DRUG DISPENSING APPARATUS

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ABSTRACT

A drug dispensing apparatus for automatically dispensing one or more individual drug doses to a common collection area in accordance with input information which represents the unique medicinal needs of a patient. Each of the three embodiments disclosed includes a locked cabinet which houses a plurality of removable and refillable cartridges. Each cartridge stores a plurality of individual identical drug doses and includes means for sequentially dispensing the drug doses on a demand basis. The dispensing apparatus further includes means for receiving the input information and control means which responds to the received input information and selectively operates the cartridges to dispense an individual drug dose or doses according to the patient's unique medicinal needs.

33 Claims, 24 Drawing Figures
DRUG DISPENSING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to automatic vending systems and more particularly to automatically controlled drug dispensing systems, specifically intended for hospitals, nursing homes and the like, where the need for controlled preparation and dispensing of drugs pursuant to physicians' prescriptions is continuous and concentrated.

2. Description of the Prior Art

The medical needs of patients in a hospital or a nursing home vary greatly in their content and in their required frequency of administration to the patients. Since the filling of a prescription involves the services of a trained pharmacist, the burden placed upon the pharmacy staff in a hospital or nursing home in accurately filling the hundreds or thousands of required prescriptions in a timely manner is obviously quite heavy, but, one which cannot lend itself to error. The problem is further complicated by the fact that in most hospitals and nursing homes, the pharmacy staff is not generally available on a 24-hour basis. Because of this, the filling of prescriptions must necessarily be anticipated during the pharmacist's absence.

In a hospital, the anticipation for a pharmacist's absence is sometimes accomplished by making the drugs or medicinal needs of a particular group of patients available at the nursing station having responsibility for the care of that patient group. Accordingly, prior to the periodic rounds of a nurse or nurses, the required patients' prescriptions are prepared directly from the inventory of drugs and medicines provided for that purpose. The same general procedure holds true for nursing homes and other similar institutions.

It has been found that such a procedure has a number of serious drawbacks. First, once the drugs and medicines have left the pharmacy, they are beyond the direct control of the pharmacist who is most knowledgeable of the drugs and medicines and their effects on a patient. In the absence of his direct control and knowledge, it is possible for a patient to be given the wrong drug or an improper dosage of the prescribed drug. This, obviously, can have a critical and perhaps a severely damaging effect on the patient involved. Further, since the inventory of drugs and medicines is usually accessible to persons other than the nurses, strict control over the inventory is lost. The unaccountable loss of drug inventory represents a significant problem to large medical institutions at the present time.

Prior art systems have been designed for distributing unit-dose medication from a central supply terminal to remote receptor terminals located, for example, throughout a hospital or nursing home. One such prior art system employs a pneumatic distribution system for actually effecting a transfer of the medicine or drug from a central pharmacy station to one of a plurality of remotely located receptor terminals. Another prior art system employs a plurality of remotely located dispensing stations, such as cabinets, located at patients' bedside or at centrally located nursing stations, each containing a plurality of drugs or the like which selectively dispense their drugs upon receipt of a coded command transmitted by telephone or other signal generating apparatus from the central pharmacy. These prior art drug dispensing systems, while reducing some of the logistical problems employed in the dispensing of drugs in a large institution, do not solve the more basic goal of enabling the pharmacist to rapidly pre-fill individual patient prescriptions in an automated, rapid and accurate manner in anticipation of their required distribution times and in anticipation of the absence of a pharmaceutical staff in their non-working hours.

The present invention is directed to apparatus for automatically dispensing individual drug doses in response to input prescription information which represents the unique medicinal needs of a given patient. While the embodiments of the present invention will be described in conjunction with their use in hospitals or nursing homes, it will be understood that the invention is not limited to these uses, but can be employed in any pharmaceutical distribution center. Further, while the present invention, as described, discloses specific embodiments of drug dispensing cartridges, it will be understood that the invention is not limited to the use of those particular cartridge designs nor to the particular arrangements thereof within the system cabinet, but that other functionally equivalent cartridge designs and arrangements may be used without departing from the spirit or intent of this invention.

SUMMARY OF THE INVENTION

The automatic drug dispensing apparatus is generally contained within a locked cabinet. The cabinet houses a plurality of refillable cartridges, removably disposed therein. Each cartridge has means for storing a plurality of individual drug doses, means for effecting movement of the individual drug doses in the cartridge in sequential order toward an outlet of the cartridge, and means for dispensing the individual drug doses from the cartridge one at a time at the cartridge outlet to a common collection area.

An information input receptor operates to receive input information that represents unique medicinal needs of a patient. In the preferred embodiments, the input receptor may receive the patient input information from data cards, magnetizable media, a digital computer, optical readers, paper tape, or the like. Control means operatively connected with the input receptor, are operable in response to the received patient input information to selectively cause the plurality of cartridges to dispense individual drug dose or doses to a common collection area.

In one embodiment of this invention, individualized receptacle means, removable from the cabinet, receive the drug doses dispensed to the common collection area. Each individualized receptacle is identifiable with specific input information and typically will be identifiable with an individual patient or bed location. Means operatively controlled by the control means sequentially present the individual receptacle means, one at a time, adjacent the common collection area to enable the individual drug dose or doses at the common collection area to be deposited therein. The control means coordinates presentation of the individualized receptacle means to the common collection area with the selective dispensing action of the plurality of cartridges such that those drug dose or doses representing the unique medicinal needs of a patient are collected in selected ones of the identifiable receptacle means.

In one embodiment of this invention, the input receptor is specifically adapted to receive the patient input information from data cards or magnetic media bearing such input information. In this embodiment, the indi-
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individual receptacle means comprise multi-bin trays, wherein each bine represents an individual receptacle for accepting one or more individual drug dose or doses. The multi-bin trays are carried by a conveyor apparatus within the drug dispensing system, and their movements are coordinated by the control means such that only selected bins of the trays are sequentially presented adjacent the common collection area for receiving drug doses therefrom.

A third embodiment of the present invention, also employing individualized receptacle means to selectively receive the individual drug doses representing the unique medical needs of identifiable patients, employs an input receptor adapted for receiving its input information from a digital computer. The input information may be directly placed into the computer from doctors' orders, etc., and is made available to the drug dispensing apparatus on a priority basis. The drug dispensing apparatus, therefore, is adaptable for control by an existing digital computer primarily employed for other purposes within the hospital or nursing home.

A second embodiment of the present invention is particularly adapted for use in nursing homes and the like, where a patient's daily prescription may remain unaltered for extended periods of time. This embodiment, generally employed to service only one patient per module of cartridges, employs presettable input means for receiving the input information representing the unique medicinal needs of that patient. This embodiment also includes means for recycling the received input information on a predetermined, periodic time basis. The control means of this embodiment operates in response to the received input information to periodically and routinely cause the cartridges to selectively dispense individual drug dose or doses to a single common collection area, generally accessible only to a nurse or doctor.

Several unique drug dispenser cartridge designs are embodied within this invention. A first such cartridge employs means for retainingly holding a tape to which are sequentially and removably attached a plurality of individual drug cartridges. This embodiment also includes means for advancing the tape past the outlet of the cartridge in response to signals from the control means, and means for removing the individual drug doses from the tape as it proceeds past the outlet, for dispensing the removed individual drug doses out of the cartridge outlet.

Another cartridge embodiment design employs a cartridge housing for defining an internal chamber designed to hold a plurality of individual drug doses loosely therein and for sequentially presenting the individual drug doses, one at a time, to the cartridge outlet. This embodiment employs a solenoid operated dispenser apparatus at the cartridge outlet for ejecting individual drug doses therefrom, one at a time, in response to signals from the control means of the dispensing apparatus.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Referring to the Figures wherein like numerals represent like parts throughout the several views:

FIG. 1 is a diagrammatic view of a first embodiment of the drug dispensing apparatus of the present invention;

FIG. 2 (sheet 2) is a block diagram representation of alternate input information sources and receiving means that can be employed by the drug dispensing apparatus illustrated in FIG. 1;

FIG. 3 (sheet 3) is a front elevational view of the drug dispensing apparatus illustrated in FIG. 1 generally taken along the line 3—3, with the front panels removed and with portions thereof broken away;

FIG. 4 (sheet 4) is a sectional view of the drug dispensing apparatus illustrated in FIG. 3, generally taken along the line 4—4 with portions thereof broken away;

FIG. 5 (sheet 4) is a sectional view of the drug dispensing apparatus illustrated in FIG. 4 taken generally along the line 5—5 with portions thereof broken away;

FIG. 6 (sheet 2) is a block diagram representation of the control elements of the drug dispensing apparatus disclosed in FIGS. 1—5;

FIG. 7 (sheet 1) is a diagrammatic view of one embodiment of a drug dispensing cartridge for use in the drug dispensing apparatus disclosed in FIGS. 1—6;

FIG. 8 (sheet 1) is a sectional view of the drug dispensing cartridge disclosed in FIG. 7 taken generally along the line 8—8, with portions thereof broken away;

FIG. 9 (sheet 3) is an enlarged fragmentary sectional view of the drug dispensing outlet portion of the drug dispensing cartridge illustrated in FIG. 8, taken generally along the line 9—9;

FIG. 10 (sheet 5) is a side elevational view of the drug dispensing cartridge illustrated in FIG. 7, taken generally along the line 10—10 with the side housing cover of the cartridge removed;

FIG. 11 (sheet 5) is a diagrammatic view of a second embodiment of the drug dispensing apparatus of the present invention;

FIG. 12 (sheet 6) is a front elevational view of the drug dispensing apparatus disclosed in FIG. 11 generally taken along the line 12—12, with the front panel thereof removed and with portions thereof broken away;

FIG. 13 (sheet 6) is a top elevational view of the drug dispensing apparatus disclosed in FIG. 11 generally taken along the line 13—13, with the top panel thereof removed and with portions thereof broken away;

FIG. 14 (sheet 7) is a sectional view of the drug dispensing apparatus disclosed in FIG. 11 generally taken along the line 14—14, with portions thereof broken away;

FIG. 15 (sheet 7) is a detail view of the cam and cam follower apparatus of the drug dispensing apparatus disclosed in FIG. 13 generally viewed along the line 15—15;

FIG. 16 (sheet 7) is a detail cross-sectional view through one of the timing wheels of the drug dispensing apparatus disclosed in FIG. 12, generally taken along the line 16—16;

FIG. 17 (sheet 7) is a detail view of the face of one of the timing diaphragms of the drug dispensing apparatus disclosed in FIG. 12 as generally viewed along the line 17—17;

FIG. 18 (sheet 8) is a diagrammatic view of a third embodiment of the drug dispensing apparatus of the present invention;

FIG. 19 (sheet 8) is a cross-sectional view of the drug dispensing apparatus disclosed in FIG. 18 taken generally along the line 19—19;

FIG. 20 (sheet 9) is a cross-sectional view of a portion of the drug dispensing apparatus disclosed in FIG. 18 taken generally along the line 20—20, and with portions thereof broken away;
FIG. 21 (sheet 9) is an enlarged fragmentary sectional view of one of the cartridge dispensers disclosed in FIGS. 19 and 20, illustrating the cooperation between the cartridge dispenser and the cabinet retaining member therefor;

FIG. 23 (sheet 9) is an enlarged diagrammatic view of one of the oral solid drug doses and its retaining capsule, illustrated in cross-sectional view in FIG. 21; and

FIG. 24 (sheet 9) is a cross-sectional view of a typical liquid drug dose suitable for dispensing by the cartridge disclosed in FIGS. 19 and 21.

DESCRIPTION OF THE FIRST PREFERRED EMBODIMENT

The term "drug dose" as employed throughout this application is defined as that measure (quantity) of drug, medicine, or the like which is dispensable by the drug dispensing system. Although the preferred embodiments of this invention will apply the term to "oral solids," "oral liquids" and "injectables," the term could also apply to other medicinal entities such as salves, lotions, etc.

A first embodiment of the automatic drug dispensing system of the present invention is illustrated in FIGS. 1–6. Referring to FIGS. 1–6, the drug dispensing system is housed in a single cabinet 30 formed of a plurality of longitudinally connected modules. In the first embodiment, the cabinet is comprised of four such interconnected modules. The first of such modules, a control module 31, generally houses the control elements of the automatic dispensing system as hereinafter described. A second module, generally designated at 32 and connected adjacent the control module 31, is adapted for storing and dispensing a plurality of drug doses generally designated as "oral solids." A third module, generally designated at 33, is connected adjacent the second module 32 and is adapted for storing and dispensing a plurality of drug doses generally referred to as "oral liquids." A fourth module, generally designated at 34, is adapted for storing and dispensing a plurality of drug doses generally referred to as "injectables." Although three drug dose storing and dispensing modules are indicated in the first embodiment, additional such modules could be added to the cabinet to increase its capacity or the number of different kinds of individual drug doses dispensable by the dispensing system, as will become apparent upon a more detailed description of the invention.

A cart 28 (FIG. 1), as hereinafter described, may be detachably functionally associated with the drug dispensing system housed in the cabinet 30.

In the first embodiment, each of the four modules of the cabinet 30 is physically and functionally segmented into three zones. A lower zone, designated as 30a (FIG. 1) is employed for general storage purposes and is accessible by means of a plurality of locked doors 35, one or more for each module. A central zone 30b, located immediately above the lower zone 30a, is employed for housing drug dose collection and transporting facilities of the drug dispensing system as hereinafter described. Access is provided to the inside of the second zone 30b of the cabinet 30 by means of a plurality of locked doors 36, one or more for each module. An upper zone 30c is positioned immediately above the central zone 30b of each module. In the second, third and fourth modules 32, 33 and 34, respectively, the upper zone 30c houses a plurality of drug dispensing cartridges as hereinafter described. In the first embodiment, the upper zone 30c of the drug dispensing modules is accessible from without the cabinet 30 by means of a plurality of locked doors 37. The upper zone 30c of the control module is accessible by means of a single locked door and houses the input data receiving and control elements for the drug dispensing system as hereinafter described.

The ends of the modules 31–34 which adjoin adjacent modules are open, except for interconnecting support members, so as to form a cavity within the cabinet 30. The modules are fastened together at their common interfaces by means of angle iron frame members, generally designated at 39 (FIG. 3, sheet 3). The outwardly directed faces of the modules are closed by the plurality of doors 35, 36 and 37 and by end panels, generally designated at 38, on the control and fourth modules 31 and 34, respectively.

The drug dispensing modules 32–34 are generally symmetrical about a vertical plane longitudinally extending through the center of the cabinet 30. Each of the drug dispensing modules 32–34, therefore, includes a plurality of locked doors (not illustrated) on the back face of the cabinet 30 which are generally symmetrically aligned with the plurality of access doors 35, 36 and 37 illustrated on the front face of the cabinet 30 in FIG. 1.

Referring to FIGS. 3 (sheet 3) and 4 (sheet 4), each of the drug dispensing modules 32–34 mounts a plurality of drug dispensing cartridges 40. In the first embodiment, each of the second, third and fourth modules, 31, 32 and 33, respectively, holds three vertically stacked tiers of drug dispensing cartridges 40 within its upper zone 30c. It will be understood that there are three of such cartridge holding tiers on each of the symmetrical halves of the drug dispensing modules. The cartridges 40 are slidably mounted immediately adjacent one another as illustrated in FIG. 3. The three tiers of cartridges are defined by first, second and third shelf-like support members 42, 43 and 44, respectively, each comprising part of the internal frame structure of the cabinet 30 and supporting a plurality of the cartridges 40 in upright alignment thereon. The shelf-like supports 42, 43 and 44 extend generally horizontal within the cabinet 30 from the front and rear walls of the cabinet 30 and are generally identical in construction to one another within any one of the drug dispensing modules 32–34. For the sake of clarity and ease of description, a more detailed description thereof will be conducted with reference only to the lower-most shelf-like support 44. Each of the shelf-like supports 42–44 terminates at a pair of tube-like flanges 46 (FIG. 4) extending longitudinally down the length of the internal cavity of the cabinet 30. A pair of retaining members 47 are connected to the outwardly directed edges of each of the shelf-like supports 42–44 and extend longitudinally therewith down the length of the internal cavity of the cabinet 30 at a position immediately internal of the plurality of access doors 37 of the cabinet.

The cartridge dispensers 40 are sized to fit snugly between the retaining member 47 and the flange 46 of each of the shelf-like supports 42–44. The tube-like flanges 46 include a plurality of male connector plugs 48 (FIGS. 3 and 4) longitudinally spaced therealong so
as to align in connecting relationship with a mating female connector (to be hereinafter described) on the inwardly directed end of the plurality of cartridges 40 when they are retainably positioned on the shelf-like supports 42-44 as illustrated in FIG. 3. The internal hollow portion of the flanges 46 houses the electrical wiring (not shown) from the power source and control module to the connectors 48.

Although not illustrated, the electrical conduits, connections and power sources, etc., required to power any electrical elements disclosed in this application will be understood to be present for providing an operatively functional system.

Several designs of drug dispensing cartridges are disclosed. A diagrammatic view of that type of drug dispensing cartridge 40 disclosed in FIGS. 3 and 4 as employed in the first embodiment, is diagrammatically illustrated in FIG. 7 (sheet 1). Sectional views, further detailing the drug dispenser 40, are illustrated in FIGS. 8 (sheet 1), 9 (sheet 3) and 10 (sheet 5). Referring to FIGS. 7-10, the cartridge 40 generally includes a housing 48 defining an internal chamber 51 and having a first end plate 52 and a second end plate 53. An outlet 54 formed in the end plate 52 defines a passageway into the internal chamber 51. The cartridge 40 is oriented in FIG. 7 as it would be positioned within the cabinet 30 (see FIG. 3). The lower side of end plate 52 has an inwardly directed offset portion which houses a female electrical connector 55 which is sized to mate with the compatible plurality of male connector plugs 48 mounted within the tube-like flanges 46 of the cabinet frame. A spring clip 57 (FIG. 8) is connected at the bottom of end plate 53 of the cartridge 40 and is employed to securely position the cartridge 40 on one of the shelf-like supports 42-44 between the flange 46 and the retaining member 47 of that shelf (see FIG. 4 — sheet 4).

Referring to FIG. 10, a mounting spindle 60 is rotatably secured to the sides of the housing 50 so as to transversely extend across the chamber 51. In the preferred embodiment, a tape 61 is wound upon the spindle 60. The tape 61 includes a plurality of individual drug dose assemblies 62 which are sequentially aligned thereon and are individually removably attached thereto. For that cartridge 40 illustrated in FIGS. 7-10, and individual drug dose assembly 62 comprises an individual drug dose 63 (see FIG. 9 — sheet 3) securely attached by means of a plastic coating 64 or the like, to a cardboard or plastic mounting base 65. The individual drug dose 63 secured to the mounting base 65 may be a pill, a container of injectable fluid, or a capsule or oral-type drug, or the like. Generally, all of the individual drug doses on a tape within any one cartridge 40 are of like kind. In the preferred embodiment, individual drug dose assemblies 62 are adhesively mounted in spaced relationship to one another upon the tape 61 (see FIG. 9). However, other mounting methods employing a tape (for example, a tape having perforations between individual drug doses, wherein the tape itself is employed as the mounting base for the individual drug doses) could equally well be employed within the spirit and intent of this invention.

The drug dose bearing tape 61 extends over a roller 70 rotatably mounted to the cartridge housing 50 adjacent the housing outlet 54 and is securely attached to a take-up drum 71. The roller 70 is rotatably mounted on an outlet shroud 73 forming a part of the housing 50 and extending transversely from the end plate 52 into the cavity 54 adjacent the housing opening 54. The roller 70 is mounted adjacent the housing outlet 54 such that as the tape 61 is advanced by rotation of the take-up drum 71, the individual drug dose assemblies 62 are sequentially presented adjacent the housing outlet 54. The take-up drum 71 is rotatably mounted to the housing 50 and includes a drive pulley 72. A tape-advance motor 74, connected to the base of the housing 50, is operatively connected to the pulley 72 of the take-up drum 71 by means of a belt 75, for rotating the take-up drum 71 in a counterclockwise direction when viewed as in FIG. 10. An idler 76 extends from a downwardly depending projection of a plate 77 and engages the belt 75 intermediate the motor 74 and pulley 72. The plate 77 forms a part of the housing 50 and extends transversely between the side walls thereof.

A stainless steel blade 78 is attached to the housing at its outlet 54 and projects inwardly thereof for slidably engaging the tape 61 (see FIG. 9). The forward edge of the blade 78 is adjustable to slidably engage the tape 61 at a radial distance from the axis of the roller 70 for allowing uninterrupted sliding movement of the tape 61 over the surface of the roller 70 but so as to frictionally retain the individual drug dose assemblies 62 from the tape 61 as it proceeds past the outlet 54. FIG. 9 illustrates an individual drug dose assembly 62 being removed from the tape 61 by the blade 78.

A sensor 80 is externally mounted to the housing 50 and adjacent the housing outlet 54 for detecting the dispensing of individual drug dose assemblies therefrom. A limit switch 81 (FIG. 10) is mounted to the housing 50 within the chamber 51 and has a toggle arm 82 extending into the chamber and slidably engaging the non-drug dose bearing surface of the tape 61 wound on the spindle 60. The switch 81 is operatively connected to a first indicator lamp 83 and to a second indicator lamp 84. When the cartridges 40 are positionally aligned within the cabinet as illustrated in FIGS. 3 and 4, the indicator lamps 83 and 84 thereof are positionally aligned with a plurality of viewing ports generally designated at 86 in FIG. 1, to provide visual indications external of the cabinet 30.

When operatively positioned within the cabinet 30, the plurality of cartridges 40 are removably disposed therein such that the cartridge dispenser connectors 48 mate with the male connectors 48 of the cabinet, and such that the cartridge outlets 54 are positioned to direct drug doses dispensed by the cartridges for falling upon the top surface of a first conveyor 90 (see FIGS. 3 — sheet 3, and 4 — sheet 4). A trough-like frame member 92, connected to the inner portions of the shelf-like members 44, longitudinally extends through the drug dispenser modules 32, 33 and 34 and partially into the control module 31. The first conveyor 90 longitudinally extends and is substantially enclosed by the trough-like frame support 92. The first conveyor 90 is suspended between a drive roller 93 and a main idler roller 94 and transversely connected across the support member 92. A plurality of auxiliary idler rollers 95 located between the drive roller 93 and the main idler roller 94 and transversely connected across the support member 92 supportingly engage the first conveyor 90.

The conveyor 90 and the trough-like support frame 92 are centrally positioned within the cabinet 30 and longitudinally extend therein within the second zone 30B of the cabinet. Vertical support is provided for the frame member 92 by means of a plurality of struts 96 connected from the bottom of the frame member 92 to
a horizontal frame member 97 of the cabinet 30 extending generally laterally across the cabinet and defining the interface between the first and second zones 30A and 30B respectively thereof. That portion of the horizontal frame member 97 extending within the drug dispensing modules 32, 33 and 34 is generally designated at 97A (FIG. 3), and that portion of the horizontal frame member extending across the control module 31 is designated at 97B.

A first conveyor drive motor 100 is mounted on the interface frame plate 97B and is connected by means of a belt 101 to drive the drive roller 93 of the first conveyor 90. The first conveyor drive motor 100 causes the drive roller 93 to rotate in a clockwise direction when viewed as in FIG. 3.

A second conveyor belt 105 extends transversely of the longitudinal path of the first conveyor 90 within the control module 31. The second conveyor 105 is supported by means of a drive roller 106, and a main idler roller 107, both rotatably connected between a pair of frame members 108 mounted upon the horizontal frame section 97B of the cabinet 30 (see FIG. 4). The top belt portion of the second conveyor 105, as mounted upon the drive roller 106 and the main idler roller 107, is positioned adjacent, slightly below and underlying the bottom portion of the drive roller 93 end of the first conveyor belt 90, such that an individual drug dose carried by the first belt 90 will be deposited onto the top surface of the second belt 105.

A second conveyor drive motor 109 is mounted to the interface plate 97B and is connected to rotate the drive roller 106 of the second conveyor 105 by means of a belt 110. The second drive motor 109 causes the drive roller 106 to rotate in a clockwise direction when viewed as in FIG. 4. An L-shaped guide plate III (see FIGS. 3 and 5) is connected to the frame members 108 and is positioned slightly above the top surface of the second conveyor 105 and so as to longitudinally oppose the first conveyor 90, for guiding individual drug dose assemblies discharged from the end of the dirt conveyor 90 onto the top surface of the second conveyor belt 105. A cumulative drug dose sensor 115 is mounted adjacent the drive roller 106 end of the second drive belt 105 for detecting movement of individual drug doses thereby as they are projected from the belt 105, as hereinafter described.

A third conveyor belt 116 is longitudinally aligned with and in spaced relationship below the second conveyor belt 105. The third conveyor belt 116 is mounted between a drive roller 118, and a main idler roller 117, and a plurality of auxiliary idler rollers 119 located at spaced intervals between the drive and main idler rollers 118 and 117 respectively. The drive, main and auxiliary idler rollers 118, 117 and 119 respectively of the third conveyor 116 aretotally secured and transversely extend between the frame extension support members 108 of the cabinet 30.

The drive pulley 118 of the third conveyor 116 is mounted adjacent an intake port 120 located in the front panel of the cabinet 30, and guides the upper surface of the conveyor 116 adjacent thereto. The main Idler pulley 117 of the third conveyor 116 is mounted adjacent an output port 121 of the cabinet 30, and guides the upper surface of the conveyor 116 adjacent thereto. The top surface of the third conveyor 116 contains a plurality of cogs (generally designated at 122) transversely extending thereacross and in uniform spaced relationship with one another.

A shaft 125 axially projects from the drive roller 106 of the second conveyor 105 and terminates at a pulley 128 of a sequencing clutch apparatus 130. The sequencing clutch apparatus 130 further has an electrical control input port 131 and an output drive shaft 132. The output drive shaft 132 of the sequencing apparatus 130 operatively mounts the drive roller 118 of the third conveyor 115 (FIG. 4). The drive shaft 132 causes the drive roller 118 to rotate in a counter-clockwise direction when viewed as in FIG. 4.

A pair of guides 135 (see FIGS. 3 and 5) are mounted in spaced relationship to one another and above the top surface of the third conveyor belt 116 for guiding a tray 138 therebetween. The bottom of the tray 138 is crogged for mating with the plurality of spaced cogs 122 of the third conveyor 116. The tray 138 is divided into a plurality of contiguous receptacles, or bins 139. The guides 135 extend to the inlet port 120 of the cabinet 30 and are obliquely shaped adjacent thereto so as to urge a tray 138 placed upon the crogged belt 116 in proper alignment therewith. The upper surface of the crogged belt 116 is spaced a sufficient distance below the bottom of the second conveyor 105 so as to enable free movement of the tray 138 therebelow when proceeding in mated relationship upon the crogged belt 116.

In the first embodiment, the top surface of the first conveyor belt 90 and the top carrying surface of the second conveyor belt 105 are collectively termed as a "common collection area" for the individual drug dose assemblies dispensed by the plurality of cartridges 40. The cabinet 30 defines a shroud 140 (see FIGS. 4 and 5) adjacent the outlet port 121 thereof. The shroud 140 extends inwardly into the central cavity of the control module 31 and terminates at a position sufficiently spaced above the top surface of the belt 116 so as to enable free movement of the tray 138 thereunder.

A plurality of pairs of position sensing elements 141 are aligned in spaced relationship to one another adjacent the top surface of the third conveyor 116 and on opposite sides thereof for detecting the relative position of the tray 138 upon the conveyor 116. The spacing between adjacent ones of said pairs of sensors 141 corresponds to the width of the bins 139 of the tray 138, wherein the "width" is measured in the longitudinal direction of the tray 138. The plurality of sensor elements 141 are operatively connected (not shown) to elements within the control module 31 as hereinafter described. A pair of sensors 142, also operatively connected to the control module 31, are positioned below the shroud 140 and adjacent the top surface of the conveyor 116 for providing an indication of when the tray 138 is available for removal at the outlet port 121.

In the first embodiment of the drug dispensing system, that portion of the cabinet 30 housing the control module 31 has a first data input port 150 (FIGS. 1 and 2) for accepting data cards generally designated at 151, and further, has a second data input port 152 for accepting magnetizable tapes generally referred to at 153 in FIG. 2. The data cards 151 may be of "magnetic" or "punch-out" construction. The tape 153 in the preferred embodiment is of the "cassette" type, but may include other types of information bearing input tapes. The cabinet 30 further has an ejector button 154 mounted adjacent the second data input port 152 for ejecting the cassette tapes 153 operatively placed...
within the port 152. In general, the control module 31 portion of the cabinet 30 houses the control apparatus for the automatic dispensing system.

Input information is fed into the control module 31 generally by means of the data cards 151, the magnetic tape 153, or by means of a digital computer 350 (FIG. 2). The first embodiment of Applicants' invention is adapted to receive input information from either the data cards 151 or magnetic tape 153. In the first embodiment, a card reader 158 is operatively connected adjacent the first data input port 150 to receive input information carried by the card 151 presented thereto. The card reader 158 has a signal output 159 operatively connected by means of a signal flow path 160 to a first input 161(a) of a decode functional unit 162.

A tape reader 163 is operatively connected with the second data input port 152 to receive data carried by the magnetic tape 153 presented thereat. The tape reader 163 has a data output 164 operatively connected by means of a signal flow path 165 to a second signal input 161(b) of the decode functional unit 162. The decode unit 162 further has a signal output 166 operatively connected by means of a signal flow path 167 to a signal input 168 of a control unit 170, to be hereinafter described.

The card reader 158 may be of any type suitable for reading the coded data from the cards 151 and for transmitting the read data by means of electrical signals to the decode unit 162. The tape reader 163 may be of any type suitable for converting the magnetic encoded data from the tape 153 to electrical signals representative of the data and for transmitting the read data to the decode unit 162. The decode unit 162 comprises any suitable electrical network for receiving the encoded data and decoding same for subsequent use by the system control unit 170.

A typical control unit 170 suitable for use in the drug dispensing system of the first embodiment is illustrated in FIG. 6, sheet 2. Referring to FIG. 6, the signal flow path 167 is directly connected to provide input signals to a timing synchronizer functional block 172. The synchronizer block 172 further has a second signal input 173, a third signal input 174, a first signal output 175 and a second signal output 176.

The cumulative drug dose sensor 115 (FIGS. 4 and 5) is operatively connected by means of a signal flow path 178 to the second signal input 173 of the synchronizer unit 172. The first signal output 175 of the synchronizer 172 is connected by means of a signal flow path 180 to a signal input 181 of a cartridge selector control unit 182. The cartridge selector unit 182 has a plurality of signal outputs generally designated at 183 connected by means of a plurality of signal flow paths, generally designated at 184 to the plurality of male connectors 48 within the frame of the cabinet 30. As previously discussed, the male connectors 48 when operatively connected with the mating female connectors 55 of the plurality of drug dispensing cartridges 40, provide input signal flow to the plurality of cartridges 40.

The second signal output 176 of the synchronizer unit 172 is connected by means of a signal flow path 185 to a first signal input 186 of a receptacle position control unit 187. The receptacle position control unit 187 further has a plurality of inputs 188 connected by means of a plurality of signal flow paths 189 to the plurality of pairs of position sensors 141 longitudinally mounted adjacent the third conveyer 116 (FIGS. 4 and 5).

The receptacle position control unit 187 further has a first signal output 190 connected by means of a signal flow path 191 to the input electrical control input port 131 of the sequencing clutch apparatus 130. The receptacle position control unit 187 further has a second signal output 192 connected by means of a signal flow path 193 to the third signal input 174 of the synchronizer unit 172.

Operation of the First Embodiment: In general, the drug dispensing apparatus of Applicants' invention is operable to selectively dispense a plurality of drug doses in response to input information representing the unique medicinal needs of a patient. Further, the automatic drug dispensing apparatus of the present invention is operable to repetitively perform such drug dispensing operations for a plurality of patients in response to input information representing the unique medicinal needs of those patients. A pharmacist enters the unique medicinal needs of a patient, in coded form, upon the input information carrying media. In the first embodiment of the drug dispensing apparatus, the input information may be entered on either the cards 151 or the magnetizable tapes 153. The pharmacist generally enters the input information in response to a doctor's orders and would typically have complete control over the data input media. Upon entering the data card 151 or magnetic tape 153 into the control module 31, the appropriate card or tape reader 158 or 163 respectively will read the input data from the data input media and will generate an electrical encoded signal in response thereto. The encoded signal will represent, in general, the identity of the patient, and his unique medicinal needs (prescriptions) ordered by a doctor.

Referring to FIGS. 2 and 6 (sheet 2), the encoded signal from the appropriate input reader is transferred to the decode unit 162 which places the signal in proper format for operation thereon by the system control unit 170. The decode unit 162, may for example, separate a continuous chain of input data representing those specific drug doses prescribed by a doctor for a plurality of patients into unique recognizable segments of input data separated by patient identity or the like. The decode unit further places the encoded input data into proper format for instructing the system control unit 170 as to which cartridges 40 should be selectively energized within a given time frame. The decoded signal thus produced is transferred by means of the signal flow path 167 to the input 168 of the timing synchronizer unit 172. The timing synchronizer 172 may consist of those logic circuits which would be required to perform the following functions. Upon receipt of input data at its input 168, the synchronizer unit 172 will retain transmission of the cartridge identifying data portion of that input data to the cartridge selector control 182 until it has received an enable signal at its third input 174. The synchronizer unit 172 will simultaneously transmit that portion of the input data representing the patient's identity, by means of the signal flow path 185, to the receptacle position control unit 187. The receptacle position control unit 187 will cause the coggd belt 116 to advance a tray 138 placed thereon such that that receptacle or bin 139 of the tray which is identifiable with the patient identification data received by the position control unit 187 is placed adjacent the drive roller 106 end of the second conveyer 105.
In the first embodiment the tray positioning control apparatus functions as follows. Referring to FIGS. 4, 5 and 6 — sheets 2 and 4, upon receipt of the patient identification data from the timing synchronizer unit 172, the receptacle position control unit 187 will energize the sequencing clutch apparatus 130 by means of the signal flow path 191. Upon energization, the sequencing clutch apparatus 130 operatively causes its output drive shaft 132 to be rotatably engaged with the drive pulley 128. It will be noted that the drive pulley 128 is continuously rotated by means of the energizing chain comprising, in reverse order of causation: the belt 127, the pulley 126, the drive roller 106, the belt 110 and the second conveyor drive motor 109. When operatively engaged for rotation, the output drive shaft 132 causes the drive roller 118 of the third conveyor belt 116 to rotate in a counterclockwise direction (when viewed as in FIG. 4) thus advancing the top portion of the clogged belt 116 and any trays 138 placed thereon into the control module from right to left, when viewed as in FIG. 4.

As the leading end of the tray 138 sequentially advances past the plurality of pairs of position sensing elements 141, they will selectively transmit signals back to the receptacle position control unit 187 by means of the signal flow path 189, thereby indicating the position of the tray 138 relative to the drive pulley 106 end of the second belt 105. In the first embodiment, each pair of the plurality of position sensing elements 141 is spaced along the conveyor 116 a distance equal to the width of one of the receptacles or bins 139 of the tray 138. Therefore, each successive activation of one of the pairs of position sensing elements 141 indicates the movement of one receptacle 139 of the tray 138 past the drive pulley 106 end of the second conveyor 105. The receptacle position control unit 187 tests the information from the sensors 141 and the patient identity information from the timing synchronizer 172 for compatibility. Such compatibility indicates that the tray 138 has advanced to a position along the conveyor 116 such that the specific bin 139 of the tray which is identifiable with the patient identity information supplied to the unit 187 is positioned adjacent the drive roller 106 end of the second conveyor 105. Thereupon, the position control unit 187 will simultaneously de-energize the sequencing clutch apparatus 130, causing the conveyor 116 to stop, and will provide an enable signal by means of the signal flow path 193 to the timing synchronizer unit 172.

Upon receipt of the enable signal from the position control unit 187, the timing synchronizer 172 will transmit the cartridge identifying data by means of the signal flow path 180 to the cartridge selector control unit 182. Upon receipt of the cartridge identifying data, the cartridge selector control unit will cause those selected cartridges identified by the received input information to be energized by means of the signal flow paths 184. Those selected cartridges 40 receiving an energizing signal, will operatively dispense a drug dose or doses upon the first conveyor belt 90 as below described. Each of the plurality of cartridges 40 within the cabinet 30 typically will hold only one kind of individual drug dose. Those drug dose or doses, therefore, collectively dispensed by the selected cartridges 40 in any one such drug dispensing cycle, collectively represent the unique medicinal needs of that patient identified with the receptacle which is at that time adjacent the drive roller end 106 of the second conveyor 105. Each of the drug dispensing cartridges 40, of the type illustrated in FIGS. 7-10, dispenses an individual drug dose as follows. An energizing signal received at its connector 55 will be transmitted by means of a signal flow path (not illustrated) to energize the tape advance motor 74. Upon energization, the motor 74 will cause the take-up drum 71 to rotate in a counterclockwise direction, as viewed in FIG. 10, by means of the belt 75. Upon rotation, the take-up drum 71 will advance the tape 61 attached thereto over the roller 70 mounted adjacent the outlet 54, causing the individual drug dose assemblies 62 mounted thereon to be sequentially presented at the housing outlet 54.

Referring to FIG. 9, sheet 3, the blade 78 mounted at the housing outlet 54 and slidingly engaging the tape 61, will peel off the drug dose assemblies 62 as they advance with the tape over the roller 70. When a drug dose assembly 62 has been completely removed from the tape 61, that drug dose assembly will be guided by the blade 78 out of the housing outlet 54 so as to fall upon the top surface of the first conveyor belt 90. The photosensor 80 mounted adjacent the housing outlet 54 of the cartridge 40 detects the dispensing of the individual drug dose from the housing outlet and provides a feedback signal by means of a signal flow path (not illustrated) to de-energize the tape advance motor 74 of that cartridge, thus preventing further dispensing action thereby. Each of the embodiment of the cartridge 40 just described, should two individual drug dose assemblies be required to be dispensed from a single cartridge 40 in one dispensing cycle, the cartridge selector control 182 would be required to provide two energizing signals to that cartridge, spaced in time by the dispensing cycle time of the cartridge 40.

The level of drug dose assemblies 62 remaining within a drug dispenser 40 is sensed by means of the limit switch 81. In normal operation, when an adequate supply of individual drug dose assemblies remains within a drug dispensing cartridge 40, the first indicator lamp 83 will be energized and the second indicator lamp 84 will be deactivated. When the level of tape 61 wound upon the mounting spindle 60 decreases to a predetermined level, the toggle arm 82 of the limit switch 81 riding thereon activates the switch 81, causing the second indicator lamp 84 to be energized and extinguishing the first indicator lamp 83. An operator of the drug dispensing system, therefore, is enabled at a glance to determine the supply status of each individual drug dispensing cartridge 40 within the system by viewing the status of its indicator lamps 83 and 84 through the plurality of viewing ports 86 in the cabinet 30.

The cumulative dispensing effect of those selected cartridges 40 identified by the cartridge identifying data provided to the cartridge selector control unit 182 is that those individual drug dose or doses representing the unique medicinal needs of a patient now collectively appear upon the top surface of the first conveyor 90. The first conveyor drive motor 100 continuously advances the conveyor belt 90 in clockwise rotation, when viewed as in FIG. 3, such that the individual drug dose assemblies carried by the belt 90 will be deposited within the control module 31 upon the top surface of the second conveyor belt 105. The second conveyor belt 105 will deposit the drug dose assemblies within that receptacle 139 of the tray 138 which is mounted adjacent and immediately below the drive roller end 106 of the second conveyor 105. Therefore, all of those individual drug dose assemblies caused to be dispensed
from the cartridges 40 by the input information representing the unique medicinal needs of a patient will have been deposited in a single receptacle 139 of the tray 138 upon completion of a single dispensing cycle.

Each tray 138 will generally be identified with a specific floor, nursing station or the like. Further, contiguous bins 139 within a tray 138 will generally be pre-identified with adjacent patients within a room or rooms for enabling ease of distribution of the unique medicinal needs of those patients by a nurse in making her normal daily rounds. By automatically filling the trays 138 as described above, the unique medicinal needs of the patients can be rapidly filled on a round basis rather than on a daily patient basis. Further, by storing the hospital drug supply within a single cabinet 30 accessible only upon entry thereto of input information as above described, individual drug inventories previously required at various nursing stations throughout a hospital can be eliminated and accurate records of drug allocation and inventories can be directly compiled from the data input media (the cards 151 or tapes 153).

Upon filling the required unique medicinal needs associated with a particular tray 138, that tray is advanced by means of the third conveyor 116 to the outlet port 121 of the cabinet 30 and may be placed within an appropriate means for transmitting the tray to the desired nursing station. One such means for sequentially holding and transporting a plurality of filled trays 138 to a nursing station, is the cart 28 illustrated in FIG. 1. The cart 28 has a plurality of locked doors 28(a) which are accessible only to the pharmacist and authorized personnel within the hospital, and which are sized to readily accept the trays 138.

The automatic drug dispensing apparatus disclosed in the first embodiment, therefore, would allow a pharmacist to enter at his convenience the input information upon the cards 151 or tape 153 representing the unique medicinal needs of a patient and to later cause the drug dispensing system to sequentially fill the orders by his entry upon the information into the system. For a patient requiring similar drug dose combinations 3 or 4 times a day, the pharmacist is required to enter that patient's unique medicinal requirements upon the input information media only once and thereafter needs only to insert the card or tape into the system whenever he chooses to periodically fill that patient's prescription. Emergency orders, however, can be filled at any time by inserting the appropriate input information into the control module of the system.

Description of a Second Preferred Embodiment

A second, operatively simplified embodiment of the automatic drug dispensing system of the present invention, is diagrammatically illustrated in FIG. 11, sheet 5. Referring to FIG. 11, there is generally illustrated a cabinet 200 having a first locked access door 201 generally accessible only to the doctor or pharmacist, a plurality of PRN selector buttons 202 and a second locked access door 203.

The second embodiment is particularly adapted for use in nursing homes and the like where the unique medicinal needs of a patient remain constant for extended periods of time. The second embodiment is more of a "personalized" drug dispensing system, one of which such dispensing systems being intended for placement within the room of each patient for supplying that patient's unique medicinal needs.
A cylindrical timing disc 220, having an axially aligned keyway 221 extending therethrough and sized to mate with the keyed end 218 of the drive shaft 217 is slidably secured over each of the keyed ends of the drive shafts 217. A spring 224 and ball 225 are cooperatively positioned within the recessed cavity 219 of each of the drive shafts 217 and cooperatively mate with an indent in the keyway 221 of each of the timing discs 220 to retainably hold the timing disc 220 upon the drive shaft 217. The timing discs 220 are mounted on the drive shafts 217 for permitting free rotational movement thereof with respect to the frame member 209. Each of the timing discs 220, thus rotates with the drive shaft 217 to which it is connected at one revolution per 20 hour rate.

Referring to FIG. 16, each of the timing discs 220 includes a main body 220(a) and a timing indicator face 226 removabley screwed to the main body 220(a). The timing indicator face 226 has a plurality of circumferentially spaced holes 227 formed therein and aligned with a like number of circumferentially spaced holes 228 in the main body 220(a) of the timing disc 220. In the preferred embodiment, there are 24 each of such circumferentially spaced holes 227 and 228. Each of the circumferentially spaced holes 228 in the main body of the timing disc 220(a) defines a shoulder 229 at a given spaced distance within the main body 220(a) of the timing disc as measured from the timing indicator face 226.

A plurality of timing pegs 230, each having an enlarged portion 231, and first and second portions 230(a) and 230(b), are slidably positioned within the holes 228 in the timing discs such that the first portion 230(a) of the timing peg extends through the holes 227 in the timing indicator face 226. The enlarged portion 231 of each timing peg 230 is larger in diameter than the holes 227 in the timing indicator face 226, thus preventing removal of the timing pegs 230 from the timing disc 220. The diameter of that portion of each peg 230(b) extending into the main body 220(a) of the timing disc and the non-enlarged portion of the holes 228 in the main body 220(a) of the timing disc are closely sized with respect to one another so as to permit sliding frictional engagement therebetween. Each of the timing pins 230 may be positioned in an “inserted” position relative the timing indicator face 226, as illustrated at I in FIG. 16, and at an “extended” position relative the timing indicator face 226, as illustrated at E in FIG. 16.

A typical timing indicator face 226 is illustrated in FIG. 17. Referring thereto, it will be noted that the timing pegs associated with one half of the timing indicator face are consecutively numbered from 1-12 and represent the P.M. hours of a day, while the other half of the timing indicator face is consecutively numbered from 1-12 and represent the A.M. hours of a day. Therefore, one timing peg is associated with each hour of the day, and individual drug dose selections can be initiated for each of the cartridge dispensers 40’ on an hourly basis for each day as hereinafter described.

Referring to FIGS. 12-14, a plurality of microswitches 235 are mounted on the cabinet 200, one of said microswitches being operatively connected adjacent each of the plurality of timing discs 220. Each of the microswitches 235 has a toggle arm 236 extending adjacent that timing disc 220 with which it is associated, and is positioned so as to be engaged by those timing pegs 230 positioned in their extended E position as the timing disc rotates, but so as not to be engaged by the timing pegs 230 when positioned in their inserted I position.

In the preferred embodiment, each of the microswitches 235 is operatively in an inactive mode when its toggle arm 236 is positioned in a horizontal position (as illustrated in FIG. 12), and is operatively in an active mode when its toggle arm is engagably moved by an extended E peg 230 in an upward direction (as illustrated in FIG. 12). When caused to become operative in its active mode, each of the microswitches 236 provides an energizing signal by means of a signal flow path (not illustrated) to the tape advance motor 74’ of that cartridge 40’ with which it is operatively associated.

In the second embodiment, the unique medicinal needs of a patient are set into the timed input control section by appropriately positioning the plurality of timing pegs on each of the timing indicator faces 226 of the timing disc 220. Since each cartridge 40’ holds a specific type of drug dose, and since each timing peg 230 is associated with a specific hour of the day, a pharmacist or doctor can cause the automatic drug dispenser to automatically produce those drugs he prescribes at specific timed intervals during the day. For example, if a patient’s unique therapeutic needs require that he receive individual drug doses which are carried by a first of the cartridge dispensers 40’ once every 2 hours, the pharmacist or doctor would “pull” (position in its extended E position) every other timing peg of the timing disc 220 associated with that first cartridge. On the other hand, if the unique medicinal needs of a patient require that he be issued that type of drug dose carried by a second of the cartridges 40’ only once every day, he would “pull” only one timing peg of the timing disc 220 associated with that second cartridge—and that specific timing peg pulled would be associated with that hour of the day (as indicated on the timing indicator face 226—FIG. 17) at which the doctor or pharmacist wished that particular drug dose to be dispensed.

Referring to FIGS. 13 and 15, it will be noted that one of the drive shafts 217 extends toward the rear of the cabinet 200, and has been designated as 240. A timing cam 241 is securely bolted to the shaft 240 for rotation therewith. The shape of the timing cam is a matter of choice, as an eight faced timing cam being illustrated in FIG. 15. A timing microswitch 242 is connected adjacent the timing cam 241 and includes a cam follower 243 which engages the cam surfaces of the timing cam 241. The microswitch is positioned relative the cam 241 such that the cam follower arm 243 of the microswitch 242 will activate or deactivate the microswitch 242 respectively when engaging high and low cam surfaces respectively. The microswitch 242 is operatively connected to a PRN control mechanism as hereinafter described.

The plurality of PRN selector buttons 202 enable a nurse to activate selected ones of the dispenser cartridges 40’ on an “as needed” basis. For example, a doctor may prescribe that type of drug dose stored in one of the cartridges 40’ “as needed every four times a day.” In such case, a nurse could activate that selected cartridge 40’ as follows. Referring to FIG. 14, it will be noted that a lock 245 is connected to provide an interlock upon the PRN button 202 assembly. Therefore, before any of the PRN buttons 202 can be energized, the interlock apparatus of the lock 245 must be removed by an authorized person having key access to the lock 245. Such a procedure would prevent a patient
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from selecting his own drug doses. Further, however, in the
preferred embodiment the timing cam 241 and
switch 242 insure that the PRN option can be exercised
only as often as prescribed by the doctor. The particu-
lar cam 241 illustrated in FIG. 15, as it rotates with
the drive shaft 240 once every 24 hours, activates the mi-
croswitch 242 four times a day or every 6 hours. The microswitch 242 is operatively connected (not illus-
trated) with the PRN interlock mechanism 145 of the
PRN selector buttons 202 to prevent activation thereof
except during the periods when allowed to do so by
the cam 241.

The cartridges 40', therefore, selectively dispense
their individual drug dose assemblies in response to the
input data preset into the timing discs 220. The individ-
ual drug dose assemblies dispensed by the cartridges
are collected at the common collection area by the col-
clection tray 205 where they can be periodically re-
moved by a nurse or the like during her rounds by her
opening of the second access door 203 of the cabinet
200.

Since the drive motor 211 continuously drives the
worm gear 214 for continuously rotating the timing
discs 220, any input information preset into the timing
discs will be automatically recycled on a daily basis.
Although a 24 hour periodic time basis has been em-
ployed in the second embodiment illustrated, other pe-
riodic time bases could be employed within the spirit
and intent of this invention by changing the time rate
of rotation of the timing discs.

Description of the Third Preferred Embodiment

A third embodiment of Applicants' automatic drug
dispensing system is diagrammatically illustrated in
FIG. 18, sheet 8. As with their first embodiment, Appli-
cants' third embodiment is particularly adapted for
large scale use in filling prescriptions in a hospital phar-
macy. The third embodiment is functionally very simi-
lar to that of the first embodiment with the exception of
the particular input information media employed and
in the particular design of the cartridge dispensers.

Referring to FIG. 18, there is generally illustrated a
cabinet 300 segmentally comprised of a control module
301, a second (oral solids) module 302, a third (oral
liquids) module 303 and a fourth (injectables) module
304. Each of the modules 302 through 304 comprises a
dual pair of such modules of like construction aligned
in spaced relationship to one another and connected by
a central rib member 305. The second through fourth
modules 302 through 304 are respectively similar in
function to the second through fourth modules 31
through 33 respectively of the first embodiment, FIG.
1. Each side of the second through fourth modules 302
through 304 respectively generally has an upper locked
door generally designated at 307 for access to a storage
area.

Both portions of the second through fourth modules
302 through 304 respectively accessible by the upper
locked doors 307, generally house a plurality of drug
dispensing cartridges 310 mounted in adjacent rows
and stacked above one another in inclined fashion when
viewed as in FIG. 19. The plurality of cartridges
310 are supported upon inclined shelf-like support
members 312 longitudinally extending with the second,
third and fourth modules 302 through 304 respectively.
Each of the shelf-like support frame members 312 has
a plurality of spaced apertures 314 near its inwardly di-
rected end (see FIG. 21, sheet 9). The apertures 314
are spaced to correspond with the width of the plurality
of drug dispensing cartridges 310 as mounted thereon.

A plurality of solenoids 315 are mounted on the bot-
tom of the inwardly directed ends of the shelf-like
member, one each of said solenoids 315 being opera-
tively associated with each of the apertures 314 in the
shelf-like frame members 312. Each solenoid 315 is
cooperatively mounted adjacent one of the apertures 314
such that a plunger 316 of the solenoid 315 is permitted
to freely extend in an upward direction through the
aperture 314, as illustrated in dotted lines in FIG. 21,
when the solenoid is energized.

An elongated bracket member 318 is connected to
and extends obliquely downward from the bottom of
each of the shelf-like support members 312. The brack-
et 318 houses a multi-wired conduit 319 which
provides operative electrical connections for each of
the plurality of solenoids 315 connected to that shelf-
like member associated therewith. The bracket 318 is
further sized to obliquely extend downwardly from the
bottom of the shelf-like support frame 312 a predeter-
mined distance for securely holding the drug dispens-
ing cartridge 310 against the shelf-like support frame
member 312, as hereinafter described.

Referring to FIGS. 19, 21 and 22, each of the car-
tridge dispensers 310 comprises a narrow sheet metal-
like housing 320 having a flat bottom 321, and defined
by a generally rectangular cross-sectional area internal
cavity. The housing has a slanted upper plate 322
downwardly depending toward a first end 323 of the
cartridge 310. The internal width of the cartridge hous-
ing 320 is sized to freely accomodate an individual drug
dose assembly 330 placed lengthwise therein, as illus-
trated in FIG. 21.

The individual drug dose assemblies 330 employed in
the third embodiment typically comprise an individual
drug dose 331 packaged within a retaining cylinder 332
(see FIGS. 23 and 24). The cylinder 332 encompassing
the individual drug dose 331 enables the drug dose 331
to be directionally oriented within the internal cavity of
the cartridge housing 320 and to roll freely therein
under the force of gravity.

The slanted upper plate 322 of the cartridge 310 ter-
minates at a position spaced above the bottom plate
321 of the housing and back from the end plate 323 of
the housing a distance slightly greater than the diame-
ter of the retaining cylinder 332 of the individual drug
dose assemblies 330 (see FIG. 21) and defines an outlet
327 of the cartridge 310. The bottom plate 321 of the
cartridge 310 further has an aperture 325 formed
therein adjacent the end plate 323 and positionally lo-
cated and sized to align with one of the apertures 314
in the shelf-like frame support 312 for allowing passage
of the plunger 316 of a solenoid 315 therethrough
when the cartridge 310 is operatively positioned on the
shelf-like frame support members 312 as illustrated in
FIGS. 19 through 21. When operatively positioned on
the shelf-like frame support 312, the bracket 318 con-
ected to the shelf-like frame support member 312 im-
mEDIATELY thereabove will engage the slanted upper
plate 322 of the cartridge 310 so as to prevent further
forward (downward) motion of the cartridge upon the
support 312. The bracket 318 further serves to force
the bottom plate 321 of the cartridge into close engage-
ment with the shelf-like support 312 for preventing any
chatter between the cartridge and the shelf during op-
eration of the solenoids 315. When so positioned, a
spring retaining clip 326 (FIG. 22) is employed to prevent movement of the cartridge in a "backwards" direction up the inclined plane of the shelf 312.

The spacing between the slant upper plate 322 and the bottom plate 321 of the cartridge 310 permit only one individual drug dose assembly 330 at a time to be presented to the outlet 327 of the cartridge. Upon energization of a solenoid 315 associated with a cartridge 310, the plunger 316 of that solenoid will move in an upward direction through the apertures 314 and 325 and will engagably eject that drug dose assembly 330 immediately adjacent the housing outlet 327 thereafter.

The plurality of drug dispensing cartridges 310 are mounted within the cabinet 300 such that their housing outlets 327 are directly adjacent the central area enclosed by the center rib 305. A first conveyor 90' is mounted below that common central area and is functionally operative as previously discussed with respect to the first conveyor 90 of the first embodiment. Therefore, any drug dose assemblies ejected by the plurality of drug dispensing cartridges 310 will fall upon the top surface of the conveyor 90'.

The first conveyor 90' is operatively connected with second and third conveyor apparatus (the common collection area) for collectively moving the dispensed drug dose assemblies to individualized receptacles as previously described with respect to the first embodiment.

Referring to FIG. 19, it will be noted that each of the upper portions of the second, third and fourth modules 302 through 304 is mounted on a track generally designated at 340 for enabling, upon release of an interlock apparatus provided in the center rib portion 305, these portions of the modules to be slid laterally outward from the center plane of the cabinet. This motion enables servicing of the modules and access to the central portion of the cabinet.

The control module portion 301 of the third embodiment generally includes those functional elements previously illustrated and discussed with respect to FIG. 6, sheet 2, but employs a digital computer, generally designated at 350, in FIG. 2, for providing the input information thereto. The input information is provided to the computer by any standard input technique. The computer supplies the input information on an available time basis by means of a signal flow path 351 to an interface unit 352 within the control module 301. The interface unit may comprise that buffer logic required to convert the output signals from the digital computer into proper format for further action thereon by the decode unit 362. The interface unit 352 provides the encoded input information to the decode unit 362 by means of the signal flow path 353. Further operation thereon is identical to that discussed with respect to the first embodiment.

Referring to FIG. 18, it will be noted that a teletype input unit 354 is illustrated as connected adjacent the control module 301 for providing the immediate input basis to the digital computer 350. It should be realized that although the teletype input unit 354 is illustrated as being directly connected to the control module 301, that this invention also applies to the use of a large digital computer to remoter terminals located external to the control module 301 and generally employed for other purposes in the hospital or the like.

The automatic drug dispensing apparatus illustrated by the third embodiment provides a means of preprogramming the unique medicinal needs of a large number of patients into the computer 350 at the convenience of the pharmacist and for enabling the computer to supply the control module 301 with the appropriate input information required to physically fill those prescriptions on a priority basis. It should be noted that since the response time of the automatic drug dispensing system is orders of magnitude slower than the response time of the computer, in effect, that computer time required by Applicant's automatic drug dispensing system is negligible. It should also be noted that the cartridge design as illustrated by the solenoid operated cartridge 310 provides a dispensing response time more in line with computer control of the system than that of the cartridge dispenser 40 which employs a drive motor for advancing the individual drug doses to the housing outlet.

While we have disclosed a specific embodiment of our invention, it is to be understood that this is for the purpose of illustration only, and that our invention is to be limited solely by the scope of the appended claims.

What is claimed is:

1. Apparatus for automatically dispensing one or a plurality of single drug doses in response to input information representing unique medicinal needs of a patient, comprising:
   a. a cabinet defining an internal cavity with cartridge supporting members disposed therein for slidably accepting and retaining a plurality of cartridge means;
   b. a plurality of refillable cartridge magazine means removably mounted in side-by-side alignment within said cabinet upon said cartridge supporting members for holding and dispensing individual drug doses, each of said cartridge magazine means being disjunct from but slidably mounted for rapid replacement upon said cartridge supporting members, wherein each cartridge means comprises:
      i. a housing defining an outlet;
      ii. means in said housing for storing a plurality of single drug doses;
      iii. means for effecting movement of said single drug doses toward said housing outlet in sequential order; and
   c. means for dispensing said single drug doses from said housing outlet, one at a time;
   d. information input receptor means for receiving said input information; and
   e. control means operatively connected with said plurality of said cartridge means and with said information input means for automatically sequentially operating selected ones of said plurality of cartridge means in response to a single entry of said received input information to dispense said single drug doses from those ones of said plurality of cartridge means which will satisfy said unique medicinal needs of a patient, wherein said unique medicinal patient needs may comprise those single drug doses prescribed to be administered to a patient at a specified time of the day.

2. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein said input information is encoded upon punched data cards, one each of such data cards containing said input information representing said unique medicinal needs of one or more patients; and wherein said information input means comprises data card handling and processing means for sequentially receiving said data cards, for de-
coding said input information carried thereby and for providing energization signals to said control means, said control means being operative to energize said cartridge means for filling the unique medicinal needs of a patient from said input information carried by a single one of said data cards.

3. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein said input information is encoded upon a magnetic tape, said tape sequentially containing said input information representing said unique medicinal needs of a plurality of patients; and wherein said input information means comprises magnetic tape handling and processing means for receiving said input information from said tape and for providing energization signals to said control means in response thereto.

4. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein said input information is stored within the memory of a digital computer, and wherein said input information means comprises digital computer interface means suitable for operative connection with said digital computer for receiving said input information from said digital computer and for providing energization signals to said control means in response thereto for automatically sequentially filling said unique medicinal needs of a plurality of patients.

5. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein said information input means comprises settable timing means for receiving a schedule of time interval settings corresponding to said input information.

6. Apparatus for automatically dispensing individual drug doses as recited in claim 1, including control override means operatively connected with at least one of said cartridge means for causing said cartridge means to operatively dispense an individual drug dose or doses or a demand basis, independent of said received input information.

7. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein said cabinet includes lock means for securely enclosing said plurality of cartridge means within said cabinet.

8. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein at least one of said cartridge magazine means is generally horizontally disposed within said cabinet with said cartridge outlet being positioned near the upper surface of said cartridge housing, wherein said one cartridge means is further characterized by the means thereof for dispensing said individual drug doses comprising an electrical solenoid having a plunger disposed adjacent said housing outlet and movable to directly eject a single drug dose therefrom upon activation of said solenoid.

9. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein each of said plurality of cartridge magazine means includes an electrical connector in its housing, wherein said cabinet further includes a plurality of mating connectors each disposed along said cartridge support members for mating engagement with said electrical connector of a respective one of said cartridge magazines, said mating connectors being positioned for snap-in alignment with the respective cartridge connector to enable rapid operative replacement of said cartridge magazines in a single sliding motion.

10. A refillable drug dispensing cartridge for detachable use in a drug dispensing system, comprising:

a. a housing designed for rapid snap-in securement within a cabinet of said drug dispensing system, said housing defining an outlet;

b. means in said housing for storing a plurality of single drug doses;

c. means for effecting movement in sequential order of said single drug doses toward said housing outlet; and

d. means for automatically dispensing said individual drug doses from said housing outlet one at a time in response to a received electrical activation signal.

11. Apparatus for automatically dispensing individual drug doses in response to input information representing unique medicinal needs of a patient, comprising:

a. a cabinet;

b. a plurality of refillable cartridge means removably disposed within said cabinet for holding and dispensing individual drug doses, wherein at least one of said plurality of cartridge means comprises:

i. a housing defined an outlet;

ii. means in said housing for storing a plurality of individual drug doses having tape handling means for retainably holding a tape upon which a plurality of said individual drug doses are sequentially disposed;

iii. means for effecting movement of said individual drug doses toward said housing outlet in sequential order by advancing said tape toward said housing outlet; and

iv. means for dispensing said individual drug doses carried thereby from said housing outlet, one at a time;

c. information input receptor means for receiving said input information; and

d. control means operatively connected with said plurality of said cartridge means and with said information input means for selectively operating said plurality of cartridge means in response to said received input information to dispense an individual drug dose or doses in accordance with said unique medicinal needs of a patient.

12. Apparatus for automatically dispensing individual drug doses as recited in claim 11, wherein at least one of said plurality of cartridge means is further characterized by:

a. said tape handling means being configured to retainable hold said tape upon which a plurality of said individual drug doses are sequentially removably disposed; and

b. said means engaging said tape at the housing outlet being operative to remove said individual drug doses from said tape one at a time, and to guide the removed drug doses out of the housing outlet.

13. Apparatus for automatically dispensing individual drug doses as recited in claim 12, wherein said one of the plurality of cartridge means is further characterized by:

a. said means for advancing said tape toward said housing outlet including means for guiding said tape past said housing outlet to present said individual drug doses disposed thereon adjacent the housing outlet; and

b. wherein said means for removing the drug doses from the tape comprises a blade-like member mounted adjacent said housing outlet and in close proximity with that surface of the tape sequentially bearing the drug doses for removably engaging said
individual drug doses therefrom as the tape advances past said housing outlet and for slidably directing said removed drug doses out of the housing outlet.

14. Apparatus for automatically dispensing individual drug doses as recited in claim 1, wherein said one of the plurality of cartridge means is further characterized by:
   a. said tape handling means thereof comprising a mounting member upon which said tape is wound; and
   b. wherein said means thereof for advancing said tape comprising, means operatively connected with said control means and engageable with said tape for controllably removing said wound tape from said mounting member and for advancing said tape adjacent said housing outlet.

15. Apparatus for automatically dispensing individual drug doses as recited in claim 14, wherein said one of the plurality of cartridge means further characterized by said means for controllably removing the wound tape from said mounting member including an electromechanical device operatively connected with said control means.

16. Apparatus for automatically dispensing individual drug doses as recited in claim 14, wherein said one of the plurality of cartridge means further includes means in said housing for providing an output signal indicative of the number of individual drug doses stored in said cartridge means.

17. An automatic drug dispenser for dispensing individual drug doses in response to input information representing unique medicinal needs of a patient, comprising:
   a. a cabinet;
   b. a plurality of refillable cartridge means removably disposed within said cabinet for holding and dispensing individual drug doses, wherein each cartridge means comprises:
      i. a housing defining an outlet;
      ii. means in said housing for storing a plurality of individual drug doses;
      iii. means for effecting movement of said individual drug doses toward said housing outlet in sequential order; and
      iv. means for dispensing said individual drug doses from said housing outlet one at a time;
   c. information input means for receiving said input information;
   d. control means operatively connected with said plurality of cartridge means and with said information input means for selectively operating said plurality of cartridge means in response to said received input information to dispense an individual drug dose or doses to a common collection area within a cabinet in accordance with said unique medicinal needs of a patient;
   e. a plurality of individualized receptacle means for receiving and holding said dispensed drug doses from said common collection area, wherein each of said individualized receptacle means may be uniquely identifiable with one of said patients; and
   f. means operatively connected with said control means for sequentially presenting said plurality of individualized receptacle means, one at a time, adjacent said common collection area to be deposited in that receptacle means presented adjacent said common collection area.

18. An automatic drug dispenser for dispensing individual drug doses as recited in claim 17, wherein said information input means comprises card handling and processing means for receiving said input information from data cards bearing said input information.

19. An automatic drug dispenser for dispensing individual drug doses as recited in claim 17, wherein said information input means comprises magnetic media handling and processing means for receiving said input information from magnetizable media bearing said input information.

20. An automatic drug dispenser for dispensing individual drug doses as recited in claim 17, wherein said information input means comprises digital computer interface means suitable for operative connection with a digital computer for receiving said input information from said digital computer.

21. An automatic drug dispenser for dispensing individual drug doses as recited in claim 17, including a tray having a plurality of bins, each of said bins comprising one of said plurality of individualized receptacle means and being suitable for receiving and holding a plurality of said drug doses, and wherein said means for sequentially presenting said plurality of individualized receptacle means comprises means for sequentially moving said tray adjacent said common collection area to enable said dispensed drug dose or doses at said common collection area to be selectively deposited therefrom into said bins.

22. An automatic drug dispenser for dispensing individual drug doses as recited in claim 21, wherein said plurality of bins of said tray are arranged in generally contiguous fashion, and wherein said means for sequentially moving said tray includes conveyor means for supporting and moving said tray such that only one of said bins is adjacent said common collection area when said drug doses are being deposited from said common collection area to said bin.

23. An automatic drug dispenser for dispensing individual drug doses as recited in claim 22, wherein said conveyor means includes a caged belt, and wherein the bottom of said tray includes coags sized to mate with coags of said belt for maintaining a predetermined position of said tray relative said belt.

24. An automatic drug dispenser for dispensing individual drug doses as recited in claim 22, wherein said control means includes means adjacent said conveyor means for sensing the advance of said tray relative to said common collection area.

25. An automatic drug dispenser for dispensing individual drug doses as recited in claim 17, including sensing means adjacent said common collection area for detecting the number of drug doses transferred from said common collection area to said individualized receptacle means.

26. A refillable drug dispensing cartridge as recited in claim 10, wherein said means for storing said plurality of drug doses comprises tape holding means for retainably holding a tape upon which a plurality of said individual drug doses are sequentially carried, wherein said movement effecting means includes electromechanical means for advancing said tape toward said housing outlet, and wherein said dispensing means comprises means engaging said tape at the housing outlet for dispensing the individual drug doses carried thereby, one at a time.

27. A refillable drug dispensing cartridge as recited in claim 26, wherein said tape holding means comprises a
mounting member upon which said tape is wound, and wherein said electromechanical means for advancing said tape includes electric motor means for controllably removing said wound tape from said mounting member and for carrying said tape adjacent said housing outlet.

28. A refillable drug dispensing cartridge as recited in claim 10, wherein said means for storing a plurality of individual drug doses comprises tape holding means for retainably holding a single tape upon which a plurality of individual drug doses are sequentially reversibly attached, wherein said means for effecting movement of said individual drug doses toward the housing outlet includes electromechanical means for advancing said tape toward said housing outlet, and wherein said dispensing means for the individual drug doses comprises means at the housing outlet for detaching said individual drug doses from said tape and for guiding the removed drug doses out of the housing outlet.

29. A refillable drug dispensing cartridge as recited in claim 28, wherein said means for removing said individual drug doses from said tape comprises a blade-like member mounted adjacent said housing outlet and in close proximity with that surface of the tape sequentially carrying the plurality of drug doses for removable disengaging said individual drug doses therefrom as the tape advances past said housing outlet and for slidably directing said removed drug doses out of the housing outlet.

30. A refillable drug dispensing cartridge for detachable use in a drug dispensing system, comprising:
   a. a housing designed for rapid snap-in operative securement within said drug dispensing system, said housing forming an inner chamber and defining an outlet therefrom, said housing being shaped for enabling said chamber to hold a plurality of single drug doses in ordered sequential alignment therein;
   b. means on said housing for effecting movement of said single drug doses toward said housing outlet, one of said drug doses being presented at said outlet at a time; and
   c. an electrical solenoid operatively connected at said housing outlet and having a plunger element extendable upon energization of said solenoid to directly engage and eject from said outlet that single drug dose presented thereat.

31. Apparatus for automatically dispensing individual drug doses in response to input information representing unique medicinal needs of a patient, comprising:
   a. a cabinet;
   b. a plurality of refillable cartridge means removable disposed within said cabinet for holding and dispensing individual drug doses, wherein each cartridge means comprises:
      i. a housing defining an outlet;
      ii. means in said housing for storing a plurality of individual drug doses;
      iii. means for effecting movement of said individual drug doses toward said housing outlet in sequential order; and
      iv. means for dispensing said individual drug doses from said housing outlet, one at a time;
   c. information input receptor means for receiving said input information, having settable timing means for receiving a schedule of time interval settings corresponding to said input information, said timing means including a plurality of timing elements, each having settable means for providing a sequence of timed responses according to said time interval schedule; and
   d. control means operatively connected with said plurality of said cartridge means and with said information input means for selectively operating said plurality of cartridge means in response to said received input information to dispense an individual drug dose or doses in accordance with said unique medicinal needs of a patient, said control means including a plurality of switching means, each of said switching means being operatively connected with at least one of said cartridge means and with at least one of said timing elements, for selectively operating said plurality of cartridge means according to said sequence of timed responses.

32. Apparatus for automatically dispensing individual drug doses in response to input information representing unique medicinal needs of a patient, comprising:
   a. a cabinet;
   b. a plurality of refillable cartridge means removably disposed within said cabinet for holding and dispensing individual drug doses, wherein each cartridge means comprises:
      i. a housing defining an outlet;
      ii. means in said housing for storing a plurality of individual drug doses;
      iii. means for effecting movement of said individual drug doses toward said housing outlet in sequential order; and
      iv. means for dispensing said individual drug doses from said housing outlet, one at a time;
   c. information input receptor means for receiving said input information;
   d. control means operatively connected with said plurality of said cartridge means and with said information input means for selectively operating said plurality of cartridge means in response to said received input information to dispense an individual drug dose or doses in accordance with said unique medicinal needs of a patient;
   e. control override means operatively connected with at least one of said cartridge means for causing said cartridge means to operatively dispense an individual drug dose or doses on a demand basis, independent of said received input information, and
   f. presettable interrupt means operatively connected with said control override means for inhibiting operation of said control override means for periodic spaced time intervals of predetermined duration.

33. Apparatus for automatically dispensing individual drug doses as recited in claim 31, wherein said timing means includes means for sequentially recycling said input information set into said timing means by recycling said plurality of timed sequence of responses on a predetermined recycling time basis.
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,917,045
DATED : November 4, 1975
INVENTOR(S) : Robert L Williams

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

In column 23, line 38 "or" should be --on--.

In column 25, line 6, "claim 1" should correctly read --Claim 11--.

In column 25, line 23 "devide" should be --device--.

Signed and Sealed this
tenth Day of February 1976

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks