Oct. 31, 1967 W. W. BUECHNER 3,349,689

PHOTOGRAPHIC TREATING APPARATUS

Filed March 9, 1964 4 Sheets-Sheet 1

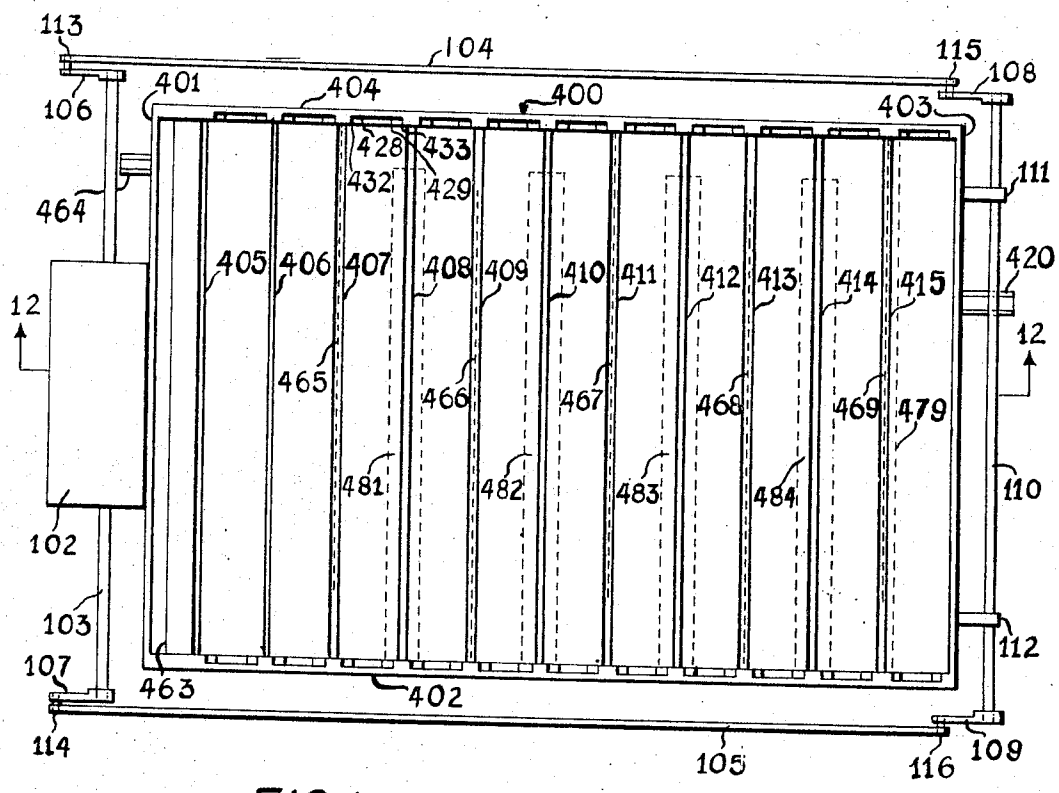


FIG.1

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BY Werner W. Buechner

Oct. 31, 1967 W. W. BUECHNER 3,349,689

PHOTOGRAPHIC TREATING APPARATUS

Filed March 9, 1964 4 Sheets-Sheet 2

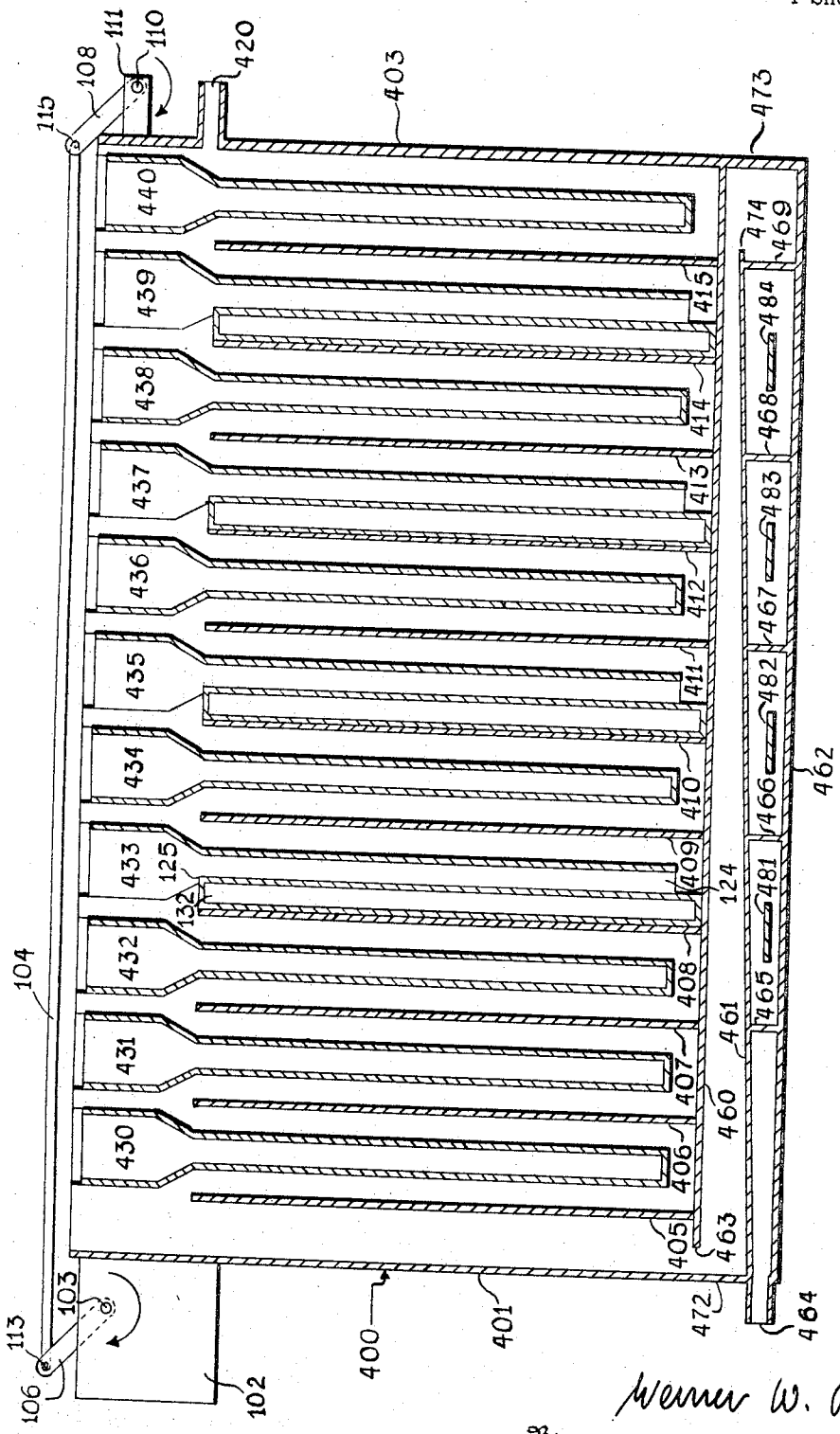


FIG. 2

Inventor

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PHOTOGRAPHIC TREATING APPARATUS

Filed March 9, 1964 4 Sheets-Sheet 3

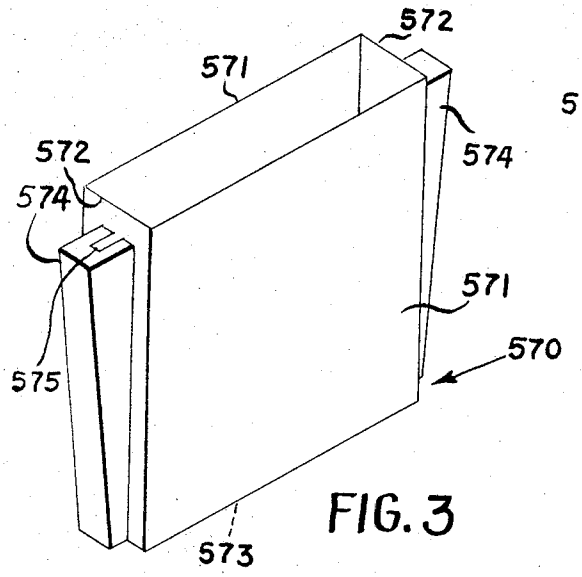


FIG. 3

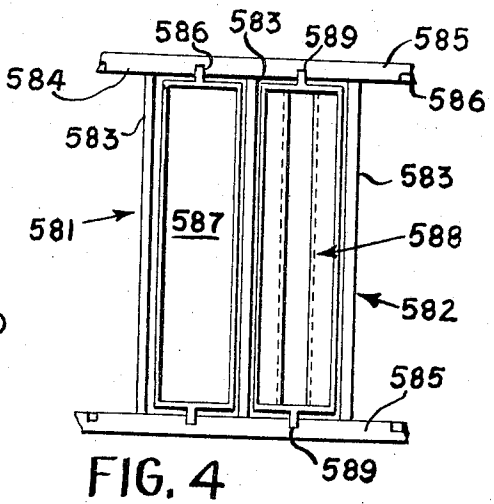


FIG. 4

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PHOTOGRAPHIC TREATING APPARATUS

Filed March 9, 1964 4 Sheets-Sheet 4

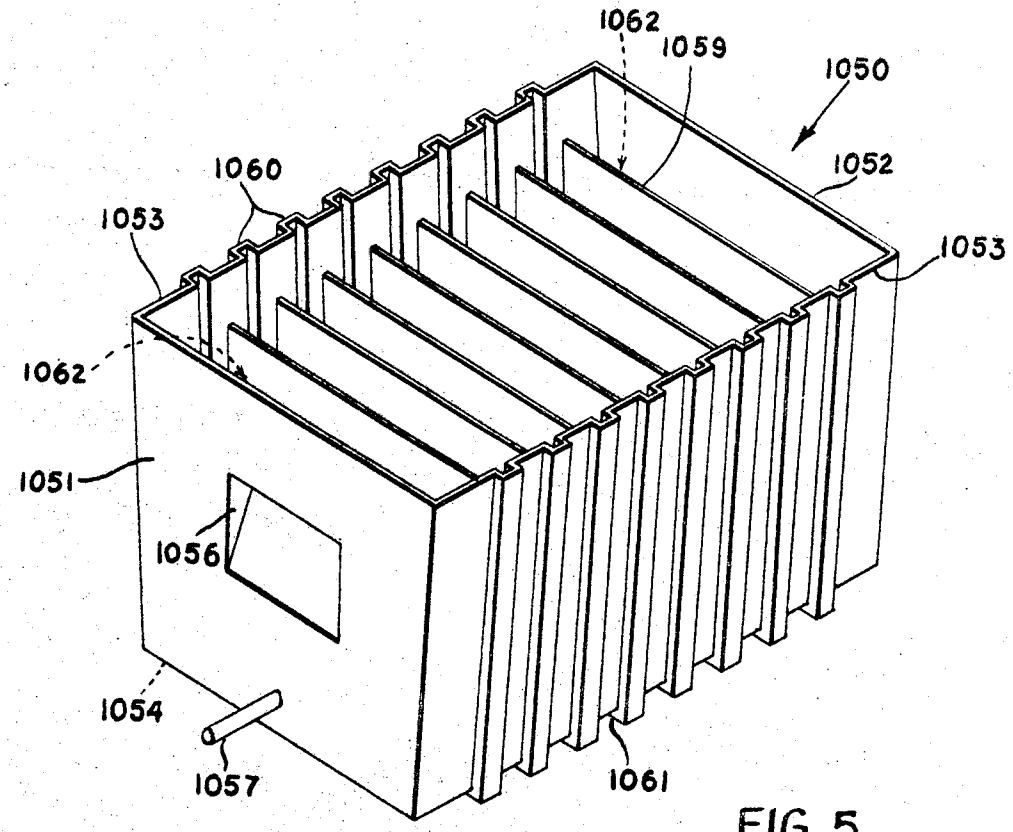


FIG. 5

INVENTOR.

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United States Patent Office 3,349,689 Patented Oct. 31, 1967

3,349,689

PHOTOGRAPHIC TREATING APPARATUS

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Filed Mar. 9, 1964, Ser. No. 350,612
23 Claims. (Cl. 95—96)

This application is a continuation-in-part of my copending applications Ser. No. 23,313, filed April 19, 1960, now Patent No. 3,124,051 entitled, Photographic Process and Apparatus; Ser. No. 52,524, filed Aug. 29, 1960, now Patent No. 3,236,649 entitled, Photographic Process and Apparatus; Ser. No. 302,902, filed Aug. 19, 1963, entitled, Photographic Timer and Method of Timing Photographic Treating Processes; Ser. No. 309,199, filed Sept. 16, 1963, now Patent No. 3,280,694 entitled, Photographic Easel; Ser. No. 342,198 filed Feb. 3, 1964, entitled, Photographic Treating Vessel; Ser. No. 342,028 filed Feb. 3, 1964, entitled, Carrier for Photographic Materials; Ser. No. 342,029 filed Feb. 3, 1964, entitled, Photographic Bath; Ser. No. 342,030 filed Feb. 3, 1964, entitled, Photographic Wash Vessel; Ser. No. 342,197 filed Feb. 3, 1964, entitled, Process and Apparatus; and Ser. No. 342,459 filed Feb. 4, 1964, entitled, Photographic Process and Apparatus.

This invention relates to methods, apparatus and device for the treatment and processing of photographic materials. Particularly, the invention is concerned with an improved apparatus for the processing of multilayer color materials, permitting the obtention of consistent reproducible results in inexpensive simple equipment.

My Patent No. 3,236,649 teaches and claims a non-continuous, batchwise process for the multistep treatment of a plane sheet of photographic material at a predetermined temperature in a multiplicity of separate treating steps which process comprises the successive contacting of said sheet with a multiplicity of different treating solutions, each being in the form of an upright vertical layer of treating solution, having two opposite major vertical faces, and the vertical layers being arranged in spaced, side-by-side relationship with their major vertical faces essentially parallel to each other, and maintaining the temperature in each of said layers at about said predetermined temperature by flowing a unidirectional stream of temperature conditioning water of about the same temperature and in form of a layer successively in a zig-zag pattern around each of said upright layers of treating solutions such that the stream of temperature-conditioning water flows in the case of each layer in a path downwardly along one of the major vertical faces, passes underneath the layer and thereafter flows upwardly alongside the opposite major vertical face of each of said layers. In a preferred embodiment of the process of said patent the streaming temperature-conditioning water serves also as the washing medium in at least one washing step by being formed into at least one separate, upright vertical streaming layer of a shape and size similar to the layers of the treating solutions. Most advantageously, the streaming temperature-conditioning water is used for the carrying out of one or more intermediary washing steps between treating steps.

For the processing of color materials requiring a large number of treating and interspersed washing steps it is generally preferred that said upright layers of streaming washing medium are interposed in spaced relationship between the layers of the treating solutions in the order in which the washing steps are to be carried out in the treating process, such that the plane sheet may simply be forwarded from step to step to the neighbouring layer.

Suitable equipment, which may with advantage be used for the carrying out of said novel photographic treating process and its modifications may be constructed in various manner. Said Patent No. 3,236,649 describes an apparatus, which may generally be used for the practicing of said process. The use of the process by the photographic amateur and by the professional operator, who wishes to handle small batches of photographic color material at a time makes special demands on the design of the apparatus as to simplicity of operation, low manufacturing cost and low market price of the equipment, and to the versatility of its operation and usefulness for a large variety of different photographic treating processes and different color materials etc.

It is therefore the primary object of the present invention to provide a simple apparatus which is specifically adapted for the treatment of photographic materials in liquid treating and/or washing media by simple procedure which apparatus is specifically adapted to the requirements of the less skilled photographic amateur.

Another object of the invention is the provision of an apparatus which is adapted to be used in the treatment of a standard sheet or of a small multiplicity of standard sheets of photographic materials or for the treatment of photographic films in strip form or in form of bands of film especially roll film.

It is still another object of the invention to provide an apparatus having a highly efficient washing action with the consumption of a minimum of a washing medium flowing through the apparatus.

Another object of the invention is the provision of an apparatus for developing and/or aftertreating photographic material by multistep procedures which apparatus indicates to the operator the time when the material is to be forwarded to the next treating medium for the completion of the next step in the processing sequence.

Another object of the invention is the provision of an apparatus which is particularly adapted for the carrying out of photographic multistep treating or developing and aftertreating processes and which apparatus permits the arrangement of the treating media required in each step, including the washing steps, in the order as they are needed in the process sequence of said processes.

Another object of the invention is the provision of an apparatus which lends itself to automatic or semiautomatic operation and control of the treating conditions with a maximum of reproducibility of the final product.

It is a further object of the invention to provide an apparatus which is capable of automatically carrying photographic material through the steps of any desired process sequence without requiring the attention of the operator.

Still another object of the invention is the provision of an apparatus which permits the operator to maintain reproducible, present operating conditions with a minimum amount of attention during the photographic treating operation.

Other objects of the invention will become apparent from the following description of the invention and from the accompanying drawings.

The objects of the invention are achieved by the provision of an apparatus for carrying out of multistep photographic treatments in a multiplicity of different treating solutions which apparatus comprises a bath which is subdivided by transversal separatory walls into a multiplicity of essentially water-tight compartments side-by-side and removably contained in compartments of said bath in sealing relationship upright treating vessels having an essentially rectangular horizontal cross section, an overflow passage at the separatory walls and a horizontal passageway beneath said vessels, at least one of the members selected from the treating vessels and compartments having on their sides vertical sealing means for establishing seal between these members upon the insertion of the

treating vessel in a compartment of said bath, such that temperature conditioning water, passing through the bath in form of a wide stream and unidirectionally, successfully circumflows in a generally vertical direction the treating vessels, flowing down on the upstream side, underflowing the vessel and flowing up on the downstream side of the vessel.

For the treatment of plane sheet and film materials it is preferred that the said bath, treating vessels, if applicable, wash vessels and said compartments, making up the apparatus of the invention have a generally rectangular horizontal cross section or configuration, respectively, and that the dimensions of said components and parts of the apparatus are such that the said plane photographic materials may be inserted in the apparatus in a generally vertical orientation, with all parts of the photographic material submerged in the treating media while they are treated therein.

The bath of the apparatus is advantageously provided with means adapted to flow a unidirectional stream of a liquid medium, preferably of water, from one end to the other end of the said bath. Suitably, an inlet is provided at one end and an outlet at the other end. Said inlet and outlet may also be provided in other suitable locations at or in the bath. The rectangular compartments are beneficially arranged in the bath side by side, with their longer sides parallel to each other and spaced from each other. The components separating the compartments may be removably or, more preferably, fixedly contained in the bath.

For the carrying out of photographic treating processes or process sequences requiring close temperature control, it is of particular benefit to employ the embodiment of the apparatus of the invention in combination with means which are adapted and capable of delivering a stream of a liquid temperature conditioning medium having an essentially constant temperature so as to maintain in the treating vessels of the apparatus the desired temperature, as said temperature conditioning medium passes by the vessels. It is of further advantage in this embodiment of the apparatus, if means are provided which permit the use of said temperature conditioning medium, which is preferably water, as the washing medium for the carrying out of intermediary and/or final washing steps being part of said process or process sequence.

Said means, delivering the temperature conditioning medium, may be conventional devices such as water mixing valves or thermostatically controlled heating devices, or, more advantageously, a novel device which is adapted to supply a flowing stream of medium of the desired temperature. High convenience, accuracy and reliability is achieved with an embodiment of the device which comprises metering means, adapted to provide a stream of essentially constant flow rate having a constant temperature lower than that of the desired temperature conditioning medium and electric heating means supplying an essentially constant quantity of heat to said stream of the medium so as to produce a continuous stream of the desired higher temperature. The said heating device and/or the metering device or any parts thereof may beneficially be integrated with, or be part of, the bath of the apparatus of the present invention. Suitable process and apparatus are described and claimed in my copending patent application Ser. No. 342,197.

The treating and if applicable the wash vessels containing the respective treating and washing media, respectively, are interchangeable and are beneficially arranged side by side in said compartments in the order as the respective treating and washing media, respectively, are required to carry out the desired treating sequence to which the photographic material is to be submitted.

The establishment of an essentially vertical flow pattern in the compartments of the bath is assisted and furthered by the provision or use of means which are adapted to provide essentially liquid tight seal between the sides of the treating vessels and the juxtaposed parts

of the compartment wherein they are contained. In the case of the treating vessels this is conveniently achieved by the provision of vertical sealing means at the vessels or of counter sealing means at the side walls of said compartments, and most advantageously cooperating vertical sealing means are provided both at the vessels and at the side walls of the compartments of said bath. In the case of some forms of the wash vessels, horizontal sealing means are preferably provided in addition to the vertical sealing means at the wash vessels or in the compartments and most advantageously cooperating horizontal sealing means are provided both at the wash vessel and in the compartments of the bath in addition to the said vertical sealing means. The sealing and the counter sealing means may have any other desired form and location, as may be desirable and necessary to establish in a compartment or bath and with the vessels of a given construction the essentially liquid tight seal.

For most efficient operation and highest convenience it is preferred to employ the apparatus of the invention in which the photographic vessels are upright treating and/or wash vessels. For the treatment of only one or a few sheets of the plane photographic material at a time or in one session, the apparatus comprising the narrow upright vessels and particularly the narrow upright treating and/or wash vessels having a trough-like reservoir at their top ends provides the highest economy in the operation of the process.

The photographic vessels used as a component of the apparatus of the present invention are preferably upright treating, of a type and construction as defined and described and claimed in my copending patent application Ser. No. 342,198. Additional benefits are achieved in the operation and use of the apparatus of the invention, if disposable treating vessels are used, if desired, in combination with supporting vessels adapted to accommodate and hold the disposable vessels in the compartments of said bath. The supporting vessels and/or the disposable vessels comprise preferably means adapted to provide essentially liquid tight seal, as described hereinbefore. The embodiment of the apparatus of the invention comprising thin upright vessels having a thickness of less than one inch and preferably less than one half of an inch, which vessels are advantageously provided with a superimposed trough-like reservoir, are generally preferred for use by the amateur photographer.

The photographic material to be processed in the rectangular embodiment of the apparatus of the invention is generally inserted in vertical orientation. As an assist in the insertion, agitation and removal of the plane photographic material the apparatus comprises advantageously at least one plane carrier which is adapted to support the plane photographic material and to maintain the plane configuration during the treatment. The carrier used in combination in the apparatus of the invention may be adapted to hold at least one band or strip of photographic film in at least one plane.

The preferred carrier of the apparatus of the invention comprises in addition guide means adapted to prevent contact of the photographic material with the other components of the apparatus during insertion, treatment and removal and to facilitate mechanical agitation of the photographic material in the treating medium during the treatment. The semiautomatic or fully automatic embodiment of the apparatus of the invention comprises with advantage in combination at least one carrier comprising an agitating and/or forwarding support. The apparatus of the invention comprising the trapezoidal type of compartmented bath in combination with the trapezoidal type of wash and/or treating vessels is generally preferred. Suitable carrier means are described in my said Patent No. 3,236,649 and in my copending patent application Ser. No. 342,028.

If it is desired to permit semiautomatic operation of the photographic treating process to be carried out in the

apparatus of the invention it is desirable to employ the embodiment of the apparatus which comprises means for automatic agitation of the treating media and/or of the photographic material and preferably automatic mechanical agitating means, as described hereinafter in detail. For fully automatic operation of the process, the embodiment of the apparatus, comprising in addition means adapted to forward the photographic material from treating step to treating step through the apparatus is most desirable. Treatment of light sensitive photographic material in the apparatus of the invention in a lighted room is made possible by the use of the light-tight, fully enclosed embodiments of the apparatus and particularly of the enclosed fully automatic embodiments of the apparatus.

For the use of the apparatus of the invention with sensitive or complex multistep processes, further benefits are achieved, if the apparatus comprises in addition in combination a program timer which is adapted to either control the actuation and operation of the said automatic forwarding means or which for manual or semiautomatic operation of the apparatus, provides signals, preferably light signals, if desired in combination with sonic signals to the operator indicating the termination and/or the beginning of the individual successive processing steps. The embodiment of the apparatus comprising a multiplicity of light signal sources, which are preferably incorporated in a light bar with each light source in juxtaposition to the individual vessels in which the individual steps to be controlled by said light source is most preferred as it permits readily the simultaneous carrying out of more than one process sequence in overlapping or delayed fashion thus greatly increasing the productivity of a given apparatus. The apparatus in combination with a program timer which has in addition at least one source of sonic signals offers additional advantages and benefits. Suitable program timers are described and claimed in my copending patent application Ser. No. 302,902.

In the most preferred embodiment of the apparatus of the invention, the components making up the apparatus, are standardized to be readily interchangeable and designed in shape and size so as to accommodate the treatment of a standard size plane photographic material. The standard size apparatus of the invention is advantageously used in combination with an easel which is adapted to provide one or more different representations on one standard size sheet of photographic material. This embodiment of the apparatus-easel combination provides not only highest productivity and efficiency but also highest economy in its operation. A suitable multiexposure enlarging easel is described and claimed in my Patent No. 3,280,694.

Further embodiments and modifications of the apparatus of the invention will become apparent in the following detailed description and drawings. The accompanying drawings show various modifications of the apparatus of the invention and extensions thereof without being restricted thereto.

FIG. 1 is a top plan view of a composite multi-vessel apparatus of the invention containing the upright vessels for the treatment of photographic sheet material in an eleven step process.

FIG. 2 is a vertical section of the apparatus of FIG. 1 taken along line 12.

FIG. 3 is an isometric view of the upright treating vessel which comprises generally vertical sealing means.

FIG. 4 depicts a top plan view of a fragment of a generally rectangular compartmented water bath containing two treating vessels of greatly varying capacity and different basic design inserted in neighboring compartments.

FIG. 5 is an isometric view of another embodiment of the rectangular multicompartment bath.

The novel apparatus of the present invention may be widely used in photographic liquid treatments and especially in the development and fixing of flexible or rigid

photographic positive and negative materials such as films, reversal films, plates and paper base materials. The apparatus of the present invention is especially useful and beneficial in its application to the more recently introduced photographic color processes and it is particularly adapted to the processing of color positive and negative multilayer color roll, sheet and cut films as well as to the processing of multilayer positive color printing materials in roll, sheet or cut form particularly those on a paper base such as Kodak Ektacolor Paper (formerly called Type C positive printing paper). My invention includes many modes of operation and many modifications of the process and apparatus which make it particularly suited for application in the said multistep color developing processes.

Prefatory to a detailed description of the process and apparatus of the invention some of the more important terms used herein will be explained in order to provide a better understanding of the nature of the invention and of its scope. Other terms and definitions used herein are explained in detail in my said Patent No. 3,236,649.

The apparatus may be used with particular advantage in the treatment of photographic sheet materials, i.e. such materials which have definite size limitations and of roll films and bands and strips of film of moderate length.

The terms "sheet material" or "plane sheet of photographic material" as used herein, include also photographic films wound on a special plane carrier such that the film lies generally in at least one plane, forming a sheet-like configuration by the positioning of a multiplicity of lengths of film material in said plane. The said lengths of film may or may not be parallel to each other. They may be spaced from each other or touch each other within the plane defined by them. They may be wound such that rectangular or triangular or truncated triangular spaces are provided between them. The film may be cut to individual suitable lengths to be placed on either one or both sides of the carrier or the lengths of film may be connected to other lengths of film. One or more films such as roll films or lengths of movie film, or rolls or bands of other photographic materials, particularly also of paper backed materials may be used to make up the "plane sheet" of film material. As can be readily seen, the terms "sheet material" and "film material" may sometimes be applied to the same material and are thus at least in part overlapping.

The term "multistep photographic treating process" is meant to designate any photographic developing or other treating process for the production of an actual image from a latent image which requires the contacting of the photographic material with a multiplicity of treating media. The term includes in its meaning any of the complete process sequences recommended for a given photographic material as well as any portion of such multistep process comprising two or more steps.

The term "washing medium" as used herein refers to any liquid medium which may be used to remove treating or other chemicals from a photographic material. Usually, it is water. Certain chemicals or solvents may be added thereto or sometimes organic solvents may be used as the washing medium.

The expression "flowing liquid medium" is used herein to refer to a liquid which is passed through the bath of the apparatus to serve as a temperature conditioning medium and/or as a washing medium in a particular process. Water is most economically used as the flowing liquid medium. If desired, it may contain certain chemicals dissolved therein.

The term "temperature conditioned," as applied to the flowing or stationary liquid medium flowing through or contained in the bath of the apparatus of the invention, is intended to mean that the said medium has a predetermined, essentially constant temperature suitable to maintain the treating media contained in the apparatus of the invention at a predetermined constant temperature.

The terminology "generally vertical flow direction" and the terminology "essentially vertical flow pattern" are intended to mean herein, that the stream of flowing liquid medium flows predominantly in a vertical direction or in a direction containing a strong vertical vector. The term includes the case that the stream of medium, when it changes direction to a downward direction and vice versa in certain places of its predominantly vertical path, flows in a horizontal or nearly horizontal path for short stretches of its path e.g. when it flows into a wash vessel or through certain short conduits provided in the apparatus of the invention. Said horizontal flow of the medium constitutes, however, in the meaning of the term, only a fraction of the vertical flow, and generally less than one third.

The term "photographic treating vessel," as used herein, refers to any type of receptacle or tank which is adapted to contain a stationary photographic material, in its normal treating and operating position, may have any orientation and form with the exception of an essentially horizontal orientation of the plane of the essentially flat material. Receptacles in which the material is contained horizontally in operating position in a relatively shallow layer of treating medium are called trays and are not included in the meaning of the term treating vessel. The term does also not include in its meaning cylindrical or truncated conical vessels or partial cylindrical vessels which are described and claimed in my copending application Ser. No. 23,313 filed April 19, 1960 and in my copending application Ser. No. 342,459 filed Feb. 4, 1964.

The term "upright treating vessel" is applied herein to photographic vessels which usually have a generally rectangular horizontal cross section or base and in which place photographic material or sheet material is inserted in generally vertical orientation for treatment. The term is applied particularly also to a novel vessel, specifically adapted to serve as a component in the apparatus of the invention and defined and described hereinafter in detail.

The term "wash vessel" is applied to any vessel of a shape and dimensions, as defined above with respect to the treating vessels, which is however distinguished therefrom by the provision of means permitting the passage of a stream of washing medium through the vessel in generally vertical flow direction.

The expression "disposable vessel" as used herein is meant to indicate that the vessel is made of a material and by methods inexpensive enough to permit disposal or discarding of the vessel after only one or after a few uses. The measure of disposability is usually determined by setting the convenience, of using a new clean vessel in relation to the need of storing and cleaning a permanent, reusable vessel after every use. The use of a disposable vessel in some of the more complex photographic processes such as in multistep color developing processes provides not only the convenience of saving the trouble and time of thoroughly cleaning the vessel after each use but eliminates also completely any risk of failure in the production of the final product due to unintentional incomplete cleaning and use of the contaminated vessel in a different step of the process where the contaminant could easily result in spoilage or adverse effect on the effectiveness or performance of the treating solution.

The term "major side walls" as used herein, is intended to refer to the pair of opposite walls, in the vessel or upright vessel, which are the largest generally vertical walls, comprised in the vessel. Usually, the major side walls are considerably longer than the vertical end walls adjoining them, though both the side walls and the end walls are usually of the same or similar height.

The term "vertical sealing means" is intended to encompass means, joined or attached to the vertical end walls or to the edges of the major vertical side walls or the upright vessels to be used with the apparatus of the invention. The sealing means provided on the vessels are intended to cooperate with coacting counter sealing means, provided in the bath or in the compartments of the compartmented water bath or with the side walls of the bath or compartment, respectively, in which the vessel is to be used. The term "vertical sealing means" comprises sealing means which are, with the vessel or upright vessel in operating position, truly vertical. It is, however, intended to encompass also any generally vertical orientation of the sealing means for example, where the sealing means are wedge-shaped or slanted so that their outermost free edges form an angle with the vertical plane of up to 30° or more but less than 45°.

The term "horizontal sealing means" is intended to refer to sealing means which are adapted to provide essentially tight seal between the bottom section and/or the major side walls of the wash vessel with the bottom of the bath and/or one of the separatory walls of the compartments in the compartmented bath. The horizontal sealing means may have any desired shape and orientation. They may represent a seal strip extending below the vessel in generally horizontal orientation, so as to engage with the bottom, or more advantageously with suitable cooperating counter sealing means, provided in or at the bottom of the bath or compartment, respectively. They may also have the form of generally horizontal sealing strips provided at one of the major side walls, so as to establish essentially liquid-tight seal with one of the separatory walls of the compartment or with suitable counter sealing means provided in or at said separatory wall. This embodiment of the horizontal counter sealing means may be an integral part of the wash vessel, such as a box-like structure of rigid or of elastomeric material joined to one of the major side walls of the vessel or they may be joined to the separatory wall of the compartment or they may be independent of both the vessel and the separatory wall, being inserted into the free space left between the separatory wall and the wash vessel when the latter is inserted in the compartment. The horizontal sealing means may be made from rigid materials in relatively close tolerances or they may be made from elastomeric materials, which are slightly larger than the space into which they are inserted, such as a pad of solid or of foamed or expanded elastomeric material, which is simply inserted into the space between the separatory wall and one of the major side walls of the vessel, facing the former to provide excellent seal for the purposes of the invention. Other forms of the horizontal sealing means include aprons joined to one of the major side walls with a strip-like gasket along the upper edge of the separatory wall providing the horizontal seal. The vertical and horizontal sealing means may be combined to form together with the major side wall of the vessel a barrier, which, when inserted in lieu of one of the separatory walls of the compartments, establishes the desired flow pattern and forms at the same time the compartments in the bath.

The term "sealing means" is meant to designate the combination of any type of the vertical sealing means with any type of the horizontal sealing means independently of their position and association with either the wash vessel or treating vessel or with the bath. The term includes also the use of separate vertical and/or horizontal sealing means, which are not joined to or integral with the wash vessel nor the bath. The term is also generally used to refer to either vertical and/or the horizontal sealing means as well as to sealing means which do not fall under the above definition of "vertical" or "horizontal" sealing means.

The term "counter sealing means" as used herein is meant to designate means which are provided removably or fixedly in or at the bath, and which are designed or capable of establishing essentially liquid tight seal with the wash or treating vessels or with the separatory walls, respectively when they are inserted in the bath. The term

does not include, the section of the side walls per se and or the bottom of the bath or individual compartments, respectively, which engage with the vessels or their components when the vessels are inserted in the bath.

The term "sealing relationship" is intended to designate the condition that a photographic vessel is inserted in the bath or its compartments in such fashion, that essentially no flowing liquid medium passes between at least a greater portion of the end walls or associated means provided at or close to the end walls, and the juxtaposed portions of the side walls of the bath or compartments under the conditions normally encountered in the bath. The passage of a small portion of liquid between these components is not necessarily detrimental, and is included in the meaning of the term. Important is, that a barrier is set up, forcing at least the major portion of the flowing liquid medium to find its way underneath the treating vessel or through the wash vessel, as the case may be. Naturally, the better the seal, the more efficient is the operation. Thus, for the more exacting processes, good seal, permitting less than 20 or 30 percent and preferably less than 10 percent of the streaming medium to pass through or by the interface between the vessels and the side walls of the bath or compartments, is preferred.

The term "working compartment" is intended to designate those compartments in the bath which are designed and adapted to receive at least one vessel or other containers for photographic treating media, such as upright treating and/or wash vessels. The working compartments in a bath are generally numbered in the direction of the flow of the stream of water. The working compartment number one is accordingly the working compartment through which the incoming stream of water passes first. Compartments, which are provided in the bath for functions other than working compartment functions are designated herein as adjuvant compartments. The latter may precede the working compartments, i.e. be located upstream of the working compartments, or they may be interspaced and/or provided downstream of the working compartments, as may be desired. The adjuvant compartments are not included in the number-herein "auxiliary compartments."

The term "adjuvant compartment" is reserved for those compartments which are not intended to receive a photographic vessel but which are communicatively connected to the working compartments, and which form part of the vertical flow pattern of the stream of liquid medium passing through the bath when it is operated. Compartments which are neither working compartments nor adjuvant compartments by the above definition are called herein "auxiliary compartments."

The expressions "bath" or "photographic bath" are used herein to designate a receptacle which is adapted to receive a multiplicity of photographic treating and/or wash vessels. They are furthermore adapted to contain a stationary or flowing liquid medium as a temperature conditioning medium and/or a washing medium. The bath may preferably have a basically rectangular configuration with a rectangular bottom section. This embodiment of the bath is called herein the "rectangular bath." The side and end walls in the rectangular bath may also be rectangular or have any other desired shape. The embodiment of the bath having trapezoidal end walls and particularly reversed trapezoidal end walls, with the base of the trapezoid at the top edge, is called herein "trapezoidal bath." The terms "bath" or "photographic bath" encompass also circular, cylindrical, half-cylindrical and irregular forms of the bath including rectangular baths which are subdivided by longitudinal divider walls, extending between the end walls, preferably parallel to the side walls into two or more parallel sections.

The embodiments of the bath which are sub-divided by separatory walls, extending parallel to the end walls of the bath, and preferably the side walls, into a multiplicity of individual compartments are designated herein by the term "compartmented bath." The bath, if subdivided by one or more vertical walls running parallel to the side walls of the bath, is called herein "segmented bath."

The term "side walls" is used uniformly and designates with respect to the compartmented bath the generally vertical walls which are generally perpendicular to the separatory walls. They are usually the longest generally vertical walls in the bath. The sections of the side walls of the bath forming part of a compartment are likewise called "side walls" even though they are generally the shorter generally vertical walls in the compartment of the bath. The walls of the rectangular vessel juxtaposed or vicinary to the side walls of the bath or compartment are generally called herein "end walls."

The terms "carrier" or "plane carrier" are intended to refer to a device which is adapted to support and hold the photographic material essentially in a plane during the treatment in a step or in a succession of steps of the process.

The expression "automatic agitating means" refers to means capable of agitating, over the duration of a treatment, the treating medium relative to the photographic material or of moving the photographic material relative to the treating medium or a combination of these means. "Automatic mechanical agitating means" achieve this relative movement of photographic material and treating medium primarily by mechanical agitation of the treating medium and/or of the photographic material.

"Automatic forwarding means" are any mechanical assemblages or devices which are adapted to lift the photographic material from one vessel and forward it to and insert it in the next vessel.

The term "program timer" refers to devices which provide signals or impulses at time intervals which correspond to the time schedule of the multistep process to be carried out. The expression "light bar" is used to designate a device containing a multiplicity of light signal sources in such arrangement that upon its combination with or its attachment to an apparatus of the invention the said light signal sources are clearly coordinated or juxtaposed to the vessel and step carried out therein which they control.

The terminology "multiexposure easel" is intended to designate an easel which permits the making of a multiplicity of different and independent exposures on a standard sheet of a size for the treatment of which the apparatus of the present invention is designed and dimensioned.

The expression "standard sheet" as used herein, is meant to refer to the maximum size of sheet for the treatment of which the upright vessel of the invention is designed. The sheet of this size can be inserted into the upright vessel in generally vertical orientation without the need for folding the sheet. As is readily apparent, the apparatus of the present invention may also be used for the treatment of sheets, having a size smaller than the standard sheet. However, the apparatus is utilized to the best advantage for the treatment of standard sheets of photographic materials or of materials which approach this size. The apparatus of the invention may also be used for the treatment of sheets, having a size substantially larger than the size of the standard sheet by use of special carrier means holding the sheet in a folded position. Suitable carrier means serving this purpose are described in my copending patent application Ser. No. 342,-028.

The preferred vessel forming part of the apparatus of the invention is an upright treating vessel which comprises a narrow vertical, generally parallelepipedal lower section, having a bottom, two major side walls, two end walls and an opening at the top and superimposed thereon in sealing relationship a trough-like reservoir of a width greater than the width of said lower parallelepipedal sec-

tion. The vessel is open at the top so as to permit the insertion of the photographic material in generally vertical orientation. The said major wall sections are advantageously parallel to each other. The end walls may be either substantially vertical and parallel to each other or slanting advantageously in such manner, that the vertical section of the vessel, taken through a plane perpendicularly to the end walls, represents a trapezoid with its base at the top of the vessel.

Another preferred embodiment of the vessel of the apparatus of the invention comprises an upright vessel formed by a bottom, two major side walls, two end walls and an opening at the top with generally vertical sealing means provided along the vertical end walls. Said end wall mounted sealing means are advantageously adapted to fit removably into cooperating counter sealing means provided in the side walls of the bath or of a compartment of the bath. The cooperating counter sealing means in the bath and on the said end walls of the vessel are preferably adapted such that they provide a substantially liquid tight seal between at least a major portion of each of the end walls of the vessel and the vicinal portion of the side walls of the water bath. In this embodiment of the vessel, the said cooperating sealing means are advantageously adapted to support the vessel in the bath in a position such that the bottom of the vessel is at least slightly raised from the bottom of the bath so as to leave a passage way, permitting free flow of a stream of water or other liquid between the bottom of the vessel and the bottom of the bath.

As will be apparent from the following description, the embodiment of the upright vessel containing the sealing means may be constructed with or without a superimposed trough-like reservoir. Generally, the superimposed trough-like reservoir is employed with greatest benefit in the very narrow upright vessels of the invention and with vessels which are designed to be used with such carrier means for the photographic materials which have a horizontal cross section not much smaller than the horizontal top opening of the vessel.

Principally, the disposable upright vessel is characterized by the design and functional features of either of the just mentioned embodiments of the upright treating vessel. The disposable vessel may be designed to be rigid enough to be self-supporting, or more advantageously, the disposable vessel is used in combination with a supporting vessel which is adapted to removably receive the disposable vessel, and which supporting vessel may advantageously incorporate any one or more of the features of the hereinbefore described embodiments of the upright vessel of the invention. The major side walls of the said supporting vessel are advantageously perforated so as to expose to the surrounding water a maximum of heat exchange surface of the thin-walled disposable vessel. The invention comprehends also disposable vessels of a shape and design differing from those described and particularly the use of disposable vessels of any desired shape and design in combination with a supporting vessel of suitably adapted design and size.

The apparatus of the invention may comprise another embodiment of the supporting vessel which is adapted to be used with the disposable vessel and which is provided with means adapted to vary the distance between the major side walls of the adjustable supporting vessel, so as to permit convenient variation of the liquid capacity of the supporting vessel and/or of the disposable vessel inserted therein, respectively.

The adjustable vessel and the disposable vessel may incorporate any one or more of the design and functional features described hereinbefore with respect to the upright vessel of the invention, particularly also the vertical sealing means and/or the superimposed trough-like reservoir.

Suitable treating vessels with and without an upper widened reservoir and with and without separate vertical sealing means are described in my said Patent No. 3,236,649 and in my copending patent application Ser. No. 342,198. Specific reference is made thereto. The various forms and modifications of the vessels described and claimed in these references are preferred for use in the composite photographic treating apparatus of the present invention.

As is readily apparent from the foregoing description, good seal of the upright treating vessels of the invention against the walls of the water bath or the sides of the compartment, respectively is important for efficient operation, sides of the treating vessel reduces the accuracy and efficiency of the temperature control in the particular vessel.

In the embodiments of the treating vessels shown in FIGS. 1 and 2 of the accompanying drawings, no special sealing means are provided. If the vessels are inserted with their end walls into cooperating sealing means such as depressions or channels contained in or at the end walls of each compartment of the water bath, the end walls of the vessels serve as sealing means. By machining or maintaining close tolerances in the dimensions of the vessels and compartments, or by other suitable means satisfactory seal may be readily achieved. Perfect seal may also be achieved without the need for machining or keeping close tolerances, if the cooperating sealing means in the walls of the bath or compartment are lined with suitably shaped and dimensioned elastomeric profiled materials. Still better seal may be readily achieved, if one employs the self-sealing trapezoidal embodiment of the treating vessels in conjunction with a compartmented water bath in which the long side walls or the cooperating sealing means contained therein have a slant, which is approximately the same as that of the end walls of the trapezoidal vessels. With the vessels inserted in the water bath, the weight of the liquid contained therein, particularly if the liquid level in the vessel is somewhat higher than the water level in the bath, holds the vessel down against the bath walls, exerting a wedge effect and producing tight seal. With vessels made from slightly compressible or elastic materials, or with the use of the said elastomeric profiles in the cooperating sealing means, exertion of slight downward pressure on the inserted vessel produces excellent seal between the vessels and the bath walls. Since these embodiments of the vessel and bath are, as stated, not dependent on the maintenance of close tolerances, less costly materials and inexpensive mass production methods may be used for their construction.

Unlimited exchangeability of the vessels in the compartments of a given bath and the possibility of using vessels of varying thickness or liquid capacity in the same bath is possible with the use of another embodiment of the upright vessel which is characterized by the provision of a vertical seal strip on the outside of each of the end walls of the treating or wash vessel. The seal strips extend preferably over the whole length or over most of the length of said end walls of the vessel and are advantageously fixedly joined thereto. They may be of the same material or of a material different from that from which the vessel is made. They may be integral with the vessel or they may be joined to the vessel by the use of adhesives or other fastening means. The horizontal cross-sectional profile of the seal strip may be square, rectangular, semicircular or of any other desired irregular shape so as to provide with the selected materials the most effective seal. The strips may be of uniform width and thickness from top to bottom or they may be tapered toward the lower end with the widest cross-section at their top ends. Many variations in the tapered design of the seal strip are possible, the more complex ones usually providing more readily perfect seal upon insertion of the vessel into the coacting sealing means contained in the bath, such as depressions, grooves or channels in the opposite end walls of the compartment. The coacting sealing means provided in the opposite end walls of the com-

partments of the bath are preferably concave counterparts of the said seal strip of approximately identical shape and dimension. If the seal strip is made of or covered by an elastomeric material such as rubber or other elastomeric material or synthetic polymeric material in solid or foamed or expanded condition, excellent seal may be achieved without the need for the observance of close tolerances in the shape or dimensions of the grooves or channels in the compartments and the coacting sealing means in the walls of the water bath or compartments may have any desired shape or size or may be omitted altogether. In this case the walls of the bath or of the respective compartment in the bath serve as the cooperating sealing means.

An example of a treating vessel having tapered or wedge-shaped seal strips is shown in FIG. 3 of the accompanying drawings. Upright vessel **570** is defined by major vertical side walls **571**, vertical end walls **572** and bottom **573**. To the outside of each of walls **572** are fixedly joined tapered seal strips **574** mounted on vertical ribs **575** provided along end walls **572**. Seal strips **574** are made of an elastomeric material and mounted such that their thicker profile is at the top and their thinnest profile is at the bottom of the vessel. Insertion of the vessel into a compartment of a suitably dimensioned compartmented water bath, having concave tapered grooves or channels of corresponding dimensions and shape, will provide instantaneous tight seal merely by the weight of the vessel filled with the treating liquid or by slight downward pressure on the vessel.

If the seal strips provided at the end walls of the vessel are made from a non-elastic material and if it is not desired to maintain close tolerances, perfect seal may be achieved by making or by lining the concave holding means in or at the end walls of the compartment or in the side walls of the bath with an elastomeric material. In this embodiment ribs **574** may directly serve as the vessel-mounted sealing means. It is important to note that the vessel-mounted sealing means extend to a level at least slightly higher than the water level in the bath, when the vessel is inserted therein so as to prevent water from overflowing the sealing means. Similarly it is desirable that good seal is established between the cooperating sealing means up to the water level in the bath.

As mentioned hereinbefore, it is usually desirable to make the treating vessel as narrow as is possible so as to reduce its liquid capacity to the minimum required for the treatment of a given number of sheets, say 2, 4, 6, 8 or 10 or more, depending on the desired use and on the circumstances. Since the treating capacity varies with the nature of the treating medium, it is often of advantage to provide in one series of treating vessels, needed for the carrying out of a given multi-step process, vessels of varying thickness or width, though otherwise of identical dimensions and thus of varying liquid capacity. Thus, a vessel intended for a treating solution A, having double the treating capacity of treating solution B, need be only half as thick in its interior dimension as the vessel for solution B and so forth.

In this manner all the treating solutions are exhausted at the same time after the treatment of a predetermined number of sheets of photographic treating material. This renders the operation of the photographic process more economical and more reliable, obviating the need for storing and reusing partially used liquids and thus eliminating an important source of error and failure as described hereinbefore. The use of vessels of varying liquid capacity interchangeably in a given bath is made possible by the use of the various supporting and sealing means described hereinbefore and by selecting identical sealing means in a given system for all types and sizes of vessels. The interchangeable use of vessels having standard seal strips in a compartmented bath having identical counter sealing means in each compartment is illustrated in FIG. 4 of the accompanying drawings. Rectangular compartments **581** and **582** forming part of a rectangular water bath are defined by major vertical walls **583**, joined at right angles with the vertical side walls **585** of the water bath and completed by the bottom of the water bath (not shown), to which walls **583** and **585** are joined in sealing relationship. Each section of wall **585** forming part of the compartment has in its center portion a vertical recess **586**. These recesses extend from the top edge of wall **585** to a point close to but above the bottom of the cell. All recesses **586** are of identical size and dimensions in all compartments making up a given bath. Upright vessel **587** is inserted in cell **581** and vessel **588** is contained in cell **582**. The vessels are of rectangular configuration. Vessel **587** is essentially a wide upright parallelepiped of a width close to that of cell **581**. Vessel **588** is a narrow parallelepiped with a superimposed reservoir of the kind described in FIGS. 1 and 2 of the accompanying drawings. Its upper trough-like reservoir has an upper inside width which is identical to that of the top opening of vessel **587**. The lower body of vessel **588** is an upright parallelepiped of an inside width which is a fraction of that of vessel **587**, thus giving it an overall liquid capacity which is also only a fraction of the liquid capacity of larger vessel **587**. To the end walls of each of vessels **587** and **588** are centrally joined vertical ribs **589**, serving as sealing means. Ribs **589** on both vessels are of identical dimensions and shape and are dimensioned to slidably fit into recesses **586** in the end walls of the compartments. The vertical downward extension of the recess controls the depth of insertion of the upright vessels. They terminate somewhat above the bottom of the cell so as to assure the maintenance of a passageway for the unidirectional stream of water passing underneath of each of the inserted vessels. The standardization of the size, shape and relative location of the recesses **586** with respect to each compartment and of the seal strips with respect to each vessel, regardless of thickness and capacity of the treating vessel assures ready interchangeability of the vessels made for a given compartmented bath.

Instead of providing male sealing means on the end walls of the vessel and cooperating female sealing means in or at the walls of the bath or in each compartment contained in the bath, the female sealing means may be provided in the end walls of the upright vessel with cooperating male sealing means provided in the bath.

The vessels of the invention may be manufactured by the usual methods. They may be constructed from individual, suitably shaped components using adhesives, or soldering or welding methods or similar methods as the means for joining the components. They may also be formed in one piece e.g. by injection molding, extrusion, stamping, or by blowing techniques, particularly if they are manufactured from thermoplastic construction materials. It was found that the vessels may be most conveniently produced by vacuum forming methods using a split mold.

The operation of the above mentioned automatic forwarding means and usually also the forwarding of the carrier means by hand is facilitated by the use of another embodiment of the treating vessel in which one of the upper edges of the long vertical wall is extended upward to a level higher than the opposite, so that the upper opening of the vessel is slanted against its normal horizontal position. The vessel is placed into the bath in such manner that the extended wall is on the far side of each vessel relative to the direction of forwarding of the photographic material in the bath. The extended wall section serves as a stop and guide which prevents overshooting of the lower end of the carrier when it is suspended and travelling toward the vessel. It will thus, upon lowering of the forwarding means be guided into the vessel without the risk of misplacement or spilling. Similar benefits may also be obtained with this modification of the treating vessel of the invention, if the carrier or support is forwarded from vessel to vessel by hand.

Instead of making the vessels from the usual heavy gauge plastic sheet materials they may be made from high quality, high impact plastic materials of relatively thin gauge, yet strong enough to withstand the strain and static pressure of the liquids contained therein. This together with the inexpensive manufacturing methods reduces their price to the point that they may be simply discarded after one use or after several subsequent uses obviating the necessity of cleaning the vessels. Thorough cleaning of the treating vessels and containers after each use is, as is well known, of prime importance with some of the color developing processes for the achievement of the outstanding consistent results.

The use of the disposable vessels thus eliminates the risk and danger of unintentional contamination by residual chemicals contained in the vessel from prior treatments, particularly if one and the same vessel is successively used with different treating solutions, without complete and thorough cleaning.

Instead of making the disposable embodiment of the treating vessel from rigid plastics one may use with advantage such other thin materials as cellulosic sheet materials, particularly paper stocks or cardboard which are coated on the inside or advantageously on the inside and the outside with chemical resistant plastic materials, or other water and chemical resistant materials.

The disposable vessel may be made strong enough to be self-supporting when it is inserted in the bath, with the treating liquid contained therein. If they are made from a thinner gauge material such that their rigidity is not great enough to prevent bulging or deformation, when the treating liquids are contained therein, they are advantageously used as an insert or lining in a supporting vessel. In this embodiment of the invention limp linings, which are fluid tight, such as those from plastic films, may be used with advantage. After each use it is only necessary to discard the inner lining and substitute in the next session a fresh liner. These liners may be made with advantage from very thin limp or rigid thermoplastic materials. Unless the supporting vessel is made from metals or other heat conductive materials the heat transfer qualities of the arrangement may be further improved, to give better temperature control within the vessel, by the use of a perforated supporting vessel as the support for the liner.

The supporting vessel has basically the shape and dimensions of the treating vessel as described hereinbefore. Any of the variations, modifications and special embodiments described hereinbefore may be used and may be applied to or incorporated in the perforated or non-perforated supporting vessel, particularly also the sealing means and the variously shaped and dimensioned trough-like reservoirs superimposed at the top of the vessel. The supporting vessel may be an exact parallelepiped or, if desired, the modifications of the basic parallelepipedal shape, described hereinbefore and falling under the term "generally parallelepipedal" as used herein, may be applied with equal advantage.

If the liner or supported disposable vessel is made of a soft or limp material, its top edges are advantageously temporarily fastened to the upper edge of the supporting structure such as by the provision of flanges or flaps or similar means overlying the upper edges of the supporting vessel or by the use of suitable hooks or clamping means. Upon filling the liner with the treating liquid, the hydrostatic pressure expands the liner, pressing it snugly against the walls of the supporting vessel which gives it the support needed to maintain the exact shape desired for the treatment of the sheet material. The rigid disposable vessel or the supporting vessel with the rigid or limp disposable vessel contained therein, is inserted into and used in the bath or in the compartments of the bath in the same manner as described hereinbefore.

The just described embodiment of the vessel of the invention provides not only the convenience of disposability of the inner liner or vessel, but also the advantage of better temperature control because most of the surface area of the very thin liner or of the very thin disposable vessel is in direct contact with the temperature conditioning water contained in or flowing through the bath, giving greatly improved heat transfer properties due to the extreme thinness of the material. Best performance of the limp liner is achieved if the treating liquid in the vessel stands slightly higher than the surrounding water in the water bath.

If the inner disposable vessel is made of a relatively rigid material, it may be of advantage to provide additional cooperating sealing means on the inside of the end walls of the supporting vessel and/or on the outside of the end walls of the disposable vessel. Provision of a thin vertical strip of an elastomeric material joined to the inside of said vertical end walls of the supporting vessel will generally be sufficient to achieve perfect seal. Alternatively, the end walls and/or the vertical edges of the disposable vessel may be provided with strips of an elastomeric material which provides the desired seal. A pair of cooperating sealing means provided along the inside of the end walls of the perforated supporting vessel and along the outside of the end walls of the disposable vessel may also be used as the means for providing the desired seal whereby the principles and materials described hereinbefore may be used with advantage to further facilitate the obtention of a perfect seal.

The perforated supporting vessel may be made of plastics or any other desired construction material including metals. It is not necessary to use stainless steel or equivalent corrosion resistant metals because the supporting vessel is not in direct contact with concentrated corrosive treating liquids, so that there is no serious problem of contaminating the treating liquids. Less expensive metals such as steel, copper or brass properly protected by the usual corrosion resistant metal coatings or by paints or coatings of other protective materials have proven satisfactory for their construction. If desired, the supporting vessel may be designed as a simple wire basket of suitable shape and dimensions, having only solid end walls.

In order to best utilize the advantage of the present invention for the purposes of the amateur, internal thicknesses of the upright vessel ranging from about 0.4 cm. to about 2.0 cm. are preferred. This preferred range is relatively independent of the maximum size of the standard sheets which can be treated in any particular vessel. Generally, economical reasons make it desirable to stay in the lower range of about 0.4 cm. to about 1.2 cm. If for any reason more than the above stated minimum of developer or other treating solution is desired to be used, the liquid may be filled to a higher level, as is readily possible in the upright vessels provided with a superimposed reservoir of substantial capacity.

Alternatively, the vessel may be made wider. If it is made 4 cm. wide, it will permit the development of up to approximately 20 sheets in one filling of the developer solution. This number will be correspondingly smaller or larger as the treating capacity of the particular developer used varies, or as other factors are introduced or modified. Replenishment will increase the number substantially.

If it is desired to treat large numbers of sheets at one time e.g. with the use of baskets holding a multiplicity of sheets or the multiple sheet carriers described in my patent application Ser. No. 342,048. the vessels may be made even wider. Widths of 8 to 10 cm. of up to 20 cm. are possible though as one increases the capacity of the vessels, one will realize less and less the particular advantages inherent in the upright vessel of the present invention. Adjusting the capacity of the upright vessel used for each step so that the quantity of treating liquids contained in each vessel is spent after the treatment of an equal predetermined number of sheets of photographic material offers additional advantages.

The flowing, temperature controlled water stream of the present invention offers the means to accomplish the washing in an accurate, well-controlled manner creating thus the desired reproducible operating conditions. The unidirectional flow pattern in the water bath, where the washing steps may be carried out, makes it impossible that chemicals or other materials introduced in a later step, are carried back to an earlier stage of the process with possible contamination and detrimental effects on the process. By proper interspersing of the washing steps between the preceding and the succeeding processing steps the wash water will have precisely the mean temperature between said treating steps. Thus any uncontrolled temperature changes in the reactive layers of the photographic sheets are effectively eliminated. In the most preferred modification of the invention one or more cells or chambers are provided between the vessels or in the water bath through which the stream of water flows on its path from around the neighbouring vessel to the next. To effect the washing the sheet is simply transferred from the vessel to the washing chamber or cell, retained therein for a predetermined time, and thereafter transferred into the next treating vessel. The washing step may be made more effective, if the water passes over the sheet material in form of a thin layer. This provides for an increased flow velocity and thus in higher effectiveness in removing and carrying away the chemicals from the sheet material. The washing action and its effectiveness may be further increased by movement of the sheet material relative to the stream of water surrounding it. Such relative motion produces small turbulences at and around the surface of the sheet material and promotes the diffusion of the chemicals and the contact of less saturated water with the surface area of the sheet material.

A highly effective washing action may be achieved if a wash vessel is used which has dimensions and appearance similar to the upright treating vessels used in a particular apparatus. However, the wash vessel is distinguished by the omission of the bottom or by the provision of a wide slot-like opening in the bottom or in the lower portion of one of the side walls. It is further distinguished by the provision of a slot-like opening in the upper portion of one of the wide vertical walls at a position, which is at or close to the water level in the bath when the wash vessel is inserted therein. Said upper slot is preferably provided in the side wall opposite that, which carries the lower slot in its lower portion if such is used. Both the lower and the upper opening extend preferably over the full width or nearly over the full width of the vessel, thus permitting the passage of a stream of flowing water over the whole width of the vessel.

The preferred embodiment of the wash vessel, which may be used in the apparatus of the invention comprises a generally parallelepipedal receptacle with an opening and a horizontal overflow at or in the top section of the vessel and a passageway for a washing medium in its bottom section, said opening at the top being adapted to permit the insertion of at least one sheet of photographic material into the vessel in substantially vertical orientation, said overflow in the upper portion of the vessel and said passageway for the washing medium in the lower section of the vessel extending substantially horizontally preferably over the whole length of the vessel, so as to permit the passage of a stream of washing medium in substantially vertical direction over the whole horizontal cross section of the vessel.

The receptacle comprises two major side walls and two end walls and optionally a bottom. In a preferred embodiment of the wash vessel of the invention is superimposed on said receptacle in sealing relationship a trough-like reservoir of a width greater than the width of said lower parallelepipedal section.

Also other forms of wash vessels are possible. Important is that the wash vessel comprise vertical sealing means—or its vertical side walls may serve this function—which have dimensions and relative positions the same as the treating vessels used in the composite treating apparatus of the invention, so that the wash vessels may be interchangeably used with the treating vessels in any one of the working compartments. This expedient permits to set up in the apparatus any desired arrangement of alternating treating vessels and wash vessels so as to accommodate in a given apparatus any desired photographic multistep treating schedule of chemical treating and washing steps in the order as they occur in the photographic process to be carried out in the apparatus. Suitable washing vessels, which may be used in the composite apparatus of the present invention are described in my Patent 3,236,649 and described and claimed in my copending patent application Ser. No. 343,030. Special reference is herewith made to these descriptions.

As is readily apparent from the foregoing description, good seal of the upright washing vessels of the invention against the walls of the water bath is important for efficient operation, if the upright wash vessels of the invention are used in the compartmented water bath, employing a unidirectional stream of water as the washing medium. Any substantial leakage around the narrow vertical sides of the wash vessel reduces the efficienty of the washing action in the particular vessel.

In the embodiments of the wash vessels illustrated in FIGS. 3, and 4 and 26 of the drawings of Patent No. 3,236,649, no special sealing means are provided. If the vessels are inserted with their end walls into cooperating sealing means such as depressions or channels contained in or at the end walls of each compartment of the water bath, the end walls of the vessels serve as the vertical sealing means.

In the operation of the apparatus of the invention the photographic sheet may be simply inserted into the vessel without any special support or holding means. However, insertion and removal of the sheets, particularly of the flexible kind, is rather difficult and inconvenient, if not assisted by some kind of holding means. It is therefore preferred to support the sheet material in some suitable fashion. Depending on the nature and stiffness of the material, wire baskets or clamps containing the sheet and having dimensions adjusted to the particular dimensions of the vertical vessel may be employed as the means facilitating insertion and removal of the sheet from the vertical vessel. This type of support, however, is not recommended with flexible materials such as sheet film and particularly paper base materials because of the considerable risk of scratching and otherwise damaging the soft surfaces of the photographically active layers of the sheet materials.

It is therefore preferred to operate the apparatus of the present invention in combination with suitable, specially adapted carriers for the photographic material. Suitable carriers for limp sheet material are described in my Patent No. 3,236,649 and various forms of more advanced and preferred carriers for limp sheet materials and for strips or lengths of film material are disclosed and claimed in my copending patent application Ser. No. 342,028. Specific reference is herewith made thereto.

If desired, the actuation of the carrier may be made automatic for instance, by the utilization of a motor in combination with mechanical means, known per se, which means translate the rotational motion of the motor into a reciprocating vertical motion. In either the manual or the automatic actuation, a stroke of one centimeter or less to 10 cm. or more, depending on the size of the sheet, the dimensions of the vessel and the nature of the treatment will generally be satisfactory. A stroke in the range from about 2 cm. to 6 cm. was found in most cases to give, in combination with the stirring action caused by the special design of the carrier, most satisfactory turbulence to produce excellent, reproducible results.

An embodiment of the automatic actuation which was found to be particularly beneficial in the multistep treatment in a multiplicity of the upright vessels, is shown in FIGS. 1 and 2. Motor **102** provided at the upper left wall of the apparatus drives shaft **103** to the ends of which are fixedly joined cranks **106** and **107**. One end each of bars **104** and **105** is rotatably connected to the free ends of the cranks over crank pins **113** and **114**. The ends of bars **104** and **105** on the right are movably connected to the free end of cranks **108** and **109**.

Rotation of shaft **103** by the motor causes bars **104** and **105** to carry out a composite reciprocating motion with a vertical stroke approximately double that of the length of the crank. A rectangular support of the construction shown, for instance, in FIG. 7 or 8, of Patent 3,236,649, if laid upon the bars will make the vertical reciprocation with the bars. Rotatable rolls **58** and **59** or **71** and **72** respectively, on the upper bar of the support permit to hold the support in a fixed position, while the bars slide back and forth in the horizontal underneath the support. Thus, only the vertical component of the composite horizontal and vertical movement of the bars is utilized, so as to give the rectangular support the desired vertical reciprocating motion. Other automatic means of actuation may be employed with similarly good effects.

The simple, automatic actuation of the photographic sheet relative to the treating liquid or of the treating liquid relative to the sheet relieves the operator from paying any attention to this part of the process. Furthermore, by proper design and proportioning of the driving and driven means a predetermined rate of relative movement is achieved which will be uniform from operation to operation. Thus, the expedient of providing automatic actuation, as described hereinbefore, does not only simplify the processing of the photographic sheet material, but provides also the utmost in reproducibility from sheet to sheet and from day to day, eliminating a source of inconsistency which is always present in the uncontrolled tray method.

Operation of the motor and actuation device as described hereinbefore with respect to the composite apparatus provides automatic reciprocation of the support within each of the treating or wash vessels wherein it is contained. In carrying out any multistep treating process, it is thus only necessary for the operator to forward the support with the sheet secured thereon from vessel to vessel at predetermined time intervals. Thus, the expedient of providing automatic actuation, as described hereinabove, does not only simplify the processing of the photographic sheet material but provides also the utmost in reproducibility from sheet to sheet and from day to day, eliminating a source of inconsistency which is always present in the uncontrolled tray method.

In any of the methods described for actuating the plane sheet relative to the treating liquid or vice versa the exchange of chemicals from the active layer or layers of the photographic sheet material can be achieved in well controlled manner by adjusting the rate of relative motion to the specific requirements of the process and materials used in each instance. Once the optimum rate of actuation has been found or established in a given apparatus and process, it can be readily maintained in absolutely the same level, and effectiveness and complete reproducibility of the process and consistency of the results are assured.

The embodiments of the carriers described in patent application Ser. No. 342,028 containing the guide means are particularly adapted to be used in combination with the upright treating or washing vessels in apparatus, providing automatic mechanical agitation. The provision of rotatable rollers at the free ends of the agitation support, such as the cross bars, facilitates automatic actuation, particularly when the agitation is provided by a circulating, reciprocating mechanical agitating means, which in addition to a vertical component or vector have also a horizontal component or vector in their reciprocating motion. Such rollers or other rotatable contact means on or at the ends of the cross bar or equivalent agitating support means are naturally not needed, if a substantially vertically reciprocating agitating mechanism is used in the apparatus.

As is readily apparent, the above illustrated and described agitating supports and particularly the cross bar type may serve simultaneously as the forwarding supports, if the forwarding means in the apparatus are accordingly adapted. In this case, with one cross bar or other support serving the said double function, only one support means need be provided.

Instead of having the carrier or support, containing the photographic sheet or sheets to be treated, forwarded by the operator by hand, one may provide automatic forwarding means, e.g. those described in my copending patent application Ser. No. 342,029.

In addition to the convenience and accuracy just described, the apparatus of the present invention utilizing a multiplicity of the vessels offers the further advantage of requiring a minimum of space or working area as compared with the convention flat trays or tanks. So for instance, requires an arrangement of eleven upright vessels, of a size which accommodates the usual 8 x 10 inches sheets, a working area of approximately 0.16 square meter in a single row arrangement which measures approximately 46 centimeters long and 34 centimeters wide. The customary flat trays for the same size of sheets require an area of approximately 11 times 0.1 square meter or a total of 1.1 square meter which is nearly seven times the area required by the new apparatus of the invention. If it is desired to place the conventional flat trays in one line, as is usually the case, a continuous working area of three meters length is required. With larger sized photographic sheet materials the saving in working area and floor space made possible by the novel arrangement and apparatus of the present invention is even greater.

The modest space requirements and the compactness of the multi-vessel arrangement make the apparatus of the invention particularly suitable for use in crowded or small darkrooms or in darkrooms which are improvised in kitchens, bathrooms or closets. The small size makes for easy storage also in the small home or apartment, still giving most of the advantages of the more expensive automatic equipment heretofore available. The compactness of the multi-vessel arrangement is in itself an important factor in maintaining proper and constant temperature within the vessels holding the treating liquids. Temperature control can readily be achieved by placing the individual vessel or any number of vessels, into one or more water baths of proper size to accommodate the desired number of processing vessels. The compactness of the water bath required for the unique vessels of the invention and the absence of an excessive free surface area assist in the maintenance of the correct temperature once it has been established.

The preferred bath which may be used with great benefit as a component in the composite apparatus of the present invention comprises a trough-like receptacle having principally two side walls, two end walls and a bottom, which receptacle is subdivided into a multiplicity of compartments by at least one separatory wall, which separatory wall is joined in sealing relationship to the side walls and to the bottom of said receptacle, and which bath is adapted to receive in sealing relationship at least one photographic treating vessel, preferably an upright vessel e.g. of the type described hereinbefore. The upright vessels to be used in the bath may be either treating vessels or wash vessels, or both kinds of vessels may be used at the same time. The bath may comprise only working compartments, or if desired, it may contain in addition one or more adjuvant compartments and/or auxiliary compartments. The photographic treating vessels are generally inserted in the working compart-

ments, preferably not more than one in each working compartment. For the successful operation of the bath not all working compartments need be occupied by treating vessels.

The separatory wall or walls are advantageously integrated with or fixedly joined to the bath. If it is inserted removably, it is preferred to employ sealing means or other suitable means, so as to establish essentially liquid tight seal between the edges of the separatory wall and the adjoining side wall and between the bottom edge of the separatory wall and the bottom section of said receptacle. The number of compartments provided in the bath of the invention may vary in wide limits. In certain specific embodiments of the bath, there may be only one compartment e.g. one working compartment. Generally, however, the bath of the invention comprises a multiplicity of compartments. Preferred is the bath, which contains a multiplicity of working compartments, advantageously three or more. The benefits of the invention are best realized with the baths, which contain a relatively large number of working compartments viz. more than six and advantageously more than eight up to twelve and for certain applications up to twenty. The bath comprising the larger number of compartments is more readily useful for the carrying out of the complex multistep color and other photographic processes having a very large number of individual steps.

The bath is beneficially provided with means such as an inlet and an outlet, which permits the passage of a unidirectional stream of water or other liquid media through the bath. For efficient operation of the bath the inlet is advantageously provided in one of the end walls of the bath and the outlet is provided in the opposite end wall. The inlet and/or outlet may also be provided in the bottom of the bath or be omitted altogether, if external means are used for each passage of the liquid medium.

If each compartment comprised in the bath is designed to receive a photographic treating vessel, it is desirable to set the water outlet in a high position in the said end wall, so as to keep the compartment adjoining said end wall filled to the intended height. A position of the water outlet approximately at the level of the upper horizontal edges of the separatory walls in the bath is preferred, because this position assures in most instances most efficient and trouble-free operation of the bath. The inlet, which may be located in a high or in a low position, as desired, is advantageously provided with a horizontal distributor, so as to assure even distribution of the flowing stream of water or other liquid medium over the width of the bath. The inlet, with or without the distributor, is advantageously connected into a first adjuvant compartment, which adjoins the end wall carrying the inlet and which precedes the first working compartment in the direction of travel of the stream of liquid medium passing through the bath. Heating means and, if desired, liquid mixing means, adapted to heat the stream of liquid medium to an essentially constant predetermined temperature, may with advantage be provided in said first adjuvant compartment or, if desired, in an additional second adjuvant compartment preceding the first working compartment and, if desired, the said first adjuvant compartment, if such is provided. The heating chamber containing said heating means and, if desired, said mixing means may with advantage be provided beneath the bottom of the water bath with an inlet at one end and its outlet communicatively connecting with the inlet of the bath. In this embodiment of the bath the outlet of the heating chamber and the inlet of the bath may be conveniently integrated and have the form of a horizontal slot provided in the bottom of the said first adjuvant compartment and extending across the bath. The heating chamber may also be provided as an independent external unit to be placed outside the bath or to be inserted in one of the adjuvant compartments.

The side wall sections of the bath, forming part of the individual compartments, may directly cooperate with suitable sealing means provided at the end walls or at the vertical edges of the vessels. Layers of an elastomeric sealing material interposed between the side walls of the bath and the end walls of the vessels may with advantage be used as the sealing or counter sealing means. More advantageously, counter sealing means are provided at or in the side walls of each compartment of the bath. The counter sealing means may be male or female, depending on the nature of the cooperating sealing means provided in the photographic vessels to be used in the bath. Female counter sealing means in the compartments of the bath of the invention and male sealing means in the vessel are generally preferred. The female counter sealing means in the compartments are advantageously provided at the side walls of each compartment along the vertical center line of each side wall of each compartment and may have the form of a groove or recessed channel, or they may be provided in form of suitable channel members on or at the inside of the side walls of each compartment, so as to form essentially vertical channels on both opposing side walls of each compartment. The grooves or channels provided in the bath or compartments, respectively, are advantageously lined with an elastomeric sealing material, if such material is not provided on the cooperating male sealing means of the upright vessels for which the bath is designed. In order to assure ready exchangeability and the possibility of free rearrangements of the photographic vessels in the compartments of the bath it is preferred that the counter sealing means in all the compartments of a given bath are of identical size, shape and relative position.

It is also of advantage, if certain bottom sealing types of wash vessels are to be used, to provide suitable horizontal counter sealing means along the bottom of each compartment such that upon insertion of the wash vessel into the compartment the horizontal sealing means, provided along the bottom side of the upright wash vessel engage with the said horizontal counter sealing means in the compartment, providing essentially liquid tight seal around the sides and bottom of the bath.

The establishment of good seal between the side walls of the compartments and the end walls of the vessels is greatly facilitated by giving the bath a trapezoidal transverse cross section with the base of the trapezoid at the top, which is achieved by slanting the side walls of the bath outwardly toward the top and extending the end walls and separatory walls correspondingly. The trapezoidal embodiment of the bath may incorporate any one or more of the various modifications and features described hereinbefore, particularly also the integral counter sealing means, adjuvant compartments, heating chambers and so forth.

Another embodiment of the bath of the present invention comprises means for automatic mechanical agitation of the photographic material to be treated in the vessels, when they are inserted in the individual compartments of the bath. This is conveniently achieved by the provision of mechanical agitating means comprising at least one, and preferably two horizontal agitator bars and means adapted to give said agitator bars a vertical reciprocating motion. The horizontal agitator bars are conveniently operated by a mechanical power source such as reciprocating linear actuators or an electric motor and associated mechanical means translating the rotational motion of the motor into a vertical reciprocatory motion of a predetermined stroke.

Another embodiment of the bath of the present invention is capable of fully automatic operation by the provision of automatic forwarding means. The preferred modification of the forwarding means comprises means which are adapted to lift the photographic material from any one of the upright vessels i.e. treating or wash-vessels

or other receptacles wherein it is contained, thereafter forwarding it to a position above the following vessel and reinserting the material into said following vessel, or in the case of the last step in a treating series, to storage or drying means, respectively. The most preferred embodiment of the forwarding means comprises a base frame, supported by servo-cylinders or equivalent mechanical lifting means, and at least one horizontal forwarding bar or equivalent means, adapted to forward the photographic material between steps horizontally by a distance corresponding to the spacing of the vessels or other receptacles, wherein the treatment is to be carried out. The lifting and forwarding means may be actuated by hand or more conveniently by suitable power sources, the operation of which may be controlled by the operator or more conveniently by a program timer which is programmed for the specific process sequence to be carried out.

The fully automatic embodiment of the bath comprises advantageously also automatic agitating means, if the process to be carried out in the bath requires agitation. Any desired mode of agitation and means therefore, such as gas burst valves, ultrasonic power sources may be combined with the fully automatic embodiment of the bath. The most preferred embodiment of the fully automatic bath, however, comprises in addition to the said forwarding means automatic mechanical agitating means, preferably of the vertically reciprocating type. A preferred embodiment of a fully automatic forwarding mechanism is disclosed and claimed in my copending patent application Ser. No. 342,029.

If this embodiment of the bath is controlled by a suitable program timer, the operator need pay virtually no attention to the progress of the treatment he wishes to carry out. The fully automatic bath comprises advantageously also a light tight hood, enclosing the bath and the agitating and forwarding means and permitting the use of light in the darkroom while the treatment proceeds undisturbed in the enclosed bath.

A composite apparatus comprising the bath of the invention and utilizing the treating vessels and the corresponding washing vessels, wherein a stream of temperature conditioned water serves the two functions of maintaining the desired temperature in a series of processing vessels and serving also the function of the wash water in one or more washing steps is exemplified in FIGS. 1 and 2 of the accompanying drawings. FIG. 1 is a top plan view of photographic treating apparatus **400** which is designed and adapted to accommodate an eleven step photographic treating process such as Kodak's Ektacolor Positive Paper Printing Process as it is presently recommended by this company. FIG. 2 is a vertical section taken along lines **12** of FIG. 1. The rectangular apparatus comprises two shorter vertical end walls **401** and **403** and longer vertical side walls **402** and **404**, which form with the bottom **460** the rectangular water bath. The water bath is subdivided into eleven individual rectangular cells of equal size, which are defined by the dividing wall sections **405**, **406**, **407**, **408**, **409**, **410**, **411**, **412**, **413**, **414**, **415** and side wall section **403**, respectively, two each of these sections being coordinated with corresponding portions of side walls **402** and **404** and of bottom plate **460**, to which the divider walls are joined. Each of the oblong rectangular cells or compartments is open at the top and comprises principally a pair of longer separatory walls and a pair of shorter vertical side walls and a bottom. The coordinated walls of equal lengths are parallel to each other and join the neighboring wall at a right angle. An additional adjuvant cell or compartment is formed at the left by side wall **401**, divider wall **405** and corresponding portions of side walls **402** and **404**, and a portion of bottom **460**. This cell is likewise open at the top and communicates with the heating zone below through rectangular slot **463**. All divider sections or separatory walls are of equal height or substantially so and terminate at a level below the upper edge of the water bath. Into each of the working compartments may be removably inserted a treating vessel or a wash vessel to provide any desired arrangement.

The rectangular heating chamber forms the lower portion of the composite device and is defined by horizontal bottom **462**, shorter vertical side wall sections **472** and **473**, longer vertical front and rear wall sections (not shown) and the bottom **460** of the bath. The heating chamber thus formed is divided by slanting baffle **461** into two distinct, wedge-shaped compartments which are connected with each other by slot-like aperture **474**. The lower compartment has at the left-hand side inlet **464** and is subdivided by baffles **465**, **466**, **467**, **468** and **469** into six distinct cells, which are interconnected by rectangular openings provided in alternating fashion between the front and rear wall sections respectively and the free ends of each of the baffles. The baffles, being shorter than the wall sections **472** and **473** are alternatingly joined to the longer rear wall sections and to the front wall sections, respectively, as is indicated by broken lines **465**, **466**, **467**, **468** and **469** in FIG. 1. This arrangement of baffles and correlating openings converts the lower compartment into a passageway following a zig-zag pattern. Each of the central four cells, making up the central portion of said passageway contains one of the heating elements **481**, **482**, **483** and **484**. The upper wedge-shaped compartment of the heating chamber has, on the left hand side, an outlet formed by rectangular aperture **463** in the bottom **460** of the water bath.

The stream of water, entering through the inlet **464** at the left, passes over the heating elements **481**, **482**, **483** and **484**, in this order, as it flows along the passageway making up the lower compartment. It is thereby heated to the desired temperature as is described in detail in my Patent No. 3,236,649. Leaving the lower compartment through rectangular aperture **474** at the right, the water reverses its general direction of flow and passes through the upper compartment which it leaves through slot-like aperture **463** to serve as the temperature conditioning medium in the water bath. This design and arrangement of the composite apparatus provides a streaming layer of temperature conditioned water underneath the bottom of the water bath, thus assisting in the maintenance of an accurate, even temperature in the water bath.

In FIG. 2 are shown closed treating vessels **430**, **431**, **432**, **434**, **436**, **438** and **440** of a kind, depicted in FIGS. 1 and 2 of my Patent No. 3,236,649 and wash vessels **433**, **435**, **437** and **439** of a type and kind as shown in FIGS. 3 and 4 of said patent. The vessels have been inserted in a number and order to accommodate all the steps of the Kodak Ektacolor Positive Paper Printing Process in the sequence the steps are to be carried out.

To facilitate insertion and removal of the treating and wash vessels into the water bath and to insure proper seal and centering and fixed positioning when inserted, the opposing side wall portions in each cell are provided with a recessed area or indenture, following the contours of the inserted vessel as is shown, for instance, in FIG. 9 and in FIG. 11 of the said Patent No. 3,236,649. Divider walls **407** and **408** are part of a cell or compartment. The recessed area or indenture is defined by edges **428** and **429**, which are parallel to each other and extend downwardly close to the bottom of the bath and which continue upward in the slanting edges **430** and **431** and parallel edges **432** and **433**. The dimensions, angles and extensions of the recessed area **427** correspond to those of the treatment and/or wash vessels to permit their insertion with close fit. As can be seen, either a closed treating vessel or a wash vessel may interchangeably be inserted into each pair of recessions or indentures provided in each cell or compartment. The apparatus thus provides for flexibility in the order in which the two kinds of vessels are arranged in the bath. The box-like body **132** provided at one side of the wash vessel is, as can be seen in FIG.

4 of my Patent No. 3,236,649 somewhat recessed so that it lies closely to the inner surfaces of the narrow wall sections of the cell when the wash vessel is fully inserted, as can be visualized in FIG. 1 of the accompanying drawings. Vertical narrow side wall **119** of the wash vessel is completely recessed in wall **404** of the water bath. Narrow side **129** and wide vertical plate **130** of box-like body **132** are shown tightly fitted against wall **404** and bath divider **407**, respectively, giving a substantially liquid tight seal. The actual washing area is enclosed by vertical walls **116** and **117**, side wall **119** and wall sections **122** and **123**, the latter rising to a level above the upper edge **125** of wall **117**. The path of the water continues through bottom opening **124** and from there upward through the space defined by the wall **116** and divider **408**.

The stream of temperature conditioned water coming from the heating chamber below the water bath and entering the left rectangular cell through aperture or inlet **463**, rises in this cell to the level determined by the upper edge of divider section **406** into the square cell containing vessel **430**, which it underflows, rising on the right side of the vessel, flowing over divider **406** into the next cell containing vessel **431**, and from there into the cell containing vessel **432**. Thereafter, the water stream flows over box-like body **132** and edge **125** of the wash vessel **433**, which it leaves through bottom opening **124** to rise upward in the right open section of the cell, which it leaves by flowing over the upper edge of divider section **409** and so forth until it has passed all cells, leaving the water bath through outlet **420**.

As has been pointed out, the water bath may also be designed without the integral heating chamber shown in FIGS. 1 and 2, and the temperature conditioned water may be taken from any desired source including a separate heating chamber, water mixing valve and so forth.

The vessels, sectional wall divisions forming the cells or compartments and the washing vessels and other parts making up this apparatus, are preferably inserted interchangeably. This permits ready, rearrangement of the parts to accommodate any other flow pattern of the stream of water and thus of the sequence of steps. The number of basic units may be higher or lower than that shown in the preferred apparatus. A similar apparatus may be combined with the eleven step apparatus if more than eleven steps are required. Or the bath or apparatus may be constructed in two or more units, having any desired number and arrangement of the basic cells, which units may be connected by tubing or pipes to permit passing of the water stream through the combined apparatus.

The operation of the apparatus comes readily to mind from the foregoing description of the apparatus and the various auxiliary devices and means. The operator opens the water supply, takes Temperature Reading A, adjusts the heat-input in accordance therewith, fills the respective vessels with the required treating solutions and prepares his photographic sheet material for the treatment e.g. by exposing the sheet in an enlarger containing the negative material. As soon as the treating solutions in the vessels have acquired the exact treating temperature, he may begin with the multistep treatment. He places and fastens the sheet onto the support or carrier, inserts it into the first vessel **430**, where it is transferred to vessel **431**. After passage of the required time it is transferred to the next vessel and so forth, until it has been treated in the last vessel, from where it is removed for drying and other aftertreatment.

The simplicity of the arrangement, utilizing the bath of the invention, reduces the complex eleven step color positive printing process to a semi-automatic easy procedure, enabling even the little experienced or the unexperienced amateur to attempt the heretofore difficult color developing process with satisfactory results.

The water bath described hereinbefore has a rectangular vertical cross section, taken parallel to the end walls. In a more preferred embodiment of the bath of the invention, the vertical cross section represents a reversed trapezoid with its base or longer parallel side on top. This embodiment of the bath is particularly adapted to be used with the trapezoidal type of upright vessels or with upright vessels, having slanting sealing means, forming together with the vessel also a reverse trapezoid.

As is readily apparent, the trapezoidal water bath has the additional advantage that perfect seal may be more readily achieved between the side walls of the bath or compartment and the end walls of the upright treating and wash vessels when they are inserted. This applies, regardless of whether or not counter sealing means are provided in or at the bath walls. If the said cooperating counter sealing means are used, satisfactory seal may be readily achieved, even if close tolerances are not observed in the manufacture of the bath and of the vessels. This permits the use of less costly construction materials and methods, permitting the production of the trapezoidal water bath by economical mass production methods. As is readily apparent, the compartmented trapezoidal bath of the invention may be designed without, or more preferably with suitable counter sealing means.

Referring to FIG. 5 trapezoidal bath **1050** comprises trapezoidal end walls **1051** and **1052**, side walls **1053** and bottom **1054**. In end walls **1051** and **1052** are provided indentures **1056**, which serve as handles for lifting the bath. Close to the bottom edge of end wall **1051** is tubular inlet **1057**. In end wall **1052** is provided tubular outlet (not shown) at a position close to the bottom of the bath. The bath is subdivided into a multiplicity of compartments by vertical transverse, separatory walls **1059**, each of which is joined to the bottom **1054** and to the side walls **1053** of the bath. At both ends of the bath are adjuvant compartments and interposed there between eight working compartments. Along the center of the side walls of each working compartment, thus formed, are provided in generally vertical orientation grooves **1060**, which serve as the counter sealing means for the insertion of an upright treating or wash vessel, having suitably shaped and dimensioned cooperating sealing means at their end walls, so as to provide essentially liquid tight seal between the ends of the vessel and the sides of the bath or compartment, respectively. Along the bottom of each working compartment are centrally provided horizontal grooves **1061** which serve as the horizontal sealing means provided at the bottom end of some of the wash vessels, which may be used with the bath of the present invention.

As is readily apparent, the provision of the closely spaced grooves in the side walls and bottom of the vessel in itself provides greater dimensional stability to the bath, permitting the use of more economical construction materials which derive their impact strength from a certain degree of flexibility. If the separatory walls are permanently joined rather than removably, the structural strength and rigidity of the bath is still better and may be excellent even with the most inexpensive construction materials such as polyethylene or polypropylene.

The adjuvant compartments **1062** comprising the end walls **1051** and **1052**, respectively, of the bath and the vicinary separatory walls **1062**, are narrower than the working compartments and are not adapted to receive an upright treating or wash vessel. It is to be noted that the separatory walls **1059** terminate at a height substantially below the top edge of the water bath. The adjuvant compartment contain indentures **1056** and serve as conduit for the incoming and outgoing stream of liquid temperature conditioning medium. When treating vessels are inserted in the working compartments, a stream of liquid medium, such as water or temperature conditioned water entering through inlet **1057** rises up in the adjuvant com-

partment at the left, overflows the first separatory wall, flows downwardly in the first working compartment, underflows the first treating vessel, flows upwardly on the far side of the treating vessel, overflows the next separatory wall to flow downwardly in the next working compartment, underflowing the next vessel and so forth, until it overflows the last separatory wall and through the adjuvant compartment at the right, where it leaves the bath through the outlet. If any one or more of the treating vessels are substituted by wash vessels, the flow pattern, which is an essentially vertical flow pattern, is still maintained except that either the down stream or the up stream in each working compartment containing a wash vessel, passes through the wash vessel itself.

In a further modification of the bath of the invention, the bottom edge of the outlet in end wall **1052** is advantageously set at least about one eighth of an inch higher than the top edge of the separatory walls, so that the level of the water or other liquid medium in the bath, when it flows through inlet **1057** and passes through the bath, stands in the bath by at least one eighth of an inch above the top edge of each of the separatory walls. This expedient assures, with the treating and wash vessels inserted, that the water or other liquid medium is flowing over the whole width of the separatory walls, even if the bath is not exactly level, preventing the formation of dead spots or pockets, which could result in less than perfect temperature control or washing action, respectively. The same beneficial effect may also be achieved by extending the height of the last separatory wall, adjoining the downstream adjuvant compartment slightly, so that its upper horizontal edge lies somewhat higher than those of the other separatory walls in the bath. Independently thereof, it is desirable that the water bath of the invention is placed as level as is possible. This is facilitated by the provision of horizontal lines or other marks at the inside of the walls of the bath or compartments, respectively, indicating the proper water level. If the water level stands above one of the lines or marks on one side of the bath and below the correlated line on the other side of the bath, the position of the bath may simply be changed until the water level coincides essentially with the marks or lines on both sides of the bath.

The grooves in the individual compartments of the just described embodiment of the water bath may have any other desired shape. Their cross section may be round, oval, wedge-shaped or have any other irregular configuration. They may also be tapering off toward the bottom of the compartment or they may be slightly curved in the direction toward the interior of the compartment. Advantageously, the grooves or other female counter sealing means terminate at a level somewhat above the bottom of the compartment, so as to form at the lower end a seat for the vessel or its sealing means in order to hold the vessel at least slightly above the bottom of the compartment, providing the required underflow passage for the flowing stream of water. However, this requirement applies only, if the bath or the vessel itself does not have spacers or other means, assuring the positioning of the bottom of the treating vessels at the proper height. Such spacers may be provided in form of an extension of the male sealing means at both sides of the vessel to a position, slightly below the bottom of the vessel by a distance equalling that of the desired height of the underflow. Depending on the stiffness and design of the sealing means, such additional spacing or sealing means may in many instances not be needed at all, since the trapezoidal design of the bath in itself controls the depth of insertion of the vessels.

The female counter sealing means, such as grooves or channels, provided in the side walls of the compartment, may be lined with a profiled elastomeric sealing material adapted to receive the cooperating sealing means provided at the treating or wash vessels. The grooves may also be omitted altogether, so that the end walls of the compartment, if used with a suitably designed upright treating or wash vessel, serve as the sealing means. Strips of elastomeric sealing material, laid between the end walls of the vessels and the side walls of the compartment, provide also in this modification excellent seal. Alternatively, male counter sealing means, such as vertical ribs, may be substituted for the grooves or channels, if the bath is to be used with vessels, having cooperating female sealing means such as grooves or channels, adapted to cooperate with the male or rib-like counter sealing means in the bath.

It was found that still better performance of the water bath of the invention can be achieved, if the water enters the first adjuvant compartment through a suitable distributor instead through the simple inlet tube **1057**. The use of the distributor produces more even spread of the flow pattern and avoids the formation of dead pockets in the bath or in any of the compartments, respectively.

Any desired distributor, which serves this purpose may be used. A simple embodiment thereof comprises a flat trough, extending across the end wall at a level high enough such that its upper edge is above the normal water or liquid level in the bath. The inlet is communicatingly connected to the interior of said trough. When the water or liquid medium enters and fills the trough, it overflows over the edge, preferably directly into the first working cell producing an even stream of liquid medium, such as temperature conditioned water, spread over essentially the whole width of the bath.

Another embodiment of the distributor comprises a perforated tube, which is closed at both ends and which extends horizontally across the bath, preferably parallel to the end wall. The inlet is communicatingly connected to the distributor tube, preferably somewhere in its center. Though the tube may be placed in any desired height at the end wall, it is advantageously located close to the bottom of the first adjuvant compartment, or at or close to the top of the first working compartment, if no adjuvant compartment is used. The perforations are advantageously arranged in a single or double row. For still better distribution, the size of the perforations such as holes, may be varied with the smallest perforations or holes in the center of the inlet connection and the largest at the outer ends of the tube, and with the area of the perforations or holes increasing proportionately as the water pressure decreases at the respective locations. Any other distributor serving the purpose may be used with equal advantage. The adjuvant compartments may, as stated, also be omitted in some modifications of the bath of the invention. This applies particularly to the terminal adjuvant compartment, i.e. the one having the water outlet. By proper design and positioning of the water outlet equally good performance may be achieved, if no terminal adjuvant compartment is used.

The water inlet and outlet may have any other desired form. The outlet may, for instance, have the form of a horizontal slot provided in the end wall **1052**, emptying if desired, into a horizontal conduit, joined to the outside of end wall **1052**. The inlet may be omitted if desired, if the stream of flowing medium is directly introduced into the first adjuvant or first working compartment e.g. by tubing or other conduit coming in from overhead.

Instead of providing the heating chamber at the bottom of the bath, as shown for example in FIGS. 1 and 2 of the accompanying drawings, the heating chamber may also be provided directly in the bath, conveniently in an adjuvant compartment. Depending on the design, size and number of the heating elements, the adjuvant compartment may directly serve as the heating chamber into which the heating elements are simply inserted. Or more beneficially, the adjuvant compartment is subdivided, so as to form a heating chamber, comprising a multiplicity of communicatively interconnecting cells and containing one or more heating elements.

An embodiment of the bath of the invention, containing a heating chamber arrangement in the first adjuvant compartment, is illustrated in my copending patent application Ser. No. 342,029 to which special reference is made.

A preferred embodiment of the fully automatic bath of the invention, comprising means for automatic agitation of the photographic material to be treated and means for automatic forwarding of the photographic material from step to step through the treating and wash vessels contained in the bath, is likewise illustrated in my copending patent application Ser. No. 342,029 to which special reference is made.

The apparatus and device of this invention may be constructed of a variety of materials. Those parts of the construction which merely serve as supports and are not contacted during the operation with chemicals other than those contained in the tap water used as the temperature conditioning medium and in the wash-water may be made in conventional manner from copper, brass, steel, or other suitable metals or from a variety of plastics, glass or other inorganic construction materials available for this purpose. The water bath may likewise be constructed from metals such as steel or sheet iron with or without protecting coating such as enamel, metal plating, plastic coatings or paints or if desired from stainless steel, copper, brass with or without protective layers, hard rubber, plastics etc. As stated, resistance to chemicals is of minor importance with these parts of the apparatus, while rigidity and mechanical stability are of prime importance. The preferred materials for the construction of the heating elements are metals, which may be used to form a sheath or cover around the heating elements carrying the electric current. Proper insulation between the heating elements and the water-tight sheaths or covers is of importance in order to render the operation safe from the point of view of shock and leakage of electric current.

Many photographic treatments capable of being carried out in the apparatus of the present invention will be benefited by the provision of an accurate timer with each step. The commercially available electric or spring-actuated timers may be used with advantage or, if desired, a simplified inexpensive timer, as it has been described in my copending application 23,313 may be employed, with suitable modifications in the process and apparatus of the present invention.

A preferred embodiment of a timer which is specifically adapted for and which may with great benefit be used as part of the composite apparatus of the present invention, particularly for the practice of the more complex multistep color developing processes, is a timing device comprising means, which are programmed to the time schedule of a succession of photographic treating steps or of at least one multistep photographic process, respectively, and which are capable of producing a succession of impulses at predetermined time intervals, corresponding to the timing schedule required for the carrying out of said succession of photographic treating steps, or of said photographic process, respectively.

The timer operates on the principle of generating successive impulses at predetermined time intervals corresponding to the time schedule required for carrying out the succession of treating steps in the individual photographic treating media, and for the removal of the material from each of the treating media and for the forwarding of the material to the next medium or step, respectively, when each of the corresponding impulses is generated, until the material has been passed through all of the treating media required for completing the said succession of treating steps. For manual operation of the process said impulse is advantageously a perceptive signal, preferably a light and/or sonic signal.

A suitable program timer, which is excellently suited to provide electrical impulses at the beginning and end of each treating step, thus timing not only the actual treating steps but also the intermediary drainage steps is disclosed and claimed in my copending patent application Ser. No. 302,902 to which special reference is made.

Particularly great benefits are achieved by the use of the program timer in conjunction with the light bar of the present invention which contains for each step of the multistep treating process at least one light source. The light sources contained in the light bar are preferably arranged and spaced so that each light source is in juxtaposition with the respective treating vessel or tray in which the step, to be controlled by the particular light signal, is carried out. Each of the light sources is in turn independently controlled by the program timer in accordance with the time schedule of the process.

The light bar is claimed and described in more detail in my copending application Ser. No. 302,902 filed Aug. 19, 1963. The various embodiments and modifications of the light bar taught in this application may be incorporated with great benefit in the apparatus of the present invention. The electric impulses provided by the program timer may be directly used for the control of some or all functions of the automatic forwarding means in the fully automatic embodiment of the apparatus of the present invention.

For the convenience of the less experienced operator some additional modifications of the process and apparatus of the present invention may be made. In order to avoid or prevent errors in the sequence of applying the treatment solutions in the individual steps, particularly in the multistep color developing processes, the vessels and the storage bottles may be color coded. Selecting one and the same color for the labels, caps etc. of packages or bottles containing the ingredients for that particular solution, for the storage bottles containing the prepared treatment solutions and for the vessel to be used for the particular step and its section of the water bath where it is to be placed makes it virtually impossible that mistakes in the proper sequence of the steps of the particular process are made.

The code color may appear on the outside or inside or on both sides of the vessel. Usually it is sufficient if only the upper portion of the vessel is marked in this manner. Generally it is desirable that the colors selected are such that their distinction remains perceivable in the monochromatic light usually employed in the darkroom for the particular process in question. The effectiveness of the color-coding means may be further improved by the additional provision or substitution of geometrical designs in the marking areas, such as dots, lines, crossing lines, circles, squares etc. These in combination with a few colors or simply black and white areas which are clearly distinguishable in the darkroom light permit complete marking and distinction of a multitude of treatment solutions and their storage and treatment containers.

The treating solutions or liquids employed in the processes practiced in the color coded apparatus of the invention may be simply kept in color coded storage bottles. To increase the storage life of the treating media, which are sensitive to the effects of the atmosphere it was found to be of advantage to keep them in storage bottles in which air or the atmosphere does not contact the solutions regardless of whether the bottles are fully or only partially filled. This can be readily achieved by the use of bottles which contain membrane means such as films, bags or similar means, one side of which is communicatingly connected with air or liquid tubing, extending to the outside of the bottle. The other side of said membrane means is contacted by the treating liquid contained in the bottle and serves to prevent access of the air or atmosphere thereto.

Said air or liquid tubing and another short narrow tube, preferably a capillary tube, for the pouring of the liquid treating medium contained in the bottle penetrate through closure means set air- and liquid-tight in

the opening of the bottle. Both the free end of the tubing and of the narrow gauge tube are provided with air and liquid tight closing means, such as stop cocks, clamps or screw caps. The said narrow tube for the treating liquid ends in the neck of the bottle, at a position close to the said closure means.

The color code, mentioned hereinbefore, may also be provided on the said light bar if one is used with the apparatus of the invention. Alternatively, elongated plates or strips of material may be provided with the color coding corresponding to a given process. The code strip is then slipped into suitable holding means provided at the edges of the bath or light bar, such that each of the code colors appearing opposite a cell may readily be matched by the insertion of a vessel of the identical color. Provisions, preventing the inadvertent reversed insertion of the said code strip and/or light bar may be made by suitable design of the said holding means in relation to the design or dimensions of the code strip or light bar, respectively.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is understood, that the invention is not limited to the specific embodiments thereof, except as defined in the appended claims.

I claim:

1. An apparatus for carrying out multistep photographic treatments in a multiplicity of different treating solutions which apparatus comprises a bath which is subdivided by transversal separatory walls into a multiplicity of essentially water-tight working compartments side by side and removably contained in working compartments of said bath in sealing relationship, upright treating vessels having an essentially rectangular horizontal cross section, an overflow passage at the separatory walls and a horizontal passageway beneath said vessels, at least one of the members, selected from the treating vessels and working compartments, having on their sides vertical sealing means for establishing a seal between these members upon the insertion of the treating vessel in a working compartment of said bath, such that temperature conditioning water, passing through the bath in the form of a wide unidirectional stream, successively circumflows, in a generally vertical direction, the treating vessels, flowing down on the upstream side, underflowing the vessel and flowing up on the downstream side of the vessel.

2. The apparatus of claim **1**, in which the treating vessels comprise generally vertically oriented sealing means cooperative with the side walls of the compartment wherein they are inserted, so as to establish essentially liquid tight seal between these members.

3. The apparatus of claim **1** in which the treating vessels comprise at their end walls vertical sealing means.

4. The apparatus of claim **1** in which the side walls of the compartments comprise vertical sealing means.

5. The apparatus of claim **1**, in which the side walls of the compartments comprise vertical countersealing means and the treating vessels comprise at their end walls vertical sealing means cooperative with said countersealing means when the vessel is inserted in the compartment.

6. The apparatus of claim **1**, in which said treating vessels are disposable vessels.

7. The apparatus of claim **1** which comprises at least one plane film carrier capable of containing and maintaining photographic film material in at least one vertical plane when said carrier is inserted in one of said vessels.

8. The apparatus of claim **1** which comprises compartments in sealing relationship and in addition means which are adapted to establish in said compartments a washing location wherein the wash water flows in a generally vertical direction.

9. The apparatus of claim **8** in combination with a program timer which is capable of providing perceptive signals at the time intervals corresponding to the treatment schedule of a particular process to be carried out in the apparatus.

10. The apparatus of claim **8**, in which said means for establishing in compartments a washing location, are interspersed in working compartments located between the working compartments containing the said treating vessels, so as to provide alternatingly chemical and washing stations in the order as required by the photographic process to be carried out in the apparatus.

11. The apparatus of claim **9** in combination with a light bar attached to said bath such that one light source is coordinated to each of the vessels contained in said bath.

12. The apparatus of claim **10**, in which the said means for establishing in working compartments a washing location are designed such that the said stream of temperature conditioning water, serving also as the washing water in said washing locations, passes around said treating vessels and through these washing locations in form of a wide spread, unidirectional stream following an up and down vertical zig-zag pattern.

13. The apparatus of claim **12**, in which said means for establishing in working compartments a washing location, are washing vessels, comprising essentially vertical sealing means, which washing vessels are removably inserted in any of the working compartments in sealing relationship.

14. The apparatus of claim **1**, which contains in addition at least one washing vessel in a compartment such that said stream of liquid medium passage through said washing vessel in an essentially vertical flow direction.

15. The apparatus of claim **14**, in which the treating vessels containing the treating media required for each step of the process and the wash vessels, one each for each washing step required by the process, are arranged side by side and in the order required by the treating sequence of the process.

16. The apparatus of claim **14**, in which the treating and wash vessels comprise sealing means cooperating with counter sealing means contained in the compartments of the bath so as to establish essentially liquid tight seal between the side walls of the compartments and the end walls of the vessels when they are inserted therein.

17. The apparatus of claim **14** in combination with means adapted to provide a stream of temperature conditioned liquid medium having an essentially constant temperature so as to maintain the temperature in the treating and wash vessels at the level required by the process to be carried out, and means adapted to pass said stream of liquid medium through said compartmented bath.

18. The apparatus of claim **17**, in which said bath comprises a heating chamber adapted to contain at least one electric heating means.

19. The apparatus of claim **1**, which comprises automatic mechanical agitating means.

20. The apparatus of claim **19**, which comprises in addition automatic forwarding means.

21. The apparatus of claim **19** in combination with at least one plane carrier having an agitating support.

22. The apparatus of claim **20** in combination with a program timer which is conductively connected to said forwarding means so as to control the actuation of said forwarding means at time intervals corresponding to the time schedule of the process to be carried out in the apparatus.

23. The apparatus of claim **21**, in which said plane carrier comprises guide means.

No references cited.

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