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[21] Appl. No. 590,455
[22] Filed Oct. 17, 1966
[45] Patented Feb. 2, 1971

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[54] **MODULAR TRANSPORT DEVICE FOR
PROCESSING A WORK PIECE**
12 Claims, 13 Drawing Figs.

[52] U.S. Cl. 95/89,
118/425; 134/83
[51] Int. Cl. G03d 3/10
[50] Field of Search..... 95/89(Digest),
89(Dip), 94; 118/423, (Inquired),
425; 134/82, 83, (Inquired); 198/218, (Inquired)

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ABSTRACT: A photographic processor having removable modular devices for transporting the film through the processor. The modular device includes a pair of spaced cam members for supporting a work holder-carrying photographic film, lifting rods for each of the cam members, and releasable stop elements for each of the cam members. The releasable stop elements maintain the work holder in a first position on the cam member when the member is in the lowered position and release the work holder in response to raising of the cam member to permit it to move along the cam member to a transfer position in which the holder overlaps and is subsequently transferred to the first position on the cam members of the modular device contained in an adjacent processing tank. The modular device also has a control mechanism for selectively controlling the time periods which transpire between raising and lowering of the cam members.

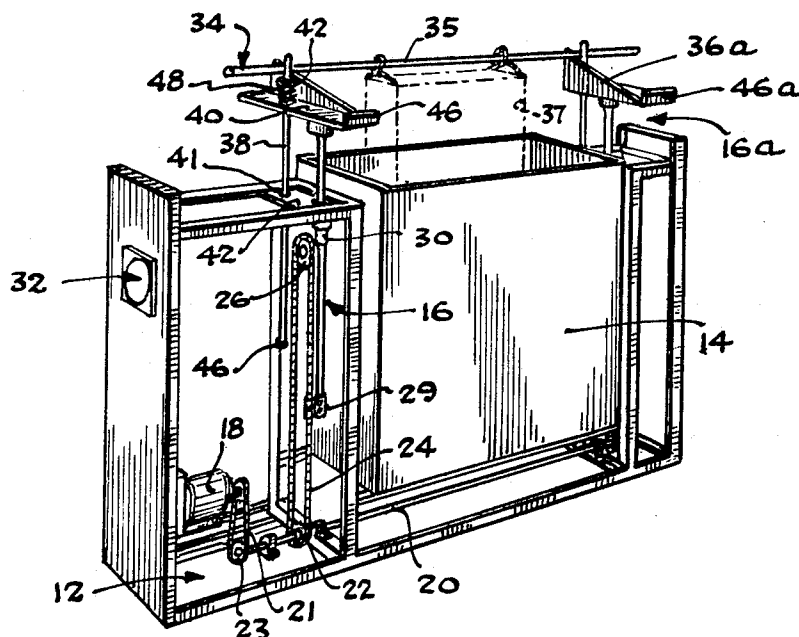


Fig. 1

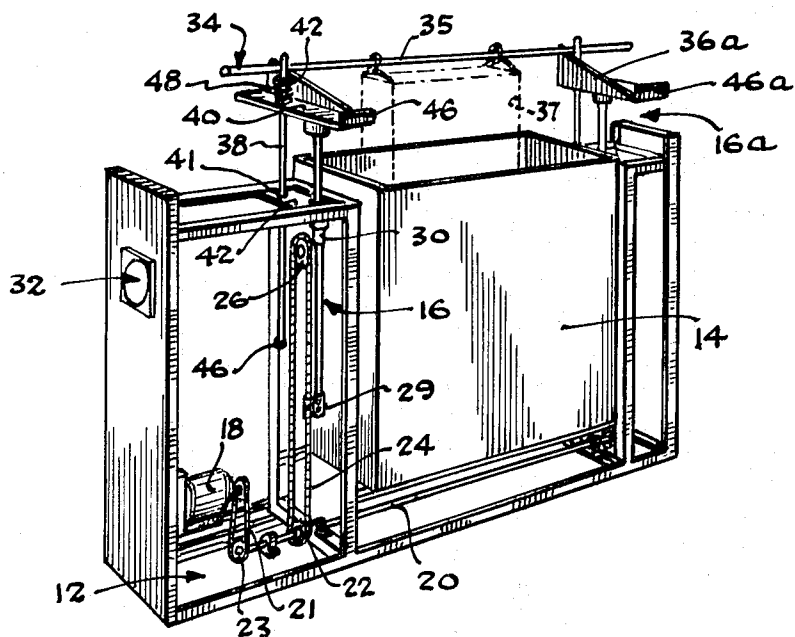
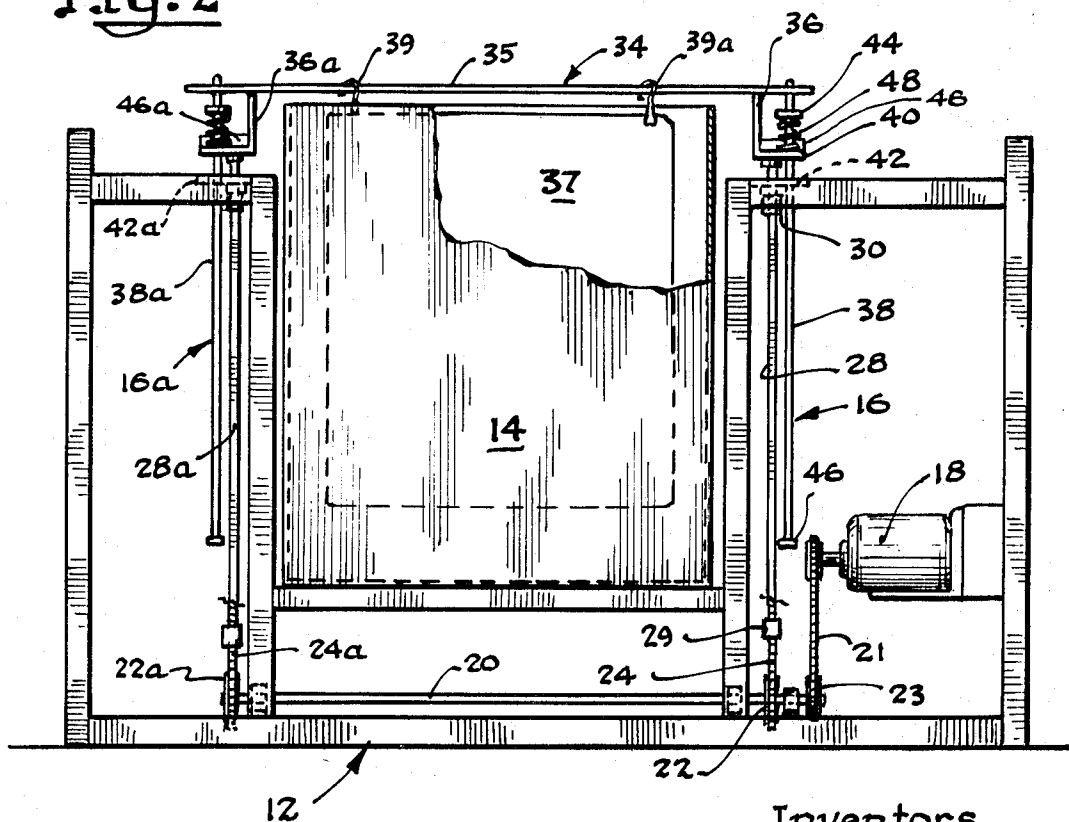
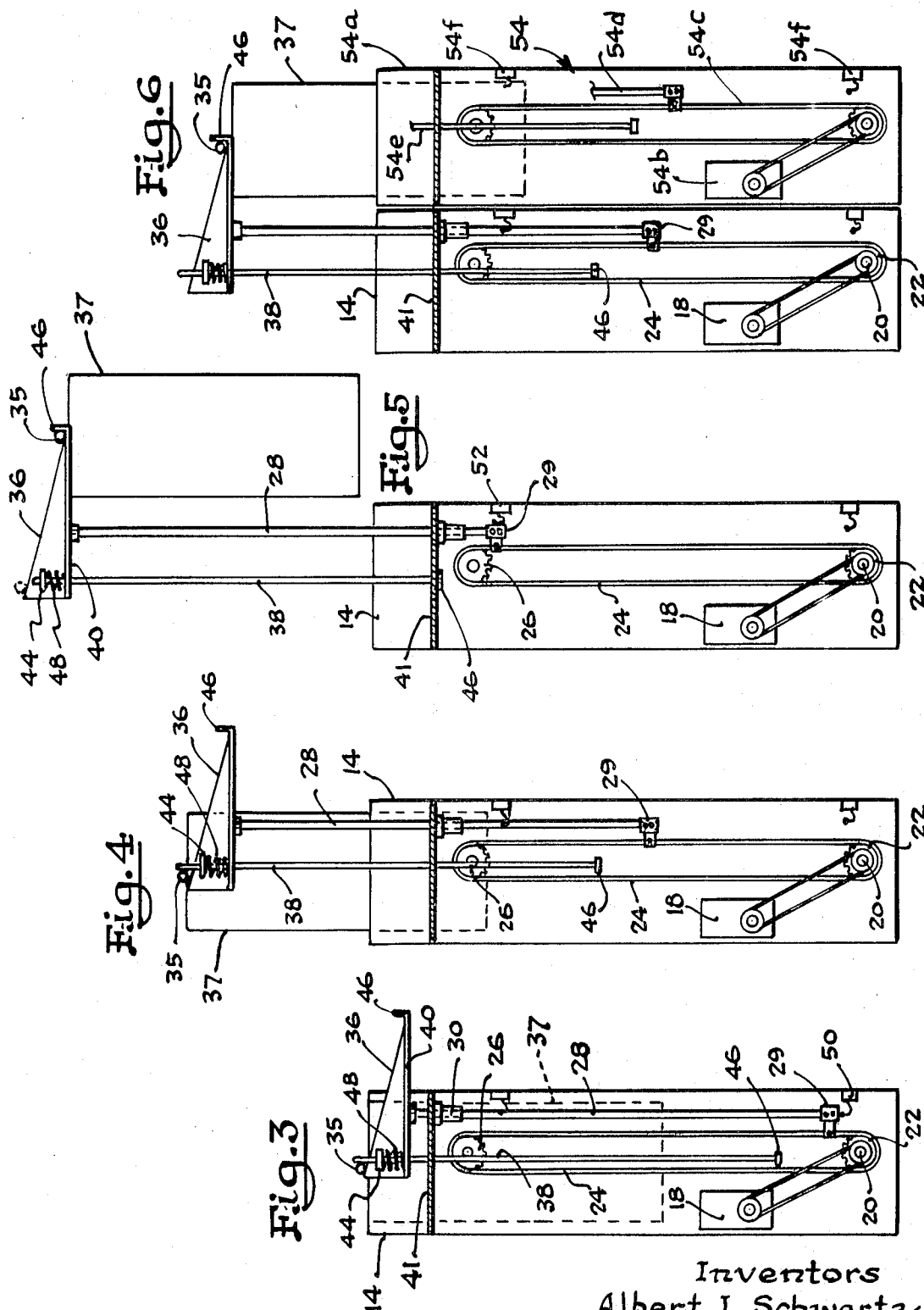


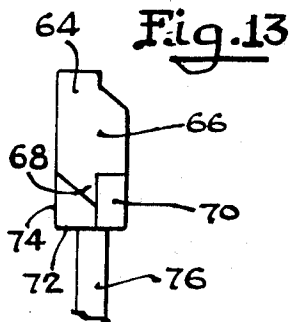
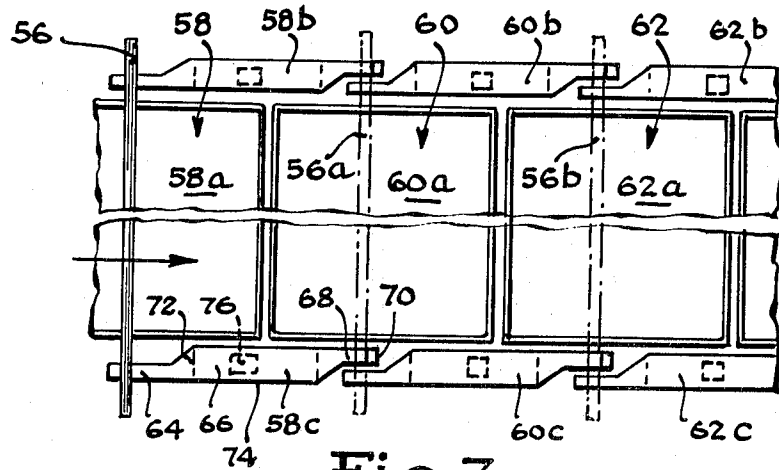
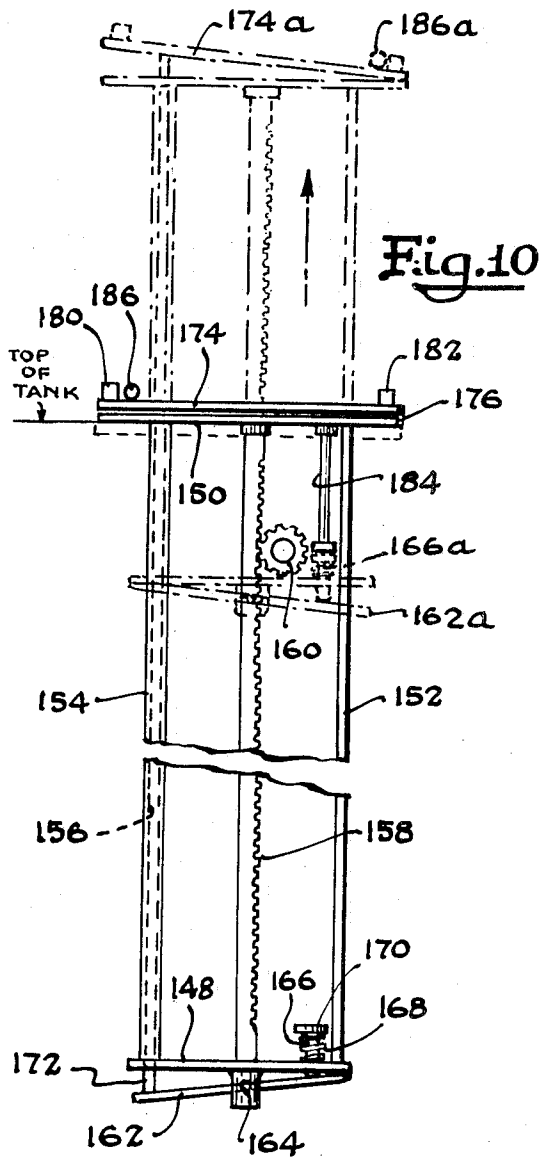
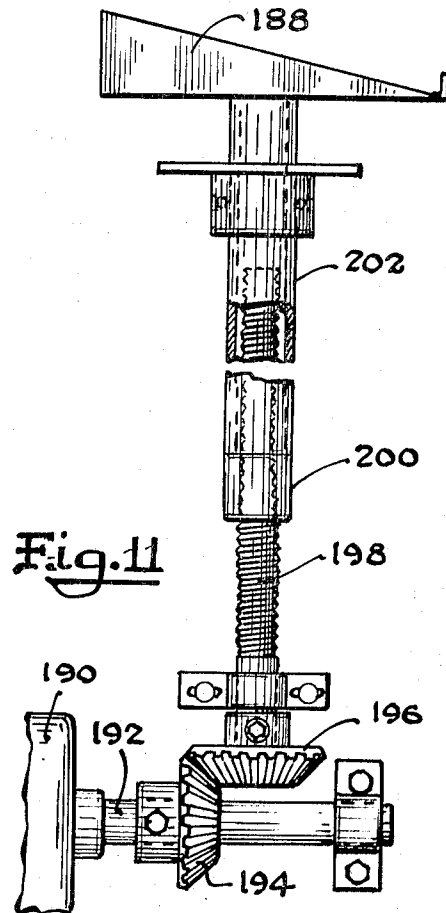
Fig. 2



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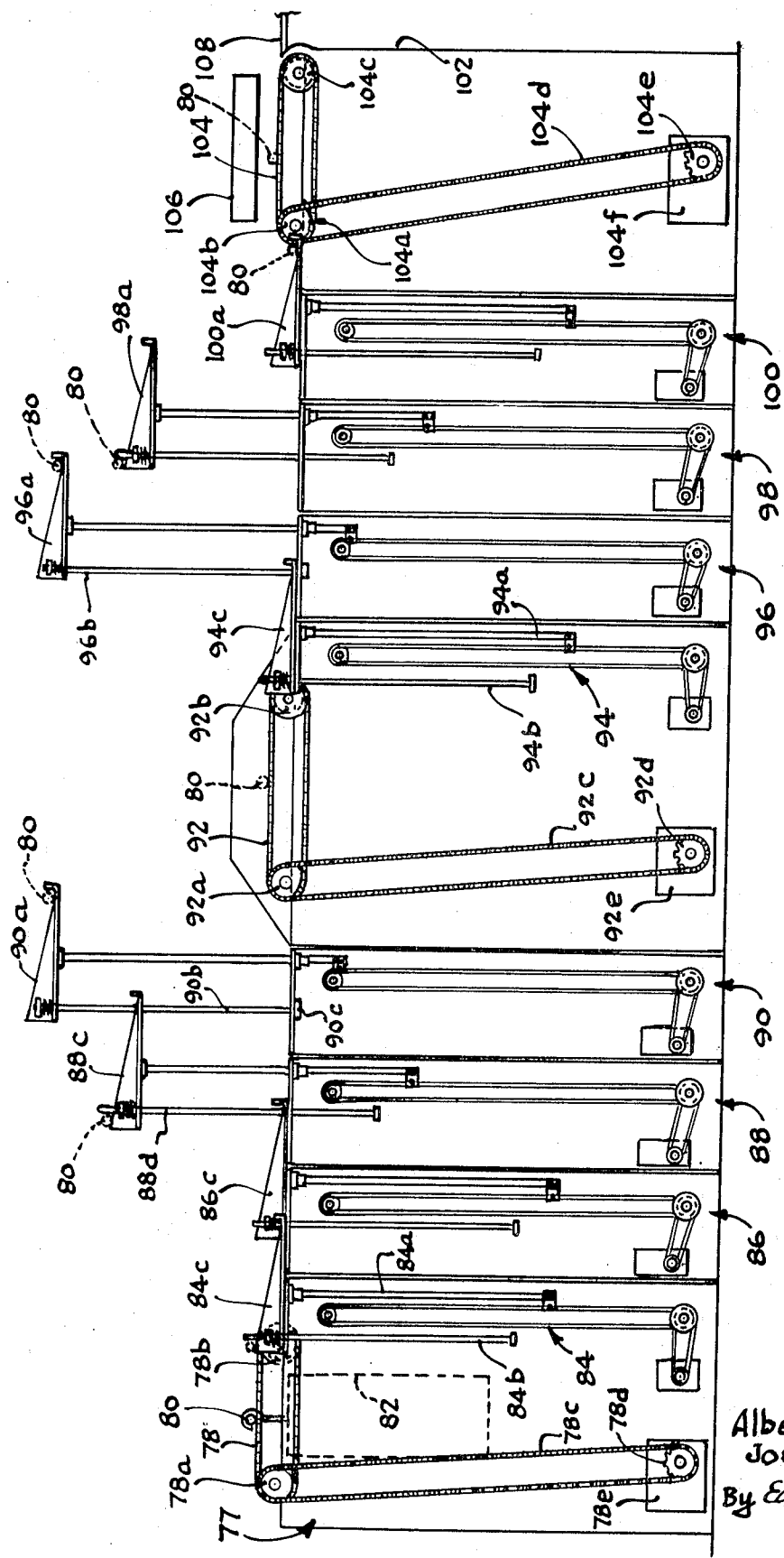


Fig. 8

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Fig. 9

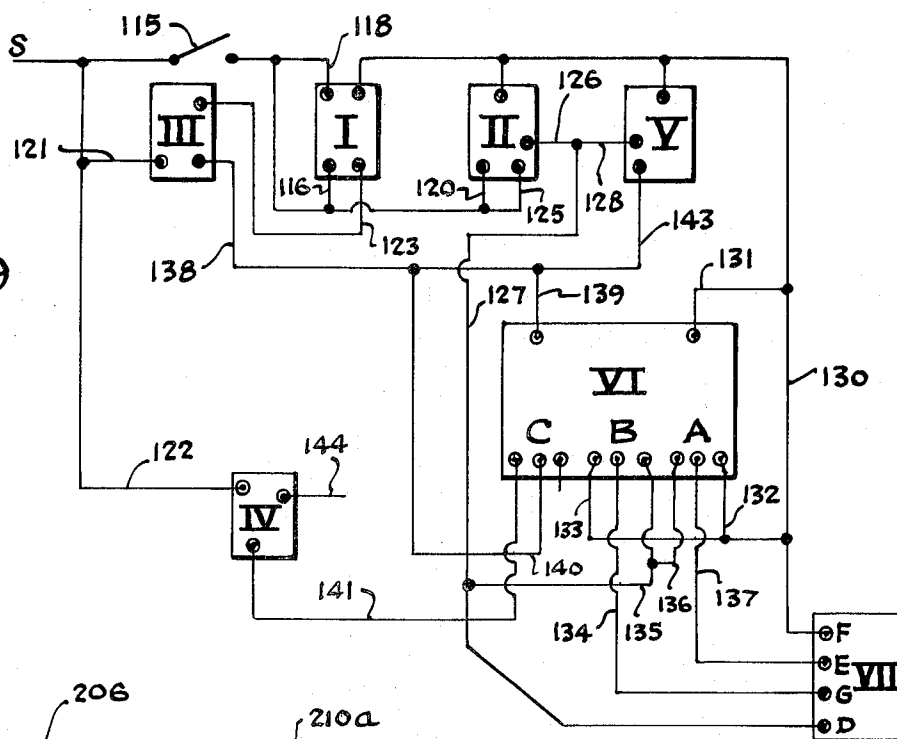
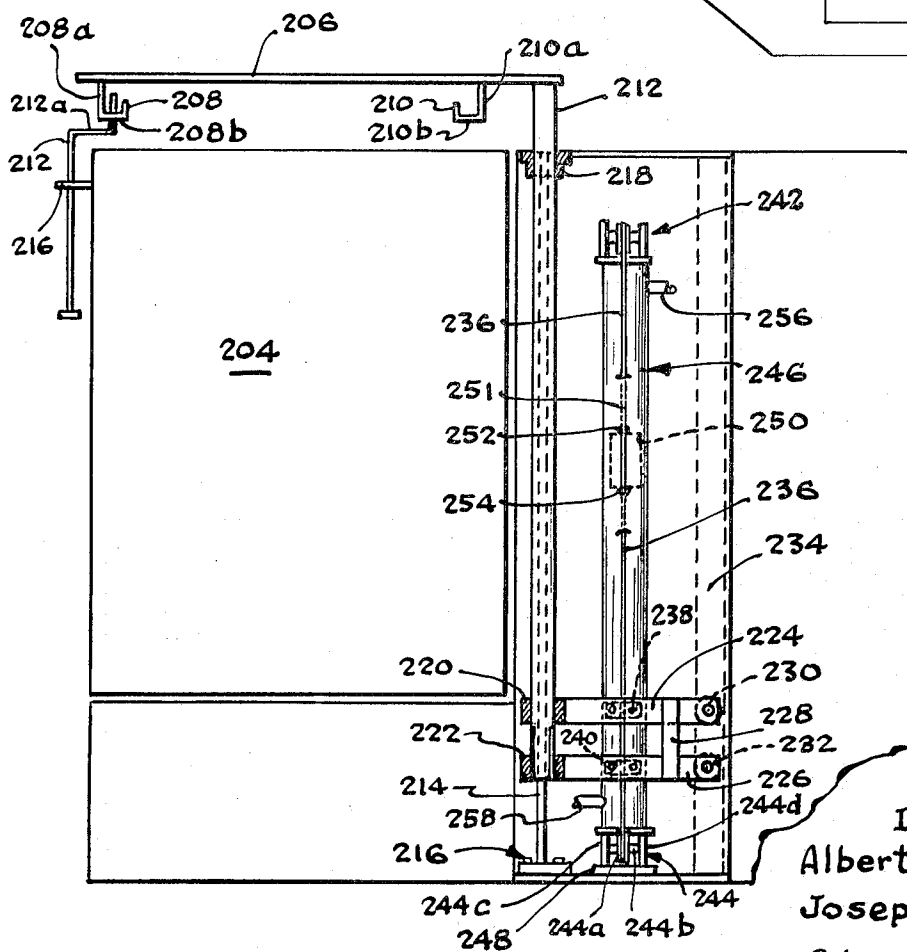


Fig. 12



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MODULAR TRANSPORT DEVICE FOR PROCESSING A WORK PIECE

This invention relates to the processing of workpieces in various processing operations requiring contact of the workpiece with a fluid bath. The invention particularly relates to modular devices which can be adapted to a wide variety of processing operations by variously grouping such modular devices, and the invention also relates to methods of assembling different processing operations by utilizing such modular devices.

This invention finds particular adaptability to the processing of photographic film, and such use will be particularly described. The disclosed apparatus and method will, however, find applicability in analogous areas where other workpieces may be processed in an equivalent manner.

Film processing is largely performed in the art by machine processing where variables in temperature, time and chemical strength are determined for a particular processing operation. The machine operation usually provides a plurality of tanks and mechanisms for transferring the film from tank to tank in accordance with prescribed time periods. The foregoing variables can be controlled in the machine, but once a machine is set up for a particular process, essentially only that process can be run in that machine. The use of the machines speeds up the processing and adds convenience, but the practitioner loses flexibility while using such costly machines.

The processing of photographic film requires different liquid baths and further requires contact of the film with the baths for different periods of time, as in the conventional steps of developing, fixing, and washing. The machines may be programmed to deliver the film for the required time periods to the different tanks, but such machines are assembled with limitations as to the number of tanks; also, the mechanism is integrated with the number of tanks so that the film may be sequentially delivered to the tanks contained in any one machine. Such machines are often assembled with the limitation that a particular type of film is used for a particular type of processing, for example, roll film, plates, and color processing. Such machines tend to reach very high costs because the mechanisms, tank facilities and the like must be correlated for a particular process. In other words, the practitioner must obtain a machine which is designed for a particular process and is therefore essentially unique. For a basically different process, the practitioner must consider the costly investment for a basically different machine.

As mentioned, each bath in the process has a distinct identity as to its ingredients and the concentrations of such ingredients; and such distinctiveness is emphasized strongly for some processing operations such as multicolor processing for the graphic arts. As is well known in that art, the processing involves color separation procedures where a separate film negative is processed for each basic color which is used. Each of such negatives must remain in the developer for different time periods and must, therefore, be processed separately. This understandably requires first running one type of negative through the machine until processing is concluded, and then readjusting the controls for the baths to change the time periods in which the film is contacted with the developing solutions. The correlated relationships of the parts and mechanisms of a machine requires either resetting the machine to obtain a new correlation, or to use another machine which is distinctively set for the modified process. These are understandable disadvantages because it is time consuming to reset the machine for a separate run, and it is highly expensive to have additional machines. In short, all the problems and disadvantages in using the machines of this art arise because of the absence of flexibility and versatility of the machines. This lack of versatility results in the most serious consequences because the machines are highly expensive, and adding more machines may result in financial burden.

Among the available automatic-processing machines are the type with roller mechanisms where a web of film is sequentially passed through a plurality of tanks in accordance with

programmed time periods. The film is thereafter collected in an unloader and dryer. This machine is limited to the roll or film web, to the number of tanks through which the web passes, and to other particularities of the process. Other types of machines use an overhead robot to pickup film plates or the like and then transport such films to succeeding tanks in the machine. Such a robot may be automatically programmed to contact the film for appropriate time periods in the various liquid baths as required by the process. A machine of this type is shown, for example, in U.S. Pat. No. 3,079,852 issued to one of the present joint inventors as a joint patentee. A robot in machines of the type shown in the foregoing patent moves along overhead rails, and mechanisms in the robot lower and raise the film holder with its loaded film to immerse and withdraw the film from the various tanks. Such robots and their controls are integrated with the particular machines, therefore, the sweep of the machine is limited by the length of the tracks, and its operation is necessarily related to the number of tanks in the unit assembly. Such machines, in general, also have other integrated stations as a part of the unit, for example, loaders and dryers for the film and the like. This understandably adds to the complexity, expense and inflexibility of the machines.

In the processing of photographic roller plate film and photographic prints, hereinafter collectively referred to as photographic materials, it is many times desirable to provide ancillary equipment to cooperatively operate with the fluid bath tanks. Such equipment may include filtering apparatus, recirculation piping, automatic replenishing of the chemical baths, agitation provision by use of plenums, and other devices used and known in this art. Such ancillary equipment is often built into the machine, or the placing of such equipment is restricted by limitations of space in a machine of given dimensions. The inclusion of such devices in a machine also limits the number or type of process operations which may be used, and the servicing of such machines may be difficult and awkward because of the fixed spatial relationships of the tanks and mechanisms in the machine.

The state of the art, as illustrated by the foregoing discussion, makes it evident that an advance which is particularly desirable is one which could markedly reduce the great expense of photographic processing by machine, to facilitate such processing, and to provide machines which are adaptable to a wide variety of processing operations. It is accordingly one primary object of the present invention to provide an apparatus which can be economically used with other similar apparatus for processing workpieces in fluid baths; and it is also one primary object to provide a method wherein a wide variety of process operations can be efficiently assembled by grouping a plurality of apparatus, each of which is similar in basic design to provide advantages and economies in production and distribution.

Another object is a modular apparatus and unit in which a workpiece such as photographic film or print sheets may be contacted with a fluid bath, and removed from such a bath in accordance with a predetermined program of process treatment.

Another object is an apparatus and unit which is adapted to serve as a module and which is adapted to be grouped with other like apparatus for processing a workpiece such as photographic material in a process operation established by said grouped modules.

Another object is a modular unit for handling a workpiece such as photographic material with means independently associated with each module, such means adapted to lower the workpiece into a processing bath, lift the workpiece therefrom, to move the workpiece into position for treatment in another like module, and to transfer said workpiece to like manipulative means independently associated with said other module. It is a further feature of this object that the foregoing modules have control means to selectively set the contact time of the workpiece in the respective processing baths in accordance with a predetermined program.

A unit or module for handling a workpiece in the manner suggested has numerous advantages and uses. Among such advantages is the facility with which a number of process operations may be established by grouping the separate and independent modules so that a workpiece such as photographic material may be processed in each module and transferred from module to module. It is therefore another primary object of this invention to provide a method for assembling a processing operation by grouping modules, of the type referred to, in a manner which will attain the purposes of a particular processing operation.

Another object is a method for establishing a processing operation in which a workpiece, such as photographic material, may be sequentially treated in processing baths, which method includes providing appropriate processing fluids in respective modules of the type referred to, grouping such modules in a desired sequence, and controlling the contact time of the workpiece in the respective sequential baths. A further aspect of this object is to establish a processing method wherein processing steps in stations, which do not include bath processing, may be added to the bath processing modules or be interposed between sets of bath-processing modules. In the photographic field such nonfluid bath stations may include loaders, pass boxes, unloaders and others known in the art.

The objects relating to establishing processing operations and methods are characterized both by the large number of operations which can be established, and the comparative ease and economy with which they can be set up. Accordingly, a further object of this invention is a method for simply establishing processing operations consisting essentially of a small number of modules of the type referred to; and a method for establishing more complex processing operations involving plural sets with each set having a required plurality of modules of the type suggested. It is likewise another object to provide a method for modifying or basically changing an established process operation by modifying the modules, adding modules or removing modules, such alteration of the processing operation being accomplished with comparative ease, facility and relatively modest cost.

The processing module disclosed herein includes the following advantages and characteristics:

1. A self-contained unit of the same basic design so as to allow interchangeability;
2. The facility to set up a variety of operations without requiring conformity to a particular process;
3. The provision of auxiliary means, such as temperature control and agitation of the bath;
4. Flexibility to allow a succeeding workpiece to be programmed to commence processing as soon as a first workpiece has progressed sufficiently to prevent interruption between the workpieces;
5. Individual control in the handling of a workpiece while permitting, if desired, a central control means to selectively control a group of modules in a particular process;
6. Individual or central control means to vary the contact time of a work piece in an individual module or selectively bypass a given module;
7. A processing operation established by a group of modules which do not require fixed or permanent superstructures or other supporting or interlocking structures;
8. A processing operation which can include nonfluid bath stations or apparatus without interfering with the operation of fluid bath module;
9. Modifications for special functions, such as providing inlets for replenishing exhausting processing fluids;
10. Versatility and wide adaptability to meet obsolescence of a given process operation.

The objects, advantages and characteristics above referred to will become apparent in considering the following disclosure, which includes drawings, wherein:

FIG. 1 is a perspective view more or less diagrammatic, of a processing module;

FIG. 2 is a rear diagrammatic view of the processing module, on an enlarged scale;

FIGS. 3—6 are side diagrammatic views with parts removed to illustrate the different operational steps of the processing module;

FIG. 7 is a top diagrammatic view of a plurality of aligned modules which particularly illustrate a means by which a workpiece is transferred from a preceding module to a succeeding module;

FIG. 8 is a diagrammatic side view, with parts removed, of a photographic processing assembly which includes a plurality of processing modules and nonfluid stations;

FIG. 9 is a schematic of an electrical circuit control for lowering and raising the workpiece in a processing module;

FIG. 10 is a more or less diagrammatic view, with parts removed, of an alternative embodiment for raising and moving the workpiece to a position for processing in an adjoining module;

FIG. 11 is a side elevational view showing another alternative embodiment, partly diagrammatic, for raising and moving the workpiece for processing in an adjoining module;

FIG. 12 is a front diagrammatic view, with parts removed, showing another embodiment for raising and moving the workpiece to a position for processing in an adjoining module; and

FIG. 13 is a front view, in an enlarged scale, of a cam with reduced width portions of the type shown in FIG. 7.

The use of the same numerals in the various views will indicate a reference to the same structures, parts, and relationships.

FIGS. 1 and 2 show a single module in which a frame shown generally as 12 is seen to include a tank 14 adapted to hold a processing bath such as photographic developing, fixing or washing solutions and other fluids. The module is shown with a lifting means indicated generally at 16. Such illustrated means include a motor 18 mounted on the frame, which motor rotates a shaft 20 by means such as a chain 21 which turns sprocket 23 fixed to the shaft 20. The shaft 20 turns a fixed sprocket 22 which, in turn, rotates an endless sprocket chain 24 around the sprocket 22 and an upper sprocket 26. A lower sprocket 22a is fixed to shaft 20 on the other side of the tank, and such sprocket turns a chain 24a around a rotatably mounted upper sprocket which is not seen in these views.

The lifting means include a lifting rod 28 which is rigidly secured at its lower end by bracket 29 to the endless chain 24. The rod 28 is raised in this embodiment as the chain moves about one-half its total length. The movable range of the lifting rod is generally a distance measured from the bottom sprocket 22 to about the upper sprocket 26. The lifting rod is supported by a collar 30 having a bore with a cross-sectional configuration matching the sectional configuration of the rod. This is preferably a polygonal configuration such as a square to better keep the rod in the collar. The collar is shown fixed to the frame to provide stable support for the rod as it makes its transit through the bore of the collar. A control panel is shown generally at 32, and it includes means to selectively turn the electric motor on and off by an electrical connection (not shown) in accordance with the requirements for treating a particular workpiece. Such a control means may allow manual control of the lifting mechanism in accordance with the timed sequence, or it may include more sophisticated electrical circuits for automatic control which can be preset by use of timers and other ancillary units in accordance with a particular programming. A representative embodiment of such a control means will be later illustrated. The opposite side of the tank also has a rod 28a similarly joined to chain 24a to cooperate with the mechanism on the other side for raising the workpiece.

A workpiece assembly 34 is shown positioned along the high surfaces of cam members 36 and 36a which are fixed respectively to lift rods 28 and 28a. The workpiece 34 is shown held at the top of the cam members or hills by a stop elements 38 and 38a shown as smaller diameter rods. A description of stop 38 will also apply to stop 38a. The rod 38 passes through an opening in a lateral flange 40 of cam member 36, and the rod 38 is also shown passing through an

opening 41 in plate 42 which may be part of the frame structure. The stop element 38 includes an upper flange 44 and a spring 48 between said upper flange 44 and lateral flange 40 of the cam member 36. The low surfaces of the cam members are shown with means to limit the travel of the workpiece such as upturned lips 46 and 46a.

The workpiece means include a support shown as a transverse member 35 supporting a workpiece 37 by hooks 39 and 39a which are removably engaged to the transverse member 35. The workpiece herein is intended to illustrate a basket for holding a plurality of film plates which are not shown. When the lifting means are lowered, the workpiece 37 is adapted to be substantially positioned within the confines of the tank 14, so the workpiece may be fully immersed therein.

FIGS. 3 to 6 depict steps to illustrate the module in operation. It is understood that the reverse side, not viewed, has a chain, lift rod, stop and cam to cooperate with the same parts on the viewed side. In FIG. 3 the workpiece 37 is shown immersed in the tank 14, and the lifting mechanism is shown in its low position as indicated by the position of the bracket 29, and the relative positions of the cam member 36 and the top of the tank 14. The tank may be considered as containing a processing bath, and the workpiece 37 may be viewed as being immersed therein for processing for a desired time period.

Following the conclusion of the desired processing time of FIG. 3, the motor 18 is started and the workpiece is raised out of the processing bath in the tank, as shown in FIG. 4.

The raising stage in the cycle of operation may be started by various control means. Such control means may include the illustrated lower limit switch 50 which is actuated by the bottom of rod 28 making contact with the switch 50. The illustrated embodiment shows the bracket 29 contacting the switch, and such switch is adapted to start the motor 18 which turns the chain 24 to lift the rod 28 in the raising stage of the cycle of operation. The cycle of operation may be considered as including a lowering stage, an immersion stage where the workpiece is in the tank for a determined time period, the raising stage, the moving stage where the workpiece is moved for immersion in a tank of a succeeding module, and a transfer stage where the workpiece is picked up by the lifting mechanism of the succeeding module.

The partly raised position of the workpiece is indicated by the intermediate position of the lifting mechanism as illustrated by the bottom of rod 28 where it is joined to the chain 24 by the bracket 29. In such an intermediate position the chain 24 has travelled about one-half the distance which is measured between the bottom sprocket 22 and the top sprocket 26. Further, the intermediate position shows the stop element 38 still retaining transverse member or crossbar 35 at the top of the hill 36. It will be realized that on the opposite side of the module, the opposite hill 36a will be raised to the same height by the opposite lifting mechanism 16a to provide two spaced support points for the crossbar 35 and the workpiece 37 mounted thereon in depending relationship.

FIG. 5 shows the workpiece in its raised position as indicated by the position of the bottom of the rod 28 where it is joined to the chain 24 by the bracket 29. The chain 24 has now travelled substantially the entire distance which is measured between the lower sprocket 22 and the upper sprocket 26. In this embodiment the chain 24, therefore, travels a distance which is about one-half its total length in order to raise the workpiece from the lowered position to the raised position.

The stop element 38 releases the transverse member from the top of the hill when the workpiece is raised to the up position shown in FIG. 5. The illustrated embodiment shows the release of a stop element by pulling rod 38 down when lower flange 46 intercepts fixed member or plate 41 on the frame structure. Continued raising of the rod 28 pulls the rod down and compresses spring 48 between upper flange 44 and the lateral flange 40 of the cam member 36. The transverse member 35 and its depending workpiece 37 then move down the hill or move to the low surface of the cam member 36. This

embodiment shows an upper limit switch 52 which is adapted to be contacted by the bottom bracket 29 of the rod 28. Tripping the switch allows the motor to be reversed so that the lifting rod may be lowered in the next stage of the processing cycle.

FIG. 6 shows the workpiece at the bottom of the hill and being lowered into the tank of an adjoining module shown generally as 54. A tank 54a of this adjoining module is adapted to contain a bath which is next required in the processing operation, for example, a water wash after film has been processed in a developer solution in the preceding module. The adjoining module 54 is aligned with the preceding module so that module 54 can receive the workpiece support 35 and the workpiece 37 in a transfer step.

Module 54 is an independent unit which contains its own motor 54b, its own lifting chain mechanism 54c with its own lifting means 54d, and its own stop element 54e. This embodiment also shows the same control means in the form of limit switches 54f to start the next stage in the cycle of operation. Module 54 may have other parts to serve a particular purpose in the processing operation of that module, such as means to control the temperature of the bath in the tank 54a. It is not required that all the modules in a particular processing operation be identical units since it may be desirable to modify a particular module to provide additional or modified operations. In addition to providing some modules with temperature control means, a plenum may be provided to agitate the bath by delivering various inert gases under pressure. Circulation conduits may also be provided to replenish exhausting supplies of the fluid bath. Many other modifications may be practiced so long as the modules retain their essential independence of one another, and so long as the modules may be aligned for functional and cooperative operation.

The transfer stage provides that the workpiece support and the workpiece be transferred to the lifting mechanism of an adjoining module.

The embodiment shown in FIGS. 1-6 shows cams 36 and 36a one of which will be slightly spaced from its adjoining sidewall. When such a module is aligned with a succeeding module, the cam and its associated lifting mechanism of such succeeding module will be slightly spaced away from its adjoining sidewall, but on a side opposite to the side where the preceding module has a similar spacing. This will allow the low cam surfaces of the preceding module to overlap the high cam surfaces of the succeeding module. The transverse support member may then be transferred between such adjoining modules. In such embodiments, adjoining modules will have small relative modifications insofar, at least, as the lifting means will be alternately spaced relative to opposite sides of the tanks. Generally, the spacing need be only a small distance, say, about 2 inches. If desired, alternating modules may be provided with tanks of varying dimensions from side to side. Thus, there may be a large dimension tank and then a smaller dimension tank with lifting mechanisms along the sides to overlap with the lifting mechanism along the sides of the larger dimension tank.

FIG. 7 indicates another embodiment for effecting such a transfer. A workpiece support 56 is shown relative to a module indicated generally as 58, said module including a tank 58a, and a pair of spaced cam members 58b and 58c. Module 58 adjoins module 60 with its tank 60a and spaced cam members shown respectively at 60b and 60c. Another adjoining module is shown at 62 with its tank 62a and spaced cam members indicated respectively at 62b and 62c. Cam member 58c shall be described in greater detail, but such description will likewise apply to the other spaced cam members.

The top cam surface of the cam member includes a high surface of reduced width indicated at 64, an intermediate surface of full width indicated at 66, and a low surface of reduced width indicated at 68. The end of the low surface 68 has an upright lip at 70 to serve as a stop for the support 56. A lateral flange 72 is positioned substantially below portion 66 and it

may be integrally formed with an inclined sidewall 74 which is also joined to the intermediate portion 66. A substantially square-shaped rod 76 is indicated as being fixed to the lateral flange 72 of the cam. This square-shaped rod moves through a corresponding square-shaped tube or collar fixed to the frame of the module in a manner similar to that shown in the views of FIGS. 1 and 2. A cam of the foregoing type is also seen in the front view of FIG. 13.

The reduced width portions 64 and 68 are generally oppositely offset relative to each other so as to permit an overlapping and offset relationships with reduced width portions of adjoining cam members. Thus, a high surface reduced width of a cam will overlap and be offset with a low surface of a preceding cam, and the low surface of reduced width of that same cam will overlap and be offset with a high surface of reduced width in a succeeding cam. The low surface of cam 58c has such a relationship with the high surface of cam 60c, and the low surface of cam 60c has such a relationship with the high surface of cam 62c. When the workpiece support is moved to the position indicated at 56a, it will be transferred to the high surfaces of cams 60b and 60c when such cams are lifted. After the support has moved to the low surfaces of cams 60b and 60c as indicated at 56b, it is transferred to the high surfaces of cams 62b and 62c where it is in position to be raised by the lifting mechanism of those cams.

The method for setting up a representative processing operation from a plurality of the processing modules is illustrated in the diagrammatic view of FIG. 8. A description of parts will be made on the side which is viewed, but like parts will be on the side not viewed. A nonfluid processing station 77 which is a loader for photographic materials, such as film or printing sheets, is used as the initial unit in setting up the process operation. This station has a conveyor chain 78 on which may be placed a workpiece support 80 with a workpiece 82 depending therefrom. The conveyor is conventionally set up with idler sprockets 78a and 78b, and a transmission chain 78c driven by sprocket 78d from a motor 78e. This station is provided with a lifting mechanism shown generally as 84, lifting means 84a, a stop element 84b and a cam member 84c. The transverse support 80 is placed on the conveyor 78 and moved to the high surface of cam 84c, whereupon it is raised, moved and transferred to the first module shown generally as 86. The workpiece is processed in the tank of the module 86 for a predetermined time period as required by the particular photographic-processing operation. Thereafter, the workpiece is lowered into the tank of module 88. The workpiece support 80 in this module is shown as being held by the stop element 88d in the intermediate raised position. The workpiece is then moved to the low surface of the cam 88c and lowered into the tank of the module shown generally as 90.

The processing operation can understandably be set up by grouping as many modules, containing the desirable bath liquids, as may be required for the particular processing operation. Each of the processing modules is essentially independent of the other modules, and even of the nonfluid processing stations such as the loader. The support in module 90 is seen after conclusion of the moving stage in which the support has moved from the high surface to the low surface of the cam 90a. The stop element 90b is shown being pulled down after its lower flange 90c is placed in abutting relationship with an interrupting surface of the module. The illustrated processing operation has been set up by grouping a set of modules, namely, 86, 88, and 90 with the loader station 77. Another nonfluid processing station is shown placed next to the last module of the first set, a pass box 92. The film material is subjected to different light conditions in the modules separated by the pass box.

The work support 80 and its workpiece 82 are transferred from cam 90a of the last module in the first set to the conveying chain 92 in the pass box. The conveying means or chain 92 includes idler sprockets 92a and 92b, transmission chain 92c, and a sprocket 92d driven by motor 92e. The pass box also in-

cludes a raising mechanism shown generally as 94, a lifting means 94a, a stop element 94b, and a cam member 94c. The cam member 94c is adapted to raise the workpiece and to lower it into module 96 which is the first module in the next set of modules.

The processing operation is further established by setting up a required number of modules in this set, all the modules in the set being placed in adjoining relationship so that the workpiece may be transferred from one module to the next module. The cam 96a of module 96 is shown in the up or raised position after the stop element 96b has been released to allow the support 80 to move to the low surface of the cam. The workpiece 82 is now in position to be lowered into the tank of adjoining module 98, whereupon it will be raised following a predetermined processing period in the tank of the module 98. The position of the support is indicated on the cam 98a at an intermediate raised level. The workpiece is then adapted to be lowered into the tank of the module 100 by reaching the appropriate stage in the cycle.

After completing the processing in the tank of the module 100, the workpiece is adapted to be transferred from the last module of the second set to another nonfluid processing station, shown here as a combination unloader and dryer 102. The support 80 is picked off the low surface of the cam 100a onto a conveyor chain 104 which may have a plurality of attached fingers such as 104a to pickup the support from the low surface of the cam 100a. The conveying chain may conventionally turn around idler sprockets 104b and 104c. A transmission chain 104d may be rotated by sprocket 104e which is turned by motor 104f. A heater 106 is shown for drying the photographic material, and a storage rack 108 is shown for holding the processed and dried photographic material.

The foregoing process operation has been conveniently set up by simply grouping the required number of modules in adjoining relationship with or without other nonfluid processing stations. The process allows convenient modifications of the established operation by adding or deleting modules as may be required by the new processing setup. The method of using the processing modules to establish a processing operation permits other useful variations and modifications. If, for example, it becomes desirable to skip a module in the processing, then a workpiece may be moved to the low surfaces of a pair of spaced cam members, but remain held at the raised position until the raising mechanism from the next module is raised to pickup the workpiece on the high surfaces of its spaced cam members. In other words, the workpiece which has been raised from the preceding module's tank is now lowered into the next adjoining module, but a transfer stage is effected in the raised position so that the workpiece which has been transferred to the adjoining spaced cams may be lowered into the succeeding module's tank. Immersion in an intervening tank can thereby be passed over. A single workpiece has been illustrated as being processed in the sets of modules and in the nonfluid processing stations, but it should be understood that succeeding workpieces may be continuously loaded and delivered to the modules so long as the forward workpiece has advanced to a succeeding module where no interruption will occur between the modules.

Various control means may be provided for controlling the time which the workpiece is immersed in the tank, the amount of time that the workpiece is held in the raised position, and the like. Among such means are automatically and electrically controlled circuits by which a particular process may be programmed according to the processing requirements of the process. By the use of relays and timers, conventional circuits may be designed so that the time periods for each module may be predetermined. One such electrical circuit control is indicated in the schematic showing of FIG. 9.

In the schematic, III and IV represent respectively the upper and lower limit switches such as 50 and 52 in FIGS. 3 to 6; I represents a relay control; II, V and VI represent timer delays; and VII represents a single phase 110 volt motor with four leads which allow the motor to be reversed. A switch or the

like 115 starts the operation and the current from the positive source S goes to the single pole double throw relay control I along 116 and 118. The positive travels to upper limit switch III and along 123 to lock the relay I, which will remain locked until the bottom of the lift rod contacts the upper limit switch III. The positive also travels to the timer clock II along 120 and 125, whereupon, after a delay, the current will pass to 126, 127 and to motor lead D, one of the four motor leads. Timer II controls the time period in which the workpiece is immersed in the tank. The positive also passes to timer delay V or the two second time delay relay. The negative 130 goes to motor lead F, and the negative also goes to the three pole delay timer VI along 131. VI has three sections, A, B, and C with the negative going to the normally open contact of A along 132, to the normally closed contact of B along 133, to the common of B along 134 and to motor lead G. The positive goes to the common of section A, and then along 137 to motor lead E to complete the connections to all four motor leads. The motor starts and raises the workpiece out of the tank to the raised position.

When the upper limit switch III is tripped by the lower end of the lifting rod, it breaks the current along 123 and the relay I is unlocked. The positive then travels to the delay timer VI along 139, to the common of section C along 140, and the motor leads G and E are then interchanged. The positive then travels to the lower limit switch IV along 141 where the normally closed contact is now changed to normally open until later tripped by the bottom of the lifting rod when it is lowered. The positive along 138 also energizes timer delay V which controls the time period in which the workpiece is held in the raised position to effect the drain and the downhill travel. After a desired delay, the positive moves along 128 and then to 127 and to motor lead D, whereupon the motor VII operates in reverse. At this condition, the positive cannot travel to the relay I or start timer relay II. When the lower limit switch IV is tripped, the positive current to timer delays V and VI is broken, and the motor is shutoff. The line 144 is then energized by the positive current to start the next operation in a succeeding control means of a succeeding module. The foregoing time periods may be preset individually for each module for a particular processing operation. A central console or the like may also be provided to centrally program an entire operation.

An alternative embodiment for raising and moving the workpiece is illustrated in FIG. 10. The lifting device has a bottom crossmember 148, an upper crossmember 150, a side connecting member 152 and a tubular connecting member 154 on the other side. Member 154 has a passageway 156 extending therethrough which is open at both ends. A rack 158 extends to the opposite crossmember's between the spaced side members. A pinion 160 is adapted to be actuated into engagement with the rack to raise the structure. The bottom crossmember has an associated rocker 162 which is pivoted at about its central portion to a pivot 164 fixed to the crossmember 148. A pin 166 extends through an opening in the crossmember and bears against the rocker 162. A spring 168 is positioned between the crossmember 148 and the head 170 of the pin to normally urge the pin away from the rocker. The rocker on the opposite side of the pivot contacts a rod 172 which is translatable positioned within the passageway 156 of the side member 154. The means to move the workpiece at the top of the structure is a rocker 174 which may be hinged to the crossmember 150 at 176. Stops 180 and 182 are shown at the ends of the rocker. Fixed to the bottom of the crossmember 150 is an intercepting pin 184 which is of a sufficient length to abut the head 170 of the pin 166 at a desirable level when the structure is raised. Such an action is indicated in phantom wherein the rocker, shown as 162a, is repositioned by the depressed pin 166a. The action of the rocker moves rod 172 to raise the rocker as indicated in phantom at 174a. The workpiece support 186 is then moved from the solid line position to the phantom position at 186a.

A further alternative embodiment is shown in FIG. 11 where a jack screw is used to lift the cam member 188. A motor 190 rotates shaft 192 and bevel gear 194 fixed thereto. Gear 194 meshes with bevel gear 196 which turns screw 198. The rotating screw advances nut 200 along the length of the screw to raise and lower sleeve 202 which is shown joined to the cam 188. The embodiments of FIGS. 11 and 12 will be positioned on both opposite sides of a module.

Another embodiment is shown in FIG. 12 wherein fluid means such as compressed air or hydraulic oil is used to raise the workpiece. In this embodiment the raising means can be provided on only one side of the tank 204. An elongated transverse bracket or overhang 206 has a pair of spaced cam members or hills 208 and 210 fixed in depending relationship to the overhang 206 by sidewalls 208a and 210a. Lateral connecting walls 208b and 210b join the cams and the sidewalls. A stop element, indicated at 212, is shown in association with cam 208. The stop element is adapted to pass through an opening in the connecting wall 208b and through an opening in the fixed side plate 216 which may be on the tank or other structure. The stop element is shown with an inset or shoulder at 212a to accommodate to a cam member when it is inset relative to the side of the tank. The stop element may, however, be straight by positioning the cam to the overhang at a point outside the sides of the tank. Only one stop element is shown and described, but it is understood that a similar stop element will be likewise associated with cam member 210.

The overhang 206 is raised and lowered with a sleeve member 212 to which the overhang is attached. The sleeve or tubular member 212 is adapted to slide over a standard 214 which is anchored to the floor portion of the frame structure or the like as at 216. The sleeve is translatable supported in an upper bearing element 218 which is rigidly fixed to the tank, frame structure or the like. The sleeve is fixed at its lower end to collars or bands 220 and 222 which are parts of a lifting bracket assembly including arm 224 and arm 226. The arms are rigidly fixed relative to each other by a brace 228. The sleeve is supported at a third point which is made up of rollers 230 and 232 rotatably mounted on the ends respectively, of arms 224 and 226; and rollably engaged with a fixed track 234 secured on the frame structure or the like.

The arms 224 and 226 are fastened to a pulley cable 236 by means such as locking plates 238 and 240. The cable is adapted to turn around an upper idler pulley assembly 242 and a lower pulley assembly 244. Such pulley assemblies are mounted, respectively, to the top and bottom of a cylinder 246. The pulley assemblies are similar and include a sheave such as 244a, and a shaft such as 244b fixed to spaced side members such as 244c and 244d. Pulley assembly 244 is shown mounted on a base supported plate 248.

Inside the cylinder 246 is a piston body 250 shown in dotted line. It is somewhat like a free floating piston. The cable 236 extends around the pulley assemblies and into the cylinder as indicated in dotted line at 251. One end of the cable is fastened to the top of the piston at 252, and the other end is fastened to the bottom of the piston at 254. Fluid such as compressed air is introduced and withdrawn on one side of the piston through port 256, and such fluid is also introduced and withdrawn from the other side of the piston through port 258. In the foregoing embodiment, advantages are realized because the lifting mechanism need be on only one side of the module. Such a mechanism attains stability from a plurality of support points which are provided for the raising sleeve 212, namely, bearing 218, connections 220, 222, and roller bearings 230, 232.

Fluid may be passed through the ports 256 and 258 by conventional manual control means which deliver the fluid from a source in accordance with a desired processing program. An automatic control may also be provided with solenoid controlled valves, timers and relays. A programmed time sequence may then be set up for the individual modules or for the grouped or sets of modules in the processing operation.

The invention described in the foregoing disclosure has wide applicability to the processing of various workpieces in the manner described for the photographic materials. The versatility of the processing modules allows various types of photographic materials to be differently processed. This includes not only film in the form of rolls and plates, but printing paper in similar forms. Appropriate film holders for such forms of photographic materials may be provided for removable fastening to the transverse support.

With such modules, a method is provided for conveniently setting up a wide variety of processing operations since no structural interconnections or structural superstructures are necessary to make the process operational. Each module is functionally independent although, if desired, some functional interdependence could be provided for specialized operations. The functional independence of the modules permits each module to be controlled for executing its functional operation so that the group of modules execute the desired modular processing. The functional independence has been attained by providing the disclosed means for lowering, raising, moving and transferring the workpiece. The moving and transferring stages have been illustrated in conjunction with a hill, but other equivalent means may be used such as cammed grooves, tracks or the like, or other transfer means which allow the modules to retain their essential functional independence.

The invention may now be practiced in the various ways which will occur to practitioners, and such invention should be limited only by the following claims as given further meaning by the disclosure and language of the preceding description.

We claim:

1. A modular device adapted to be grouped with one or more similar modular devices for processing a workpiece carrying photographic film through a plurality of baths; which includes:

a tank adapted to hold a processing fluid;

a workpiece-holding means positioned above the tank, said holding means adapted to permit said work piece to move therealong, said workpiece-holding means including spaced members on opposite sides of said tank, each cam member having a cam surface;

a lifting rod adjoining each of said spaced cam members;

a transverse member supported by said spaced cam surfaces, said workpiece depending from said transverse member;

means to actuate said lifting rods to lower and raise the holding means so that the workpiece positioned thereon may be lowered into the tank and raised out of the tank; and

a releasable stop to hold said transverse member at a first position on a high cam surface of said cam member and to allow said workpiece to move along said cam member to a transfer position at a low cam surface of the cam members upon release thereof, and control means to selectively determine the actuation of the lifting rods so that predetermined time periods transpire during lifting and raising, during movement of the transverse member down the cam members, and during transfer to an adjoining modular device.

2. A device as in claim 1 further characterized in that said actuating means include a motor driven endless chain on one side of the tank, another endless chain on the other side of the tank, the lower ends of said lifting rods being fixed to said endless chains, and transmission means extending between the spaced endless chains, whereupon actuation of the motor raises and lowers the lifting rods as the endless chains are turned.

3. A device as in claim 1 further characterized in that the lifting rods have a polygonal cross-sectional configuration, and such lifting rods pass through a fixed sleeve of like configuration, whereby a tendency towards rotation of the lifting rods is resisted, which tendency is incurred from lifting and lowering weights of the photographic films and their supports.

4. A device as in claim 1 further characterized in that said means to release the transverse member include an elongated rod which in the stop position projects above the top of the high surface of the cam members to hold the transverse member in the initial position;

said elongated stop rod being releasably mounted to the cam member so that the rod is raised with the cam member, a flange member being at the bottom of the stop rod;

an intercepting means being adapted to abut the flange and stop the rod while the cam member continues to rise to thereby pull the stop rod below the high cam surface and permit the transverse member to move down the cam surfaces; and

means to urge the rod back to its stop position after the lifting rod is lowered to remove the flange from abutting relationship with the intercepting means.

5. A device as in claim 1 further characterized by an including a frame structure, said tank being within said frame structure:

a pair of upper and lower sprockets rotatably mounted on the frame on one side of the tank, another pair of upper and lower sprockets rotatably mounted on the frame on the opposite side of the tank, endless sprocket chains rotatably mounted on each of said sprocket pairs;

a motor mounted on the frame, transmission means between the motor and one of the endless chains, other transmission means to transmit driving force from one endless chain to the other endless chain, said lifting rods connected to aligned sides of each endless chain;

the bottoms of said cam members having a flange member;

an elongated rod extending through an opening in each flange member, an upper flange on said rod, a lower flange on said rod, a spring between the upper flange rod and the cam member flange, said elongated rods being raised with their cam members as the lifting rods are actuated, the top of said rods projecting over the high surface of the cam members, said tops of the elongated rods being pulled down when the lower rod flanges abut intercepting portions of the frame structure, whereupon, the transverse member may move down the surface of the cam member to the transfer position of said cam member; and said control means selectively starting, stopping and reversing said motor to allow expiration of said predetermined time periods.

6. A device as in claim 1 further characterized by and including the combination of a plurality of said modular devices, each of said devices adapted to receive a processing fluid which, in the sequence of the assembly, is adapted for the processing of a particular workpiece, and the control means of each device raising, transferring and lowering the particular workpiece in accordance with a predetermined program to complete the processing of the workpiece in a predetermined manner.

7. A combination as in claim 6 further characterized in that the spaced cam members of the plurality of devices are inter-related so that when said transverse member with the attached support for the photographic film is moved to said transfer position at the low surfaces, the transverse member may thereafter be transferred to a succeeding first stationary position on an adjoining pair of spaced cam members of an adjoining modular device.

8. A combination as in claim 7 further characterized in that the low surfaces of a pair of spaced cam members are in offset relationship with the high surfaces of an adjoining pair of spaced cam members so that the transverse member at the transfer position at the low surfaces can be transferred to the stationary position of the high surfaces by picking the transverse member up as the adjoining cam members are being raised.

9. A combination as in claim 7 further characterized by and including processing structures to provide an assembled photoprocessing unit, said unit including:

a loader to receive a holder with photographic film;

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a required plurality of said modular devices to provide a first set for a required processing, conveyor means between said loader and said first set to transfer the holder to the initial position on the high surfaces of the spaced pair of cam members in the first module of said first set;

a pass box;

second conveyor means between said first set and said pass box to pickup the film holder from the transfer position at the low surfaces of the spaced cam members in the last module of said first set;

a second set of modular devices, said second conveyor means adapted to transfer said film holder to the required plurality of said modular devices in said second set;

an unloader and dryer compartment; and

conveyor means in said unloader to pickup the film holder from the transfer position at the low surfaces of the spaced pair of cam members in the last module of said second set.

10. A combination of modular devices for processing a workpiece through a plurality of separate baths, including:

a plurality of modular devices, each of said devices adapted to receive a processing fluid which, in the sequence of the assembly, is adapted for the processing of a particular workpiece;

each of said modular devices having a tank for holding a processing fluid, oppositely disposed means to hold a transverse member to which a workpiece is mounted, means to lower and raise the holding means and the workpiece therewith, said holding means having a first position to support the transverse member while the holding means are raised to move the workpiece out of the tank,

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said holding means having a second position to support the transverse member while the holding means are lowered to move the workpiece adjacent to said tank, means to move said workpiece from said first position to said second position on said holding means; and

the second position on said holding means of one modular device being in overlapping relationship with the first position on said holding means in an adjoining modular device, whereby when said transverse member and mounted work piece is moved to the second position of said one modular device, the transverse member and mounted work piece is thereafter transferred to the first position of a holding means in said adjoining modular device.

15 11. A combination of modular devices as in claim 10 wherein the workpiece is adapted to carry photographic film for processing in the separate tanks of plurality of modular devices, and wherein controlled means are included to raise, transfer and lower the photographic film in the workpiece in accordance with a predetermined program to complete the progressing of the photographic film in a predetermined manner.

20 12. The combination of a plurality of modular devices as in claim 11 wherein said spaced holding means of each modular device includes cam members on opposite sides of the tank, the opposite end portions of said transverse member being engageable with cam surfaces on said cam members so that said first position of the transverse member on the holding means is associated with a high surface of the cam members and said second position on said holding means is associated with a low surface of the cam member.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,559,557 Dated February 2, 1971

Inventor(s) Albert L. Schwartz et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 11, line 41, after "spaced" insert -- cam --.

Signed and sealed this 25th day of May 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, J
Commissioner of Patent