive roller for engaging and turning film segments around the surface of said lowermost drive roller between the lowermost idler roller of one vertical row of idler rollers and the idler turn roller below the lowermost drive roller and between said idler turn roller and the lowermost idler roller on the opposite side of said lowermost drive roller; means positively driving each of said idler rollers about their axes at the same surface speed as the drive rollers, said rollers contacting each other rotating in the same surface direction at the point of contact to provide guide surfaces guiding film segments therebetween and with the concave surfaces of said guide members and said guide means defining a path of movement of film segments through the module, the rotating drive rollers and idler rollers providing the sole guide for the film segments during horizontal and vertical movements of the segments between the rollers, and the concave turn surfaces directing said segments in a path in contact with the roller adjacent which they are disposed in close parallel relationship for turning the film segments between horizontal and vertical paths of movement; whereby the rollers and guide turn members define a path of movement of film through the module in first a horizontal path, then in a downward path on one side of the drive rollers, then a reverse turning path around the lowermost drive roller, then in an upward vertical path on the other side of the row of drive rollers, and then in a horizontal exit path; said guide means and turn means being detachably secured between the side frame members; drive means carried by one of the frame members for positively rotatably driving the drive rollers; each of said drive rollers and idler rollers having gear means outside the side frame members on one end of their shafts meshing with gear means of another roller for causing simultaneous rotative movement of all the rollers in the module at identical surface speed; and said drier module comprising: a pair of side frame members; a horizontally disposed row of drive rollers rotatably mounted between said side frame members at fixed horizontally spaced positions; an equal number of idler rollers rotatably mounted on said side frame members and movable vertically toward and away from said drive rollers into and away from contact therewith; said rows of drive rollers and idler rollers being disposed in a common horizontal plane with said at least one pair of idler guide rollers of the adjacent module in said wash water tank; means for resiliently biasing said idler rollers into engagement with said drive rollers; and means for positively driving each of said rollers of said drier module at a common identical surface speed identical to the surface speed of the rollers of the other modules.

8. A film processing apparatus of the character set forth in claim **7** wherein all parts of the processing apparatus contacting the film are formed of a substantially rigid non-conductive, inert plastic material not subject to corrosion.

9. A roller conveyor module for a film processing apparatus for conducting film segments through processing areas including: a pair of spaced parallel side frame

members having parallel vertical side edges; a vertical row of a plurality of vertically spaced drive rollers rotatably mounted on shafts at fixed points medially between the side edges of said side members and having drive gears on the outside of the side members connedted on the shafts of each of said drive rollers for driving said drive rollers; a pair of vertical rows of vertically spaced idler rollers rotatably mounted on shafts on opposite sides of and parallel to said row of drive rollers and each movable laterally horizontally toward and away from adjacent drive rollers, one row of said pair of rows of idler rollers being each disposed on diametrically opposite sides of said row of drive rollers with one roller of each vertical row of idler rollers disposed in a common horizontal plane with each drive roller; an idler turn roller rotatably mounted on said frame member below and movable vertically toward and away from the lowermost drive roller; an idler guide roller rotatably mounted on the frame members vertically above and movable vertically toward and away from contact with the uppermost idler roller of each vertical row of idler members disposed in a common horizontal plane with the uppermost drive roller of said vertical row of drive rollers and movable vertically into engagement with said uppermost idler roller; at least one pair of guide rollers comprising a drive roller and an idler roller one rotatably mounted in a fixed position between said side frame members and the other rotatably mounted on said side members and movable vertically thereon into and out of engagement with said one fixed position roller, said pair of guide rollers being mounted one in the same horizontal plane with the upper drive roller of said row of drive rollers and the other in the same horizontal plane with said idler guide roller mounted vertically above the uppermost of each of the vertical rows of idler rollers on opposite sides of said vertical row of drive rollers; means biasing all said idler rollers toward the adjacent fixed drive rollers and idler rollers with which they are movable into contact to resiliently hold said idler rollers in engagement with the adjacent drive rollers and idler rollers; upper guide means fixedly secured between the side frame members and having concave turn members thereon disposed on opposite sides of the uppermost drive roller and extending in close parallel spaced relationship about the uppermost idler roller of said vertical row of idler rollers lying in the same horizontal plane with said uppermost driven roller and disposed to engage film segments passing between said idler guide roller above said uppermost idler roller to turn the same around the surface of said uppermost idler roller to engagement between said idler roller and the next roller in engagement therewith; turn means having concave surfaces thereon disposed adjacent and extending in close parallel spaced relationship around the lowermost drive roller of said vertical row of drive rollers between the lowermost idler roller lying in the horizontal plane with said lowermost drive roller and the idler turn roller rotatably mounted below said lowermost drive roller for engaging and turning film segments around the surface of said lowermost drive roller between the lowermost idler roller of one vertical row of idler rollers and the idler turn roller below the lowermost drive roller and between said idler turn roller and the lowermost idler roller on the opposite side of said lowermost drive roller; means positively driving each of said idler rollers about their axes at the same surface speed as the drive rollers, said rollers contacting each other rotating in the same surface direction at the point of contact to provide guide surfaces guiding film segments therebetween and with the concave surfaces of said guide members and said guide means defining a path of movement of film segments through the module, the rotating drive rollers and idler rollers providing the sole guide for the film segments during horizontal and vertical movements of the segments between the rollers, and the concave turn surface directing said segments in a path in contact with the roller adjacent which they are disposed in close parallel relationship for turning the film segments between horizontal and vertical paths of movement; whereby the rollers and guide turn members define a path of movement of film through the module in first a horizontal path, then in a downward path on one side of the drive rollers, then a reverse turning path around the lowermost drive roller, then in an upward vertical path on the other side of the row of drive rollers, and then in a horizontal exit path; said guide means and turn means being detachably secured between the side frame members; drive means carried by one of the frame members for positively rotatably driving the drive rollers; each of said drive rollers and idler rollers having gear means outside the side frame members on one end of their shafts meshing with gear means of another roller for causing simultaneous rotative movement of all the rollers in the module at identical surface speed.

10. A roller conveyor module of the character set forth in claim **9** wherein the means resiliently biasing all said idler rollers into contact with the adjacent rollers is removable and said idler rollers are mounted in slots in said side frame members extending in the direction of movement of said idler rollers away from and in contact with the rollers which they are disposed to contact, whereby when said resilient means is disengaged from said idler rollers, said rollers may be moved outward of said slots away from the rollers fixedly secured between said side frame members, and said detachable guide means are removable from between said side frame members, to permit quick cleaning thereof, said gear means on the shafts of the drive rollers and idler rollers being readily engageable and disengageable to permit such removal of the idler rollers for cleaning.

11. A roller conveyor module of the character set forth in claim **9** wherein said module includes a second pair of guide rollers comprising: a guide roller and an idler roller, one rotatably mounted in a fixed position between said side frame members and the other rotatably mounted on said side members and movable vertically thereon into and out of engagement with said one fixed roller; said second pair of guide rollers being mounted one in the same horizontal plane with the upper drive roller of said row of drive rollers and the other in the same horizontal plane with said idler guide roller mounted vertically above the uppermost of each of the vertical row of idler rollers on opposite sides of said vertical row of drive rollers; means resiliently biasing said movable roller toward the fixed position roller into contact therewith; and means for positively driving said second pair of guide rollers at the same surface speed as the other rollers of said module.

12. A roller conveyor module of the character set forth in claim **10** wherein each of the guide means comprises a polyvinyl chloride plastic member having resilient clamping means for securing the same in place in the module.

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