United States Patent

Orr et al.

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[54] DEVELOPING APPARATUS

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[52] **U.S. Cl.** .....**95/89 D**, 118/423, 134/78, 134/142

[51] **Int. Cl.** **G03d 3/10**

[58] **Field of Search** .....95/89 R, 89 D, 93, 94 R, 100; 118/30, 423, 425; 134/78, 142

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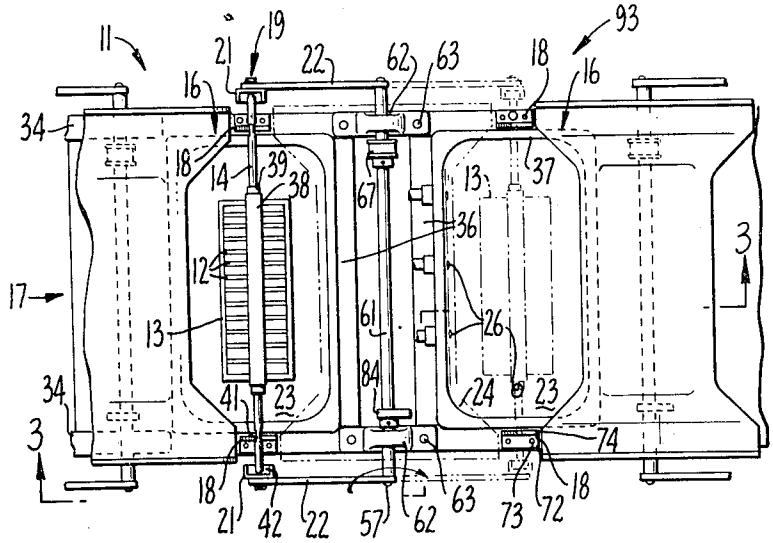
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Assistant Examiner—Fred L. Braun
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[57] **ABSTRACT**

A photographic developing apparatus having a series of processing stations through which a tray carrying photographic slides is transported by a transfer mechanism. The transfer mechanism comprises at least one pair of crank arms which are rotatably mounted at one end thereof intermediate the processing stations, members journaled at the other ends of the arms for engaging the supporting rod of the tray, and a motor for rotating the crank arms through a complete revolution. A timer control device is provided for sequentially operating the transfer mechanism to thereby transport a tray from one processing station to another after a predetermined processing time has elapsed.

10 Claims, 8 Drawing Figures



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SHEET 1 OF 4

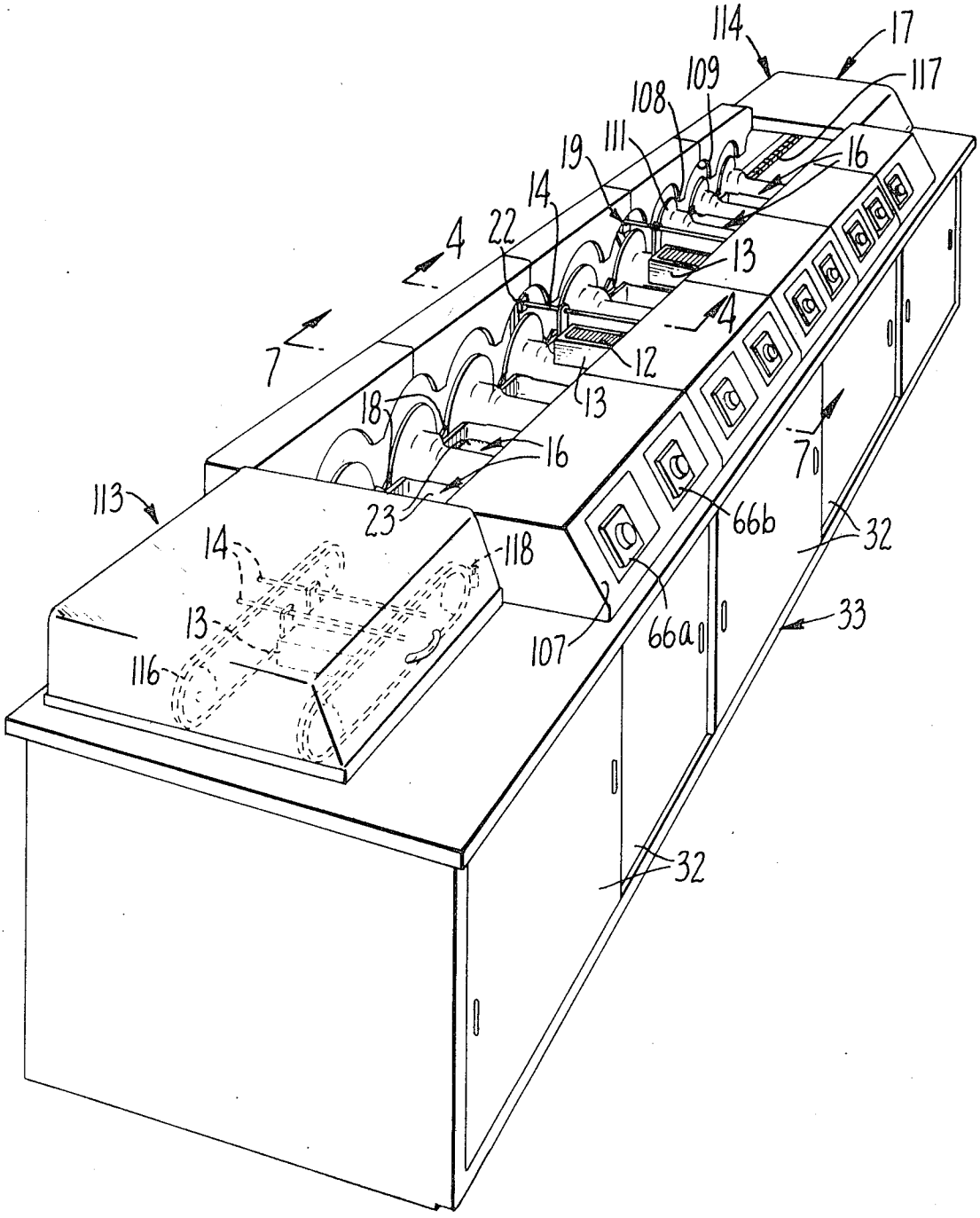


FIG. 1.

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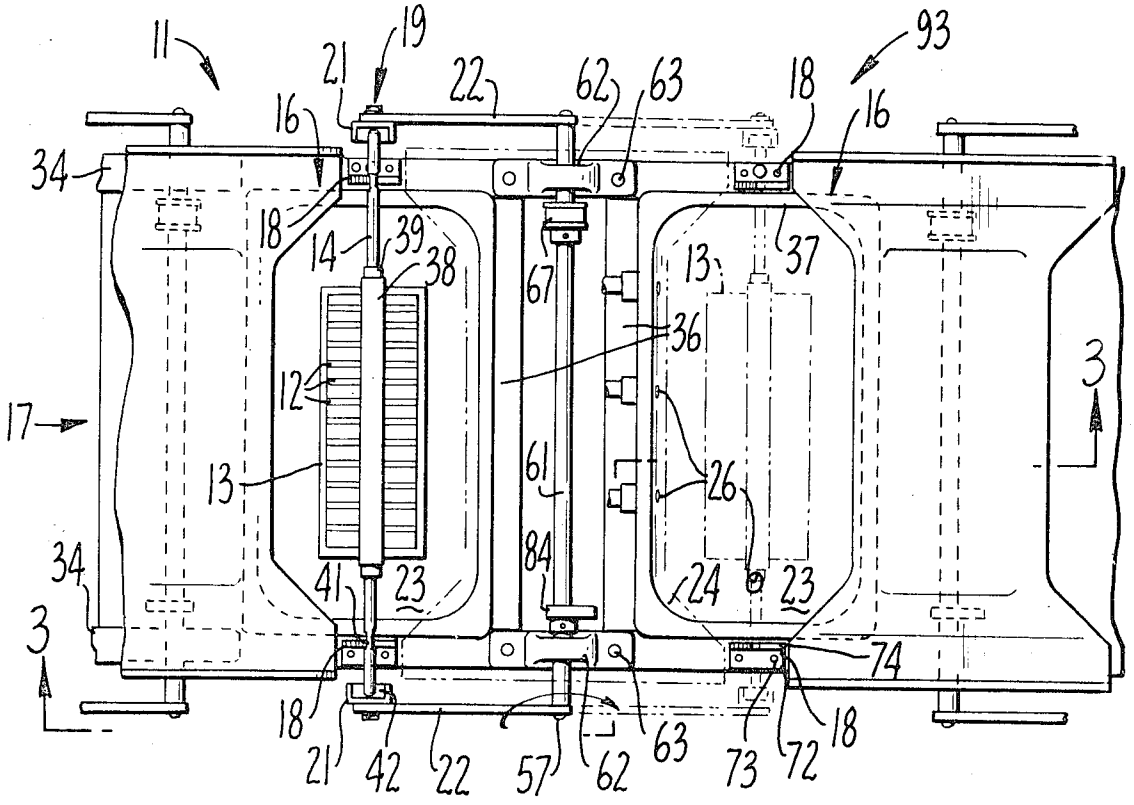


FIG. 2.

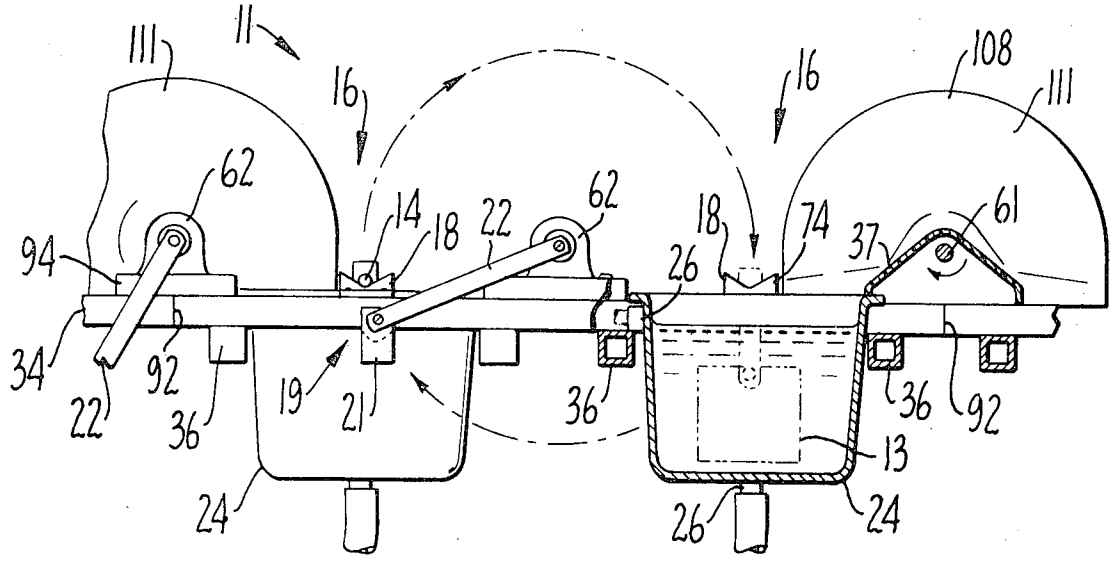


FIG. 3.

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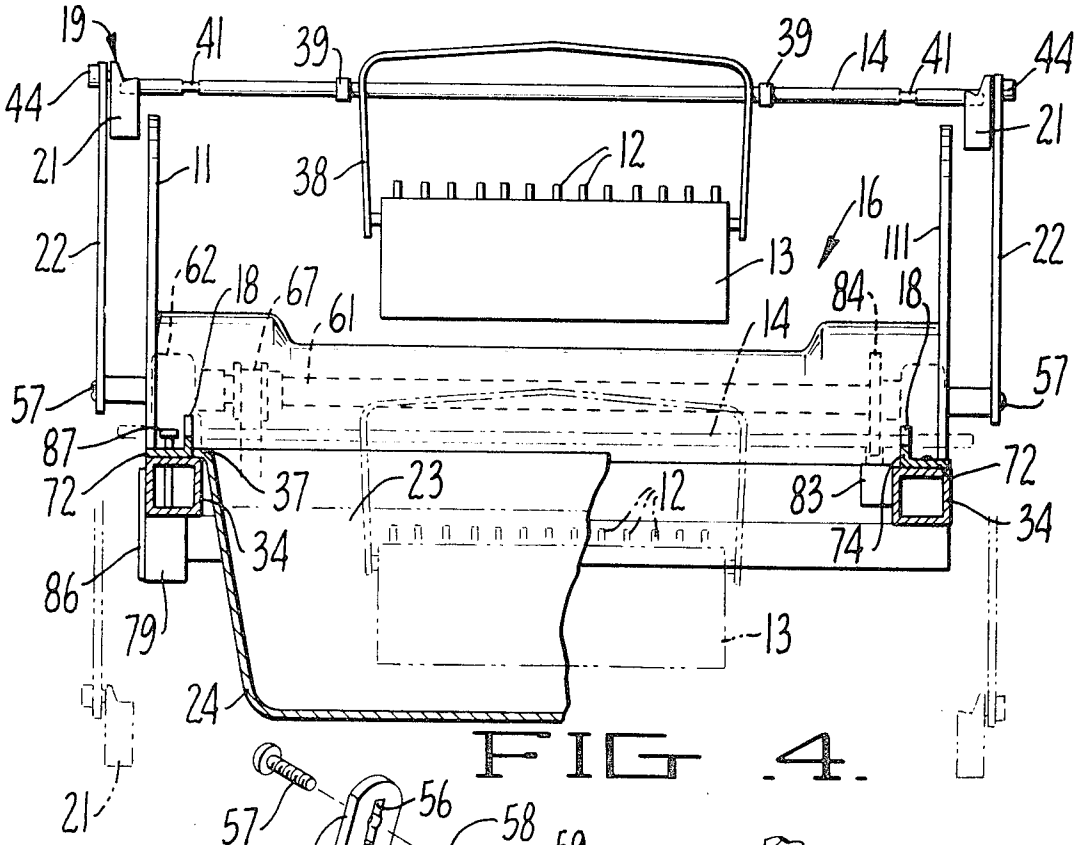


FIG. 4.

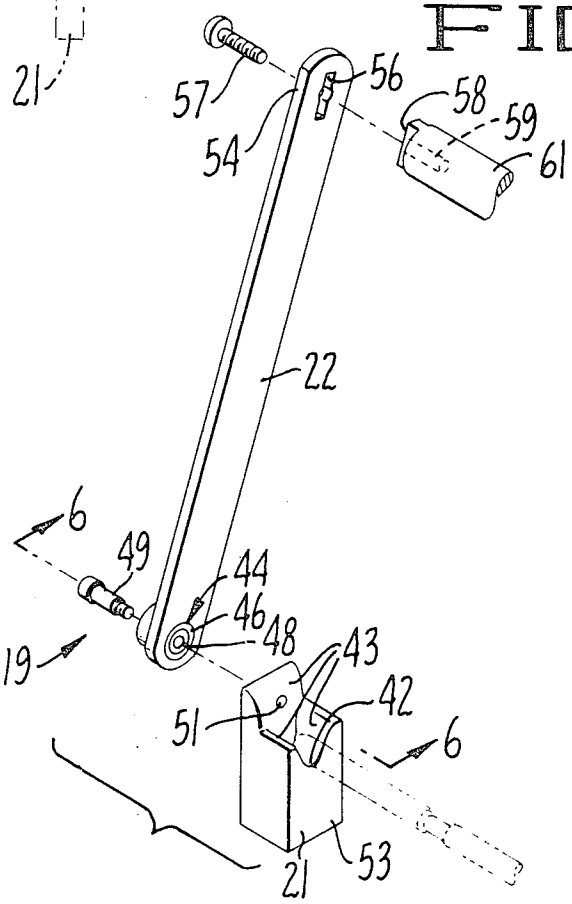


FIG. 5.

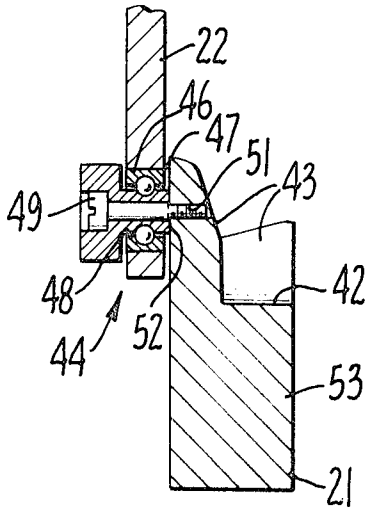


FIG. 6.

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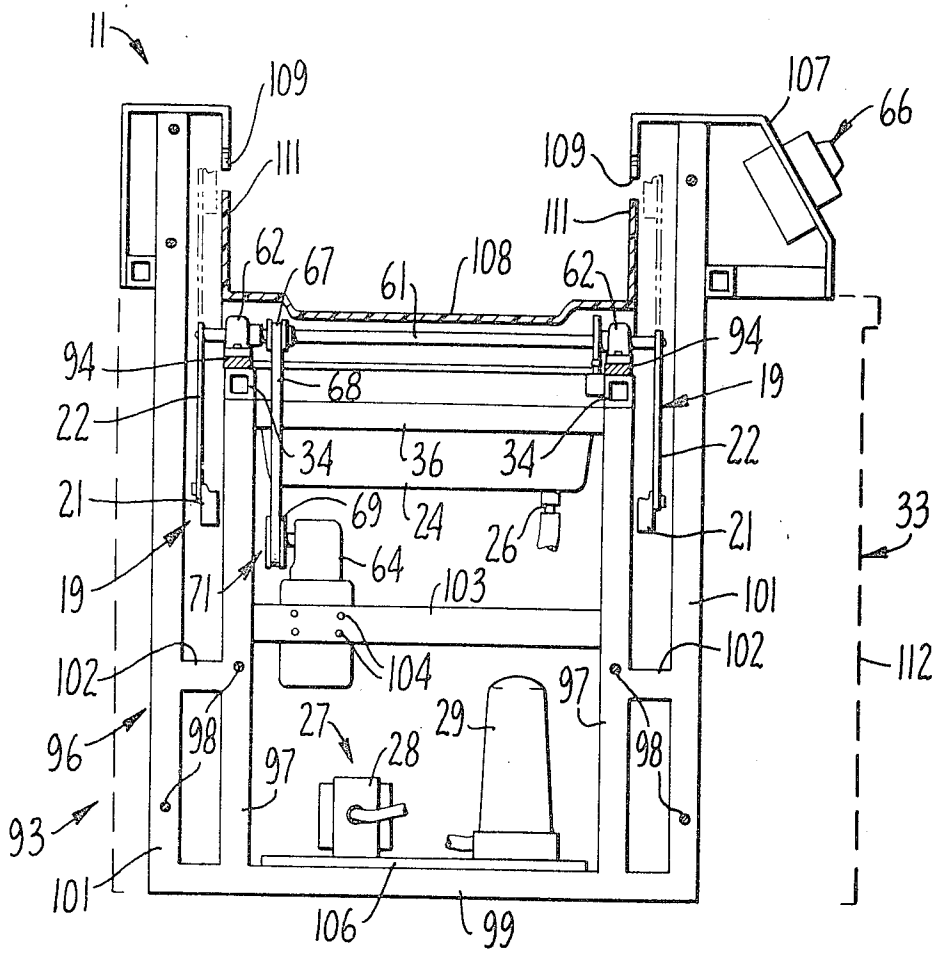


FIG. 7.

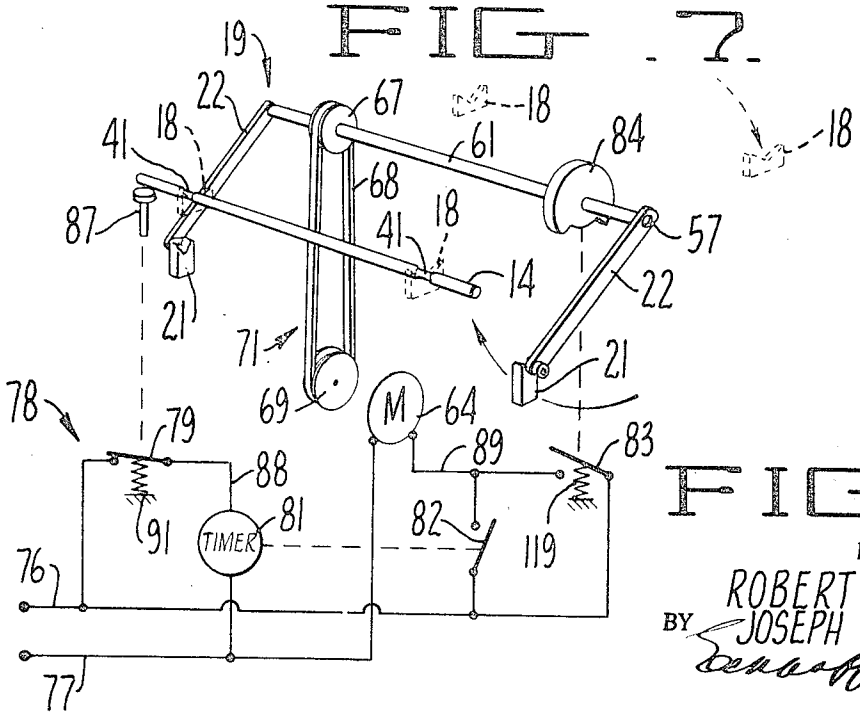


FIG. 8.

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DEVELOPING APPARATUS

BACKGROUND OF THE INVENTION

In the electronic industry, photographically produced masking slides are used in great numbers. These masks are used in manufacturing microelectronic circuits such that each microelectronic circuit produced consumes one slide in its production. This requires processing of the slides in large numbers under conditions meeting the rigid specifications imposed in this field. Processing of these slides is complicated since, during the production run, slides of different sizes or in different quantities or having different processing requirements may be processed at the same time.

More particularly, we provide a developing apparatus for processing photographic slides through a series of developing, fixing and rinsing baths. The slides are supported in support means or trays each of such suspended from a carrier rod. The trays are serially transported from one bath to the next in an individually timed sequence determinative of the duration of processing at each station.

The baths are equidistantly spaced along a processing line and the carrier rods extend transversely of the line and beyond the margins of the baths with he individual rods supported in V-shaped sockets medially of the baths during the processing period.

A series of transfer mechanisms are positioned between adjacent baths for transporting each carrier tray and included slides between the baths. Each transfer mechanism includes a pair of opposed cradles journaled at the distal ends of crank arms wherein orbiting of the crank arms will cause the cradles to intercept the ends of a carrier rod and transport it from one set of V-shaped sockets to the next. The crank arms are carried on the ends of a shaft bridging the line intermediate the bath stations. The shaft is rotated through one cycle of revolution by an electric motor and control.

A sequence timer is actuated upon the arrival of a tray at a station and after the proper processing duration starts the motor to initiate the transfer cycle. A cam on each transfer shaft operates a switch to continue to supply power to the motor until the cradles are conveyed through a complete circuit.

The several processing baths are confined in tanks supported between longitudinal frame members. Similarly, the V-shaped sockets are supported on the longitudinal frame members outboard of the line of tanks. The transfer shafts are journaled in bearings carried on the frame members at a position elevated from the sockets whereby, as the cradles orbit outboard of the sockets, the slide trays are elevated from the baths through a steep angle.

The framing of the station units is in modular form such that the line may be made up of a succession of units as determined by the number of processing steps desired.

SUMMARY OF THE INVENTION

It is a principal object of the present invention to provide a developing apparatus having a great degree of flexibility and which can process slides of different characteristics at the same time. This is accomplished by providing the apparatus with a series of processing baths and conveying the slides successively through the baths in individually timed sequences.

Another object is to provide such an apparatus which has a large throughput of slides and which will accept mixed lots of individual trays of slides and process them in a linear fashion through a series of baths and wherein the baths and their associated transfer mechanisms are integral units with the duration of immersion in each bath being individually timed.

Still another object wherein each processing station is a wholly contained modular unit such that any number of stations may be linked together to form an entire processing group.

A further object is to carry the slides in trays from one station to the next on a transversely disposed carrier rod and to use the rod to align the trays in the baths and also initiate the timing cycle when the trays are lowered into the baths and wherein the carrier rod describes a path of overlapping arcs between adjacent baths such that the trays enter and leave the baths at a steep angle.

Finally it is an object to provide such an apparatus along a longitudinally extending processing line wherein the baths and their associated controls are visually displayed to the operator in adjacent relation and wherein the transfer mechanism is housed and substantially concealed in shrouds to provide a safe environment for the operator.

BRIEF DESCRIPTION OF THE DRAWINGS

The preferred form of the invention is illustrated in the accompanying drawings forming a part of this specification, in which:

FIG. **1** is a perspective view of a developing apparatus constructed in accordance with the present invention;

FIG. **2** is a fragmentary plan view of the apparatus shown in FIG. **1** with portions removed to view the underlying structure;

FIG. **3** is an elevational section taken substantially along the plane of line **3—3** in FIG. **2**;

FIG. **4** is a fragmentary elevational section taken substantially along the plane of line **4—4** in FIG. **1**;

FIG. **5** is an exploded perspective view of the crank arm and cradle structure of the transfer mechanism;

FIG. **6** is an elevational section of the cradle structure taken substantially along the plane of line **6—6** in FIG. **5**;

FIG. **7** is a cross-sectional view taken substantially along the plane of line **7—7** in FIG. **1**; and

FIG. **8** is a schematic and diagrammatic representation of the transfer mechanism and associated control including the circuitry.

While only the preferred form of the invention is shown, it should be understood that various changes or modifications may be made within the scope of the claims attached hereto without departing from the spirit of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring particularly to FIGS. **1**, **2** and **3**, the developing apparatus **11** is for processing photographic slides **12** and the like wherein the slides are carried in trays **13**, each being suspended from a carrier rod **14**. The apparatus is in the form of a series of processing stations **16** spaced along a processing line **17** and includes holding sockets **18** positioned transversely of each station **16** to support the carrier rod during processing of the slides at that station.

A series of transfer devices **19** are carried intermediate each station for transporting each carrier rod and its associated tray from one station to the next in cradles **21** engageable with the ends of a carrier rod. The cradles **21** are journaled at the distal ends of crank arms **22** and are spaced therealong to intercept a carrier rod on the sockets **18** whereby orbiting of the crank arms **22** transports the carrier rod **14** and included tray **13** from one station to the nest independently of the other transfer devices.

The several baths **23** each include the proper developing, fixing and rinsing agents or any other desirable processing agent. The baths are carried in tanks **24** and are preferably constantly circulated through the tanks by way of suitable inlet and outlet openings **26**. Furthermore, each bath may be provided with suitable auxiliary devices **27** such as a pump **28** and filter **29** for purifying or otherwise ensuring the proper processing characteristics of the bath. These devices are conveniently housed in a bay **31** under the tanks **24** and are readily serviced through sliding doors **32** in the cabinet **33**. The tanks are of a size to accept the largest slide tray contemplated and still allow ready circulation of the liquid in the bath over the slides.

The baths are supported along the processing line **17** between longitudinally extending frame members **34**. Frame members **36** are spaced along the line **17** transversely of mem-

bers 34 for supporting the upper flanges 37 of the tanks. This supports the tanks at the proper spacing and elevation while allowing ready removal of any tank for replacement if necessary.

The slides 12 are carried through the baths in a vertical position in trays 13 of the type having an open grillwork for efficient liquid circulation and draining. The trays 13 are suspended by inverted V-shaped hangers 38 from carrier rod 14. In operation, the rod is carried transversely along the processing line of tanks and is of such length to extend from the hangers 38 equidistantly beyond the margins of the banks 24 and frame members 34. Each rod 14 is provided with shoulders 39 which center the hanger and suspended tray midway of its ends. Each rod also has equidistantly spaced relieved portions 41 which rest in the holding sockets 18 when the tray is immersed in a bath. This ensures that each tray of slides will be suspended in the proper position for processing in the bath and also for proper pickup by the transfer mechanism.

As mentioned, integral transfer devices 19 are provided to transport the slides from one bath to the next. Each transfer device has a pair of interconnected cradles 21 which pick up the extreme ends of a carrier rod 14 and move it upwards and along a generally semicircular path from one bath to the next succeeding bath. The cradles 21 have V-shaped recesses 42 formed by converging faces 43*a*, 43*b* and 43*c* which provide a large entrance area to facilitate picking up the rod ends and a smaller confined area for precisely locating the rod ends for subsequent placement in the next pair of holding sockets. Furthermore, the cradles are journaled on crank arms 22 at a point above the recesses and above the center of gravity of the cradles. This again allows some tolerance in picking up the rod.

The journaling of the cradle on the crank arm is accomplished by a low-friction ball bearing 44. This bearing has an outer race 46, press fit into a bore 47 in the crank arm, and an inner race 48 providing a sleeve for capscrew 49. Screw 49 attaches the arm 22 to the cradle 21 through a threaded hole 51 while a shoulder 52 on the sleeve provides proper spacing therebetween such that the cradle has ample freedom of rotation about the arm. Correspondingly, the cradle is fashioned with a large mass 53 to provide a desired low center of gravity to keep recess 42 below the attachment point 51. This cooperation with the low-friction bearing ensures that the "V" of the recess is always pointed upward for proper pickup and also provides protection against tipping of a tray of slides during transport.

The crank arms 22 are attached at their inner ends to a common drive shaft 61. This attachment is provided by keyways 56 and screws 57 fitting complementary keys 58 and threaded bores 59 on either end of a shaft 61. Shaft 61 extends between the crank arms 22 across the line 17 intermediate the baths and is journaled in bearing blocks 62 held to frame members 34 by screws 63. The axis of rotation of this shaft is slightly above the horizontal plane of the carrier rods when the carrier rods are resting on the holding sockets at the bath stations. This allows the path of rotation of the cradles to describe arcs which overlap the median plane of the adjacent baths such that the rod and included slide trays are picked up included lowered through a steep angle at each bath.

The drive shaft 61 if rotated through one revolution by an electric motor 64 in response to the dictates of a control timer 66. The motor is of the gear type and drives pulley 67 through belt 68 and drive pulley 69. A slip clutch may be interposed in this belt-pulley drive 71 to prevent breakage if any part of the transfer mechanism is jammed.

The holding sockets 18 are provided in proper position for pickup and release of a carrier rod by the transfer device. The sockets are made from angle stock and have a base 72 attached to frame members 34 by fasteners 73. The upstanding side 74 is cut into the appropriate V-shaped socket 18 and cooperates with relieved portion 41 of the carrier rod to locate precisely each tray in a bath and the rod ends for subsequent pickup.

As mentioned, the trays of slides are transferred along the line in response to a timer control 66 at each station. As is shown in FIG. 8, suitable electrical power is supplied through powerlines 76 and 77 to a control circuit 78. This circuit is repeated for each transfer mechanism and is determinative of the duration of processing at the anterior station adjacent that transfer mechanism. Each control circuit includes a feeler switch 79, responsive to the landings of a carrier rod at the anterior station, an electric timer 81 controlling switch 82, the electric drive motor 64 and a cycle completion switch 83 responsive to the rotary position of shaft 61 as indicated by cam 84.

Feeler switch 79 is carried on bracket 86 along frame member 34 under one of the holding sockets 18 and has an actuating rod 87 extending into the path of the carrier rod 14. Upon landing on the socket, the carrier rod depresses the actuating rod 87 and causes the contacts of switch 79 to close. Power is then applied across line 88 and sequence timer 81 starts its countdown. The timer 81 may be of any construction which will provide a switching output after a specified time duration and is preferably readily adjustable over a time span greater than any of the expected processing time periods.

After a specified processing time as measured by timer 81 has elapsed at a given tank, switch 82 is closed and power is fed along line 89 to motor 64. Motor 64 will commence to rotate shaft 61 through belt and pulley drive 71 to orbit the crank arms toward the ends of carrier rod 14 and lift the rod with cradles 21. The raising of the carrier rod releases actuator rod 87 and allows spring 91 to open switch 79. This removes power from line 88. Timer 81 will then open switch 82 and internally reset for the next sequence. Prior to this, cam 84 on shaft 61 is rotated onto a position to depress and close switch 83. Power continues to drive motor 64 through line 89 until the cradles have made one complete orbit. As a carrier rod 14 is lowered onto the next or posterior station, a corresponding circuit is actuated to continue the progression of slide trays along the processing line in the chosen sequence.

In the preferred embodiment, the framing is modularized in units each of which supports two tank stages on each frame unit. As mentioned, longitudinal frame members 34 provide the support for the tank carrying cross frame 36, the bearing 62 of shafts 61, the holding sockets 18 and the brackets 86 of feeler switches 79. These frame members 34 are conveniently sectioned at points 92 (see FIG. 3) to form the necessary breaks for the module units 93. These breaks are bridged by ties 94 to form the continuous line 17. Also, the ties 94 in turn provide the proper spacing for elevating the drive shaft bearings 62.

The sectioned longitudinal frame members 34 are supported in a boxlike subframe 96 on columns 97. Subframes of neighboring modules are bolted together by bolts 98 to form a continuous ridged frame for the apparatus. As shown in FIG. 7, the subframe 96, in cross section, includes a base 99 and upstanding columns 101. The columns 101 support the cabinet 33. Also the frame members 34 are spaced so the crank arms of the transfer mechanism can orbit. Cross-bracing 102 and 103 is also provided while the motor 64 is conveniently mounted on one of the braces 103 by fasteners 104. A platform 106 is also provided to support a plumbing device 27 such as a pump 28 and a filter 29.

The cabinet 33 includes a canted surface 107 forming a control panel for positioning the timer 66 and temperature and flow controls adjacent their designated baths. The cabinet also forms shrouds along the sides of the line, behind which the transfer mechanism is housed and substantially hidden from view. Similarly the drive shaft 61 and bearings 62 of the transfer mechanism are housed under shrouds 108 to protect them from any dripping bath fluid. The cabinet shroud has scalloped shaped cutouts 109 along its depending side. Shrouds 108 have upstanding semicircular shaped sides 111 which are complementary to and fit within cutouts 109. In this way only an area as defined by the paths of the carrier rods need be open and exposed to the inner workings of the rest of the mechanisms. An outer cabinet defined by dotted lines 112

may correspondingly be constructed around any number of modules.

The apparatus also includes loading stage **113** and unloading stage **114** at the respective ends of the processing line **17**. This permits automatic handling of the slides without the constant supervision of an attendant. Each of these stages consists of spaced chain conveyors **116** and **117** on which the carrier rods are held prior to and after processing. The loading conveyor **116** advances the carrier rods to a holding station **118**, initial to the processing cycle. The unloading conveyor **117** accepts the carrier rods of the processed slides and is incrementally advanced to space them along its length.

In operation, and prior to running of the slides, each tank is filled with an appropriate processing fluid and its temperature and flow monitored at each station on the control panel. Similarly, the desired duration of processing at each station is selected on the associated timer control **66**.

Next the transparent hood of the loading stage is raised and the trays are placed therein with he carrier rods **14** resting on chain conveyor **116**. The conveyor chains are driven toward the baths by an appropriate motor (not shown) until a rod reaches the holding station **118** of the first transfer mechanism. At this station a switch is engaged to stop the conveyor and actuate the first sequence timer. This timer is set for a longer period than any of the processing timers to ensure that the trays will not bunch up at some station along the line.

After the first sequence timer **66***a* has operated for the selected period, the first transfer device **19** picks up the ends of the carrier rod **14** and transports the tray to the first processing station. This station is usually a prerinse or cleaning bath. As the tray of slides enters this bath, a second timer **66***b* designated for this bath is actuated through a feeler switch **79** in response to the lowering of rod **14**. After the appropriate period in the bath, timer **66***b* energizes an internal relay coil and closes switch **82**. A second transfer mechanism **19**, driven by a motor **64** in response to the closing of switch **82**, then lifts the rod and included tray out of the first bath. As the rod is lifted, switch **82** opens and allows the timer to reset. At this time, cam **84** on shaft **61** has closed switch **83** to continue to supply power to motor **64**. When the transfer mechanism reaches the next bath, the rod ends will contact the holding socket **18** and actuating rod **87** of switch **79** to start the third timer. The transfer mechanism continues to rotate after depositing the carrier rod on the holding sockets to some resting place thereunder. This resting place is, of course, out of the paths of its neighboring transfer mechanisms. At this point, the cam **84** on shaft **61** will allow switch **83** to open under pressure from spring **119**.

This procedure is repeated at each station through the entire line of baths with the duration in each bath varying by the time selected on the respective timer controls. If desired, the developing bath may be provided by two tanks to provide the longer period needed for the bath without unduly slowing down the total processing time of the other slide trays.

The duration and other parameters of the processing may be monitored from the designated control devices placed opposite each station on the control panel. Similarly, a tray of slides may be followed visually along the processing line and appropriate changes made for it at each station.

Any combination of tray and slide sizes that are within the range of the apparatus may be mixed in the same run since the control is responsive to and determinative only of the position of the carrier rod.

At the end of the line each carrier rod and included slide tray is deposited at an unloading stage **114**. This stage has a pair of conveyor chains **117** similar to those of the loading stage for holding a quantity of trays of slides. Upon arriving at this stage, a switch is actuated to advance the conveyor a specified increment in any well-known manner to space the slide trays along the conveyor chains. This stage may also include a dryer if desired.

From the foregoing, it will be seen that the developing apparatus of the present invention provides for processing photographic slides in an efficient manner by transporting them along a processing line independently of other slides being processed.

We claim:

1. A developing apparatus for processing photographic slides and the like, comprising a series of processing stations spaced along a processing line, a carrier rod having means thereon for supporting said photographic slides therefrom, holding sockets at opposite sides of each station to support the carrier rod and slides during processing of the slides at the station, a series of transfer devices each positioned intermediate adjacent stations for transporting the carrier rod and slides from one station to the next station, each said transfer device comprising a pair of crank arm means rotatably mounted at one end thereof at opposite sides of the stations, means journaled at the other end of said crank arm means for supporting engagement with said carrier rod and spaced to intercept the carrier rod held on the sockets upon rotation of the crank arm means, and means connected with the crank arm means to rotate them through a complete revolution so that the journaled means on said crank arm means engage a carrier rod and transport the carrier rod from one station to an adjacent station, where a successive crank arm means engages and transports the carrier rod to a further station upon rotation of said successive crank arm means.

2. The apparatus as defined in claim **1** wherein said journaled means comprises a cradle, the axis of revolution of said crank arms being in a plane elevated above a carrier rod when supported on the holding sockets such that the rod is intercepted by the cradles to raise the trays through an arc of approximately 180° and from one station to the next.

3. The apparatus as defined in claim **1** wherein the crank arm means are rotatably mounted outboard of said holding sockets such that the journaled means intercept the ends of a carrier rod and wherein the crank arm means are interconnected by a shaft bridging the processing line intermediate the stations.

4. The apparatus as defined in claim **1** wherein rotation of said crank arm means is responsive to a timer control at each station.

5. The apparatus as defined in claim **1** wherein the holding sockets have converging supporting surfaces to center the rods medially of the baths.

6. The apparatus of claim **1** wherein the journaled means comprise cradles having converging surfaces to center the carrier rod thereon and precisely position the rod for proper placement at the next station.

7. The apparatus as defined in claim **1** wherein said plurality of tanks are arranged in a line and spaced apart a like distance in such line, said means for supporting the slides from each rod comprising a tray fitting in the tanks, said transfer means picking up a tray in one tank and moving the tray to the next tank for immersion in the liquid in that tank.

8. Apparatus as in claim **7** wherein timing means are provided for timing the period of tray immersion in a tank.

9. A developing apparatus for processing photographic slides and the like wherein the slides are carried in trays suspended from a carrier rod comprising spaced frame members extending longitudinally along a processing line, a series of bath stations disposed equidistantly along said line with the baths confined in tanks supported between the longitudinal frame members, holding sockets positioned on the said frame members medially of each bath station for supporting a carrier rod during the processing of the slides at that station, and transfer devices for transporting the carrier rods and included trays between adjacent baths and having a shaft journaled in bearings supported by the frame members intermediate the holding sockets, crank arms carried by the shaft outboard of the said frame members, cradles journaled in low-friction bearings at the distal ends of the crank arms and positioned to inscribe a path intercepting the ends of a carrier rod held at an adjacent holding socket, said cradles having a carrying recess defined by three converging faces which act to center and

align said carrier rod during transport and wherein said recess is spaced below the point of attachment of the low-friction bearing.

10. A developing apparatus for processing photographic slides and the like wherein the slides are carried in trays suspended from a carrier rod and comprising a series of processing stations spaced along a processing line, holding sockets positioned transversely of each station to support the carrier rod during processing of the slides at the station, a series of transfer devices each positioned intermediate adjacent stations for transporting the carrier rod from one station to the next including cradles engageable with the ends of said carrier rod, a pair of crank arms, said cradles being journaled at the distal ends of the crank arms and spaced to intercept the carrier rod held on the sockets, means for oscillating the crank arms to transport the carrier rod and included tray from one station to the next station, and an electric motor coupled to said transfer mechanism to orbit said crank arms, said motor being responsive to a timer control at the preceding station, the timer control is actuated upon the carrier rod arriving at the preceding station and is determinative of the duration of processing at said last-mentioned station.

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