

March 11, 1969

C. B. JONES, JR

3,431,864

PERISTALTIC PUMP

Filed Dec. 22, 1966

Sheet 1 of 5

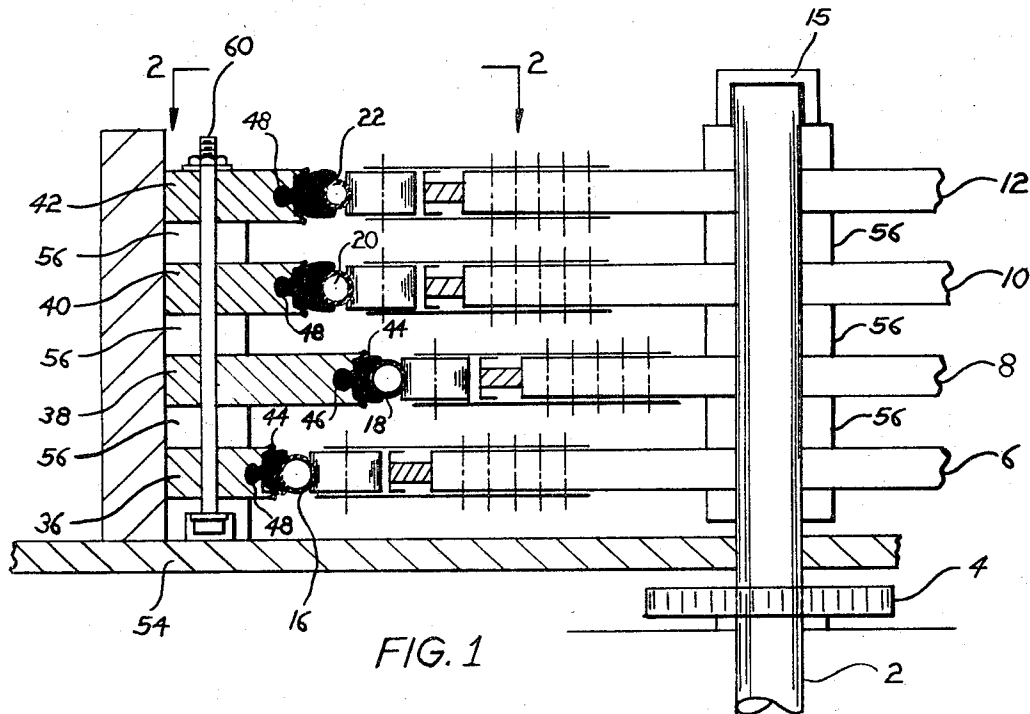


FIG. 1

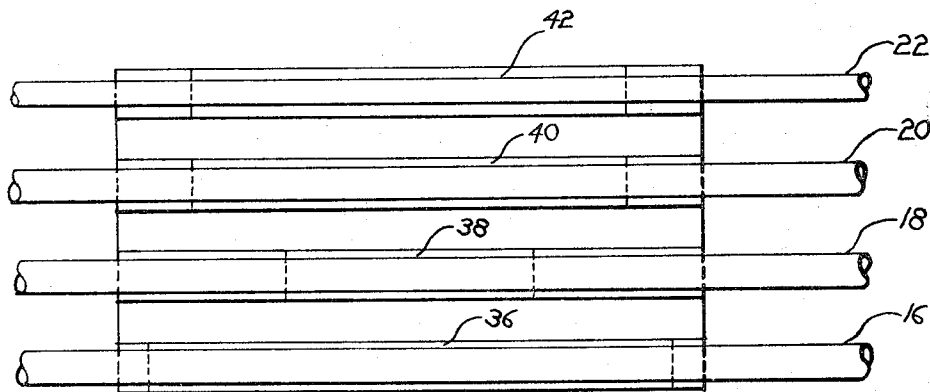


FIG. 3

INVENTOR.

CHARLES B. JONES JR.

BY

Sperry and Zoda  
ATTORNEYS

March 11, 1969

C. B. JONES, JR

3,431,864

PERISTALTIC PUMP

Filed Dec. 22, 1966

Sheet 2 of 3

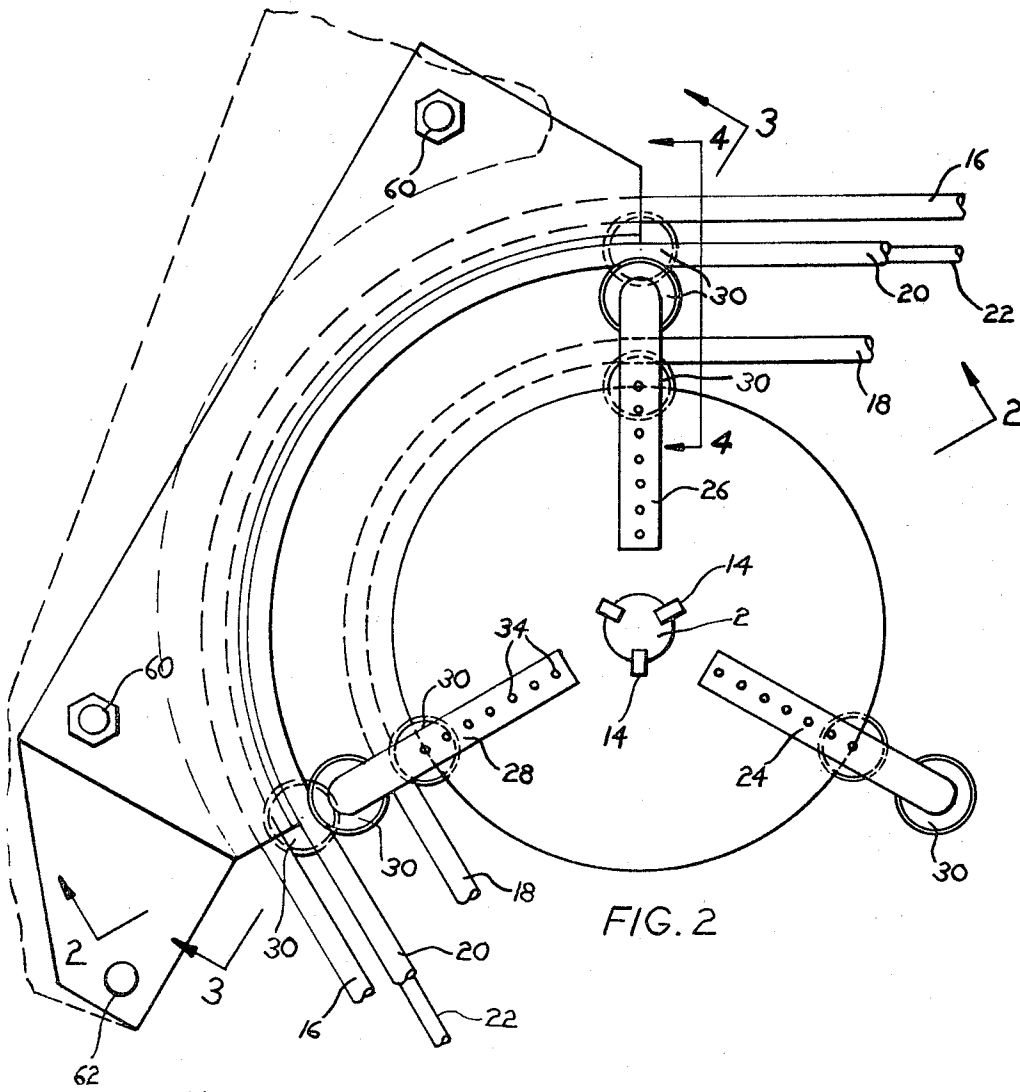


FIG. 2

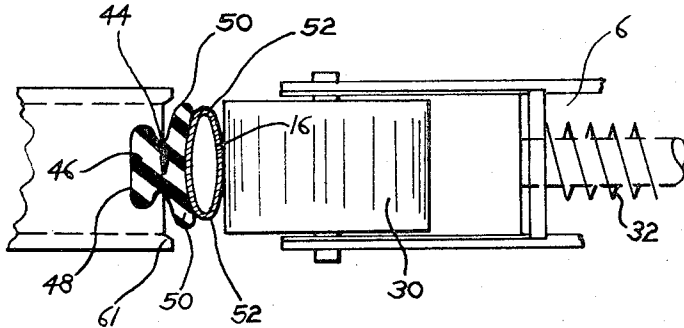


FIG. 4

INVENTOR

CHARLES B. JONES JR.

BY

*Sperry and Joda*  
ATTORNEYS

March 11, 1969

C. B. JONES, JR

3,431,864

PERISTALTIC PUMP

Filed Dec. 22, 1966

Sheet 3 of 3

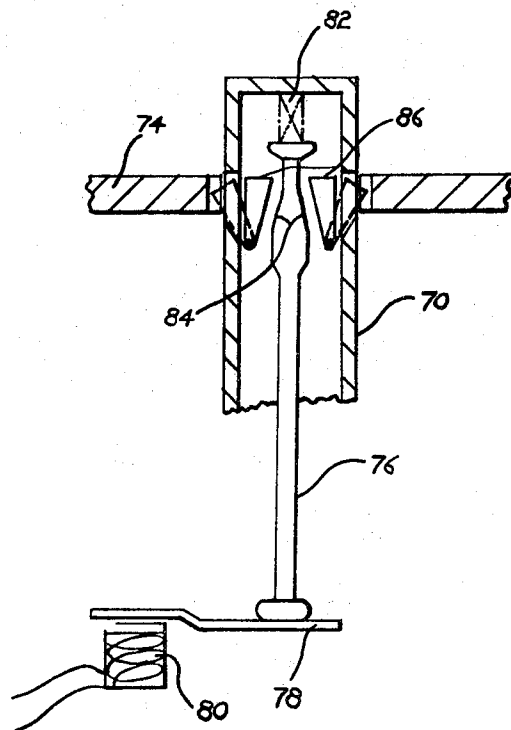


FIG. 5

INVENTOR

CHARLES B. JONES JR.

BY

*Sperry and Zoda*  
ATTORNEYS

1

2

3,431,864

## PERISTALTIC PUMP

Charles B. Jones, Jr., % Ireland Army Hospital,  
Fort Knox, Ky. 40121

Filed Dec. 22, 1966, Ser. No. 603,935

U.S. Cl. 103—149

11 Claims

Int. Cl. F04b 43/12, 43/08

### ABSTRACT OF THE DISCLOSURE

A peristaltic pump having a plurality of compressible tubes arranged in parallel relation and engageable by rollers movable longitudinally of the tubes to compress the tubes and advance liquid therethrough. The rollers are carried by rotatable means and are spaced different arcuate distances apart to cause a different or predetermined length of the compressible tube to be confined between the rollers whereby different amounts of fluid may be advanced through each tube on each cycle of operation even when using tubes having the same internal diameter. The tubes are preferably supported by platens of different radii or arcuate length to cooperate with the rollers moving longitudinally of the tubes upon rotation of the rotatable means.

This invention relates to fluid pumps and is directed particularly to peristaltic pumps adapted for use in producing mixtures of fluids for pathological, medicinal, surgical, chemical, industrial or other purposes.

It has been common practice heretofore to provide pumps for controlling the flow of a plurality of fluids through tubes or passages at predetermined rates for mixing or other purposes. Pumps of this type are of particular value for use in pathological, hospital, chemical and industrial operations wherein it is desired to produce accurately controlled mixtures of sera, solutions, liquids, gases or the like. For this purpose, it is quite usual to pass the fluids through compressible tubes of predetermined diameter under the action of rollers or the like and in a peristaltic manner wherein one roller after another engages and compresses each tube while moving longitudinally thereof to confine and advance a predetermined volume of fluid through the tube on each cycle of operation of the peristaltic means.

However, in order to vary the amount of any liquid or fluid advanced in this manner, it has been usual to provide tubes of different diameter so as to cause a different but controlled volume of fluid to be delivered from each tube in a given length of time or upon each cycle of operation of the pumping means. As a result, it is generally necessary to provide a relatively large number of tubes of accurate and predetermined internal diameter in order to permit the pumping equipment to be used in producing the wide variety of types, concentrations, or mixtures of fluids required in many applications and uses of such pumps. Moreover, tubes of the requisite accuracy in diameter and quality are relatively expensive and must be replaced frequently whereas the differences in the lumen or internal diameter and delivery capacity of the tubes are often so small that it is difficult to differentiate between tubes of different sizes. As a result, there is always a possibility that a tube of the wrong size may be used and the composition of the mixture being produced may not be accurate or safe for its intended use.

In accordance with the present invention, these difficulties and objections inherent in peristaltic pumps of the prior art are reduced or eliminated and means are provided whereby the accuracy of the mixtures produced thereby may be more readily controlled and maintained.

These results are preferably attained by providing peristaltic pumps with means for varying the length of each or any tube which is confined and compressed in each cycle of operation of the pumping means. In this way, it is possible to reduce the number of different sizes of tubes which are employed and it is even possible and generally desirable to employ multiple tubes of uniform internal diameter which may be interchangeably employed to pump concurrently a great variety of different volumes of fluids for any required purpose.

In the preferred embodiments of the invention herein shown and described, such variation in the length of each tube which is confined and compressed in each cycle of operation is accomplished by locating the tubes on concentric arcuate platens having different radii and correspondingly different circumferential lengths for any given arc of rotation of the peristaltic pumping element used.

Accordingly, the principal objects of the present invention are to simplify the construction and improve the operation of peristaltic pumps; to reduce the number of tube sizes required for use in peristaltic pumps employed for simultaneously providing different fluid volumes; and to permit variation in the length of the tubes in which fluid is confined and advanced in each cycle of operation of a peristaltic pump.

A specific object of the present invention is to provide peristaltic pumps embodying a plurality of compressible tubes through which fluid is advanced by peristaltic pumping means, with concentric arcuate platens or tube supports which have different radii.

These and other objects and features of the present invention will appear from the following description thereof wherein reference is made to the figures of the accompanying drawings.

In the drawings:

FIG. 1 is a vertical sectional view through a portion of a typical form of peristaltic pump embodying the present invention;

FIG. 2 is a plan view of the construction illustrated in FIG. 1;

FIG. 3 is a sectional view taken on the line 3—3 of FIG. 2;

FIG. 4 is an enlarged view of a detail of the construction shown in FIGS. 1, 2, and 3 taken on the line 4—4 of FIG. 2; and

FIG. 5 is a diagrammatic sectional view through a portion of an alternative driving connection for a peristaltic pump embodying the present invention.

In that form of the invention chosen for purposes of illustration in FIGS. 1 to 4 of the drawings, the pump embodies a rotatable drive shaft 2 driven by a gear 4 or the like and having a plurality of discs 6, 8, 10, and 12 secured to the shaft by keys 14 or other suitable means and held in place on the shaft by a threaded cap 15. For purposes of illustration, four discs are shown with the disc 6 being associated with a flexible tube 16; disc 8 associated with the flexible tube 18; disc 10 associated with a flexible tube 20; and disc 12 associated with a flexible tube 22. However, any desired number of discs and tubes may be employed in a single pumping assembly, depending upon how many fluids are to be pumped through the tubes.

Each of the discs 6, 8, 10, and 12 is provided with a plurality of radially extending arms 24, 26, and 28 which are provided at their outer ends with rollers 30 that are urged radially outwardly by a spring 32 to engage, compress, and collapse the lumen of one of the tubes through which the fluid is to be pumped. The arms 24, 26 and 28 are adjustable radially on the discs by which they are carried by means of bolts 34 or other means to assure proper engagement of the rollers 30 thereon with the tube

through which it is to pump fluid. Furthermore, if desired each disc may be provided with any suitable or preferred number of arms and rollers sufficient to assure continued engagement of the rollers with the tubes during rotation and to prevent reverse flow of fluid in any tube during operation.

As shown in FIGS. 1 and 2, the tubes 16, 18, 20, and 22 are each located in fixed positions on concentric arcuate platens or tube supports 36, 38, 40, and 42 respectively. The tubes are preferably permanently fixed to cushioned mounting members 44, which as shown have a bead or head 46 received within a groove 48 in the inner arcuate face of the platen. The mounting members 44 have yieldable supporting side portions 50 which partially embrace the tube and support the sides thereof so as to aid in maintaining the normal rounded shape of the tube. However, the side portions 50 are flexible and move outward when the tube is compressed, as shown in FIG. 4, to form a cushion between the flattened tube and the platen or tube support whereby they reduce or prevent excessive pinching or cracking of the tube at the sides 52 thereof upon repeated flexing of the sides as the rollers 30 move along the tube. Furthermore, as shown in FIG. 4, the platens 36, 38, 40, and 42 are flanged along their arcuate faces by projections 61 that further relieve the pressure of roller 30 against the flexible tubes to prevent the application of excessive pressure against the tubes so as to prolong the life of the tubes during operation.

As shown in FIGS. 1 and 2, the platens 36, 38, 40, and 42 are mounted in fixed position on a base 54 and present inwardly facing, tube supporting arcuate surfaces concentric with the drive shaft 2 but spaced selected and predetermined radial distances from the axis of rotation of the shaft 2. Thus, the radius of the tube supporting surface of the platen 36 is substantially greater than the radius of the tube supporting surface of the platen 38. The radii of the tube supporting surfaces and platens 40 and 42 are the same but are less than the radius of the platen 36 and greater than the radius of the platen 38. These differences in the radii of the tube supporting surfaces of the various platens serve to establish corresponding and predetermined differences in the length of the circumferential arcs of the platens and the tubes supported thereby which are intersected by the radially extending arms 24, 26, and 28 and the rollers 30 carried thereby as shown most clearly in FIG. 3. Therefore, it is possible to use flexible tubes having the same lumen or internal diameter on each platen, and yet at the same time, the construction serves to vary the amount of fluid delivered from each tube on each cycle of rotation during operation of the pump. The amount of fluid delivered will depend in each case upon the radius and circumferential length of the tube and tube supporting surface with which the rollers cooperate to advance the fluid.

As shown, by way of example in FIG. 3, the tubes 16, 18 and 20 supported on the platens 36, 38, and 40 are all of the same internal diameter but the length of the arc of the tube 36 which is engaged by the rollers 30 on the arms 24 and 26 during each cycle of rotation is greater than the length of the arc of the tube 18 on the platen 38. In a similar way, the length of the arc of the tube 20 on platen 40 is greater than the length of the arc of the tube 18 on platen 38 but is less than the length of the arc of the tube 16 on platen 36. As a result, the amount of fluid confined and advanced through each of the tubes 16, 18, and 20 by the rollers 30 on each cycle of operation will be different and dependent upon the radius and circumferential length of the arc of the tube engaged by the rollers.

Further, by way of example as shown in FIGS. 1, 2, and 3, the tube 22 supported on the platen 42 is of smaller diameter than the tube 20 on the platen 40 although the radii of the platens 40 and 42 is the same. It will thus be apparent that, if desired, it is still possible to vary

the amount of fluid pumped through any tube of the equipment by the use of tubes of different internal diameter without change in the construction or arrangement of other elements of the assembly. Nevertheless, the number of sizes of tubes required to attain wide variation in the amounts of the various fluids pumped by the equipment can be reduced and in many instances only a single size of tube will be required. The tubes are therefore largely, if not completely, interchangeable for any pumping operation and when producing any desired proportioned mixture of fluids for whatever purpose desired.

Since the volume of fluid which is pumped through any particular tube in accordance with the present invention and the length of the tube within which the fluid is confined during the pumping operation is dependent upon both the radius of the platen and the internal diameter of the tube, it is desirable to provide a plurality of interchangeable platens of different radii for assembly on the base 54 of the pump and to provide a series of tube mounting members 44 for receiving tubes of different sizes if desired. Selected platens and tube holders can then be arranged in spaced relation by spacing blocks 56 so as to be located in the planes of the interchangeable discs and rollers rotated by drive shaft 2. The elements then may be secured in place on the base by bolts 60 or the like and the various tubes can be located in place and connected to selected fluid sources and mixing chambers or other means. As a result, it is readily possible to attain a high degree of accuracy in the pumping and mixing of fluids. At the same time, by interchange, substitutions, or rearrangement of the various platen elements 36, 38, 40 and 42, etc., it is also possible to change the proportions of the fluids being pumped through the tubes with a minimum of difficulty and without the attendant danger of error in the selection of the proper tubes to be employed for pumping predetermined amounts of given fluids. Furthermore, all of the tubes employed may be of the same diameter so as to be uniform and interchangeable, or in the alternative, only a very limited number of tubes of obviously different lumen diameter may be used so that identification and selection of the proper tube to be used for handling any particular fluid can be made quickly and with certainty.

In order to facilitate the changing or rearrangement of the arcuate platens and the tubes carried thereby and in order to permit ready adjustment of the rollers 30 on the rotatable discs 6, 8, 10, 12 etc., the assembly of platens on tubes may be pivotally movable about pivot means 62 on the base 54, as shown in FIG. 2, if desired. In this way, the assembled platens and tubes and the discs and rollers rotated by drive shaft 2, are relatively movable into and out of cooperating relation to permit ready substitution, replacement or variation thereof as desired.

While the peristaltic pumps of the present invention have wide application and are of particular value in pathology and chemical control procedures, they are also adapted for use in industry and elsewhere. Moreover, wherever employed, they can further be constructed to provide for selective operation of any one or more of the pumping elements independently or in cooperation with other elements of the pump. Thus as shown in FIG. 5 of the drawings, the drive shaft 70 may be provided with clutching means 72 for engaging and disengaging any one or more of the discs 74 or other driving elements of the pump in a selective manner. The clutching means illustrated embodies an actuating rod 76 located within the tubular drive shaft 70 and movable axially thereof by suitable means such as a lever 78 operatively connected to a solenoid 80 or the like. A spring 82 serves to urge the actuating rod 76 downwardly to a position wherein camming elements 84 on the rod are removed from the pivoted dogs or clutching means 86. However, upon operation of the solenoid 80 to tilt the lever 78 for raising the actuating rod 76, the camming elements will serve to rock the clutching means 86 about their pivots into posi-

tions wherein the outer ends of the clutching means project through adjacent openings in the shaft 70 to engage and rotate the disc 74 with the shaft and any other discs or pumping means driven by the shaft.

Constructions of this type may for example be used in liquid dispensing equipment, such as "coffee machines" to permit cream to be added to the coffee upon operation of the solenoid 80, whereas black coffee only may be dispensed when the solenoid 80 is rendered inactive or remains idle.

The equipment may of course embody a plurality of such clutching means for selective operation of any one or more of the pumping elements of the assembly, and the solenoid or control means therefore can be of a type responsive to any condition such as the pH value or light density of a liquid so as to modify the operation to maintain a constant condition or compensate for any deviations from a predetermined norm.

It will thus be apparent that the various elements of the pump can be changed or modified in many respects to adapt the equipment for use in any particular installation or field of operation. In view thereof, it should be understood that the particular embodiments of the invention shown in the drawings and described above are intended to be illustrative only and are not intended to limit the scope of the invention.

I claim:

1. A peristaltic pump comprising a plurality of arcuate platen members spaced different radial distances from a common axis, compressible tubes supported on said platen members, pressure members presenting tube engaging portions located different radial distances from said common axis and means for rotating said pressure members about said common axis and into and out of engagement with said tubes to cause different volumes of fluid to be advanced through said tubes.

2. A peristaltic pump as defined in claim 1 wherein tubes having the same internal diameter are supported on platen means of different length whereby different volumes of fluid will be advanced through said tubes on each cycle of operation of said pressure means.

3. A peristaltic pump as defined in claim 1 wherein the internal diameter of at least some of said tubes is different.

4. A peristaltic pump as defined in claim 1 wherein yieldable tube positioning members are located on the surfaces of said platen means which are engaged by said tubes.

5. A peristaltic pump as defined in claim 4 wherein said yieldable tube positioning members have flexible side portions movable into positions between the edges of said tubes and the platen means upon compression of said tubes by said pressure means.

6. A peristaltic pump as defined in claim 4 wherein said platen means are provided with marginal flanges located between flexible side portions of the tube positioning members and said tubes to prevent the application of pressure to said tubes in substantial excess of that required to close the lumen of said tubes.

7. In a peristaltic pump embodying a plurality of compressible tubes arranged in parallel relation and a rotatable

member rotatable about a fixed axis extending transversely with respect to said tubes, the combination of one set of rollers engageable with each of said tubes, the rollers of each of said sets being arcuately spaced apart on said rotatable member to compress the tubes at spaced points thereon while being movable longitudinally of the tubes to advance fluid through the tubes upon rotation of said rotatable member, the tube engaging portions of the rollers of at least one of said sets being spaced a different radial distance from the fixed axis of the rotatable member than the tube engaging portions of the rollers of another of said sets.

8. A peristaltic pump as defined in claim 7 wherein said rotatable means has a plurality of arcuately spaced arms secured thereto, said rollers being mounted on said arms and engageable with said tubes at spaced points thereon, said rollers being selectively movable into positions wherein they are spaced different predetermined distances from the axis of rotation of said rotatable means and spaced different predetermined arcuate distances apart.

9. A peristaltic pump as defined in claim 7 wherein at least a portion of said compressible tubes have substantially the same internal diameter.

10. A peristaltic pump as defined in claim 7 wherein means are provided for selectively connecting said sets of rollers to said shaft to cause any one or more thereof to rotate with said shaft.

11. A peristaltic pump having a rotatable shaft with a plurality of sets of radially extending arms secured thereto, said arms being variable in length and each having a roller located at the outer end thereof, a plurality of platen members presenting concentric flanged arcuate surfaces spaced different radial distances from the axis of rotation of said shaft and grooved to receive flexible supports to which are permanently fixed compressible tubes supported on the arcuate surfaces of said platen members in position to be engaged, and compressed by the rollers on one of said sets of arms to occlude the lumen of said tubes upon rotation of said shaft to advance fluid through said tubes, the length of said tubes supported by said platen members being equal to the circumferential length of the arcuate surfaces of the platen member by which it is supported whereby the volume of fluid confined and advanced through each of said tubes by said rollers on each rotation of said shaft will be dependent upon the length of the arcuate surface of the platen member by which it is supported.

#### References Cited

##### UNITED STATES PATENTS

|           |         |          |         |
|-----------|---------|----------|---------|
| 125,442   | 4/1872  | Darker   | 103—149 |
| 315,667   | 4/1885  | Serdinko | 103—149 |
| 2,332,157 | 10/1943 | Mapson   | 103—149 |
| 2,893,356 | 7/1959  | Murray   | 103—149 |
| 3,172,367 | 3/1965  | Kling    | 103—149 |
| 3,353,567 | 11/1967 | Isreeli  | 103—149 |

DONLEY J. STOCKING, *Primary Examiner*.

WILBUR J. GOODLIN, *Assistant Examiner*.