June 16, 1964 G. W. HAHN 3,137,242

INFUSION PUMP

Filed Jan. 22, 1962 2 Sheets-Sheet 1

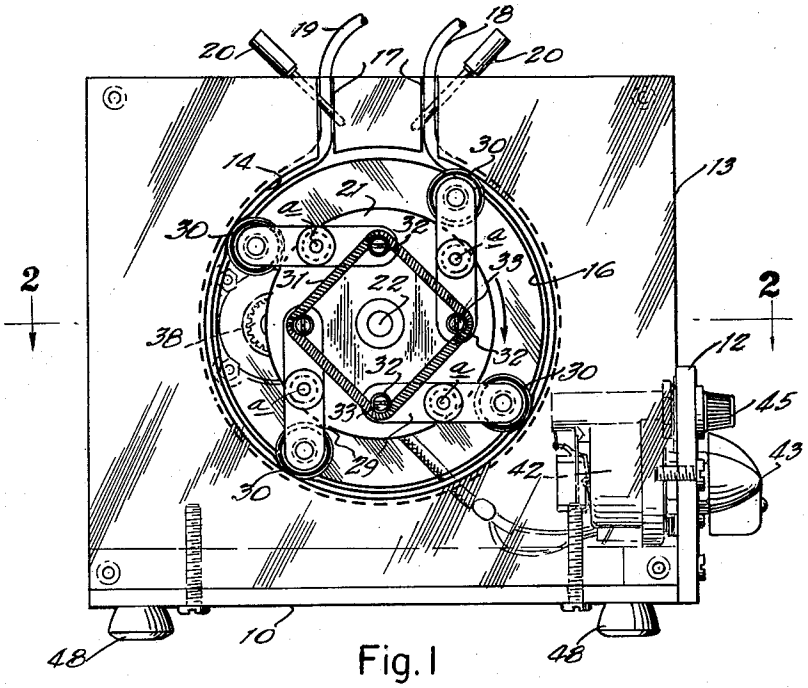

Fig. 1

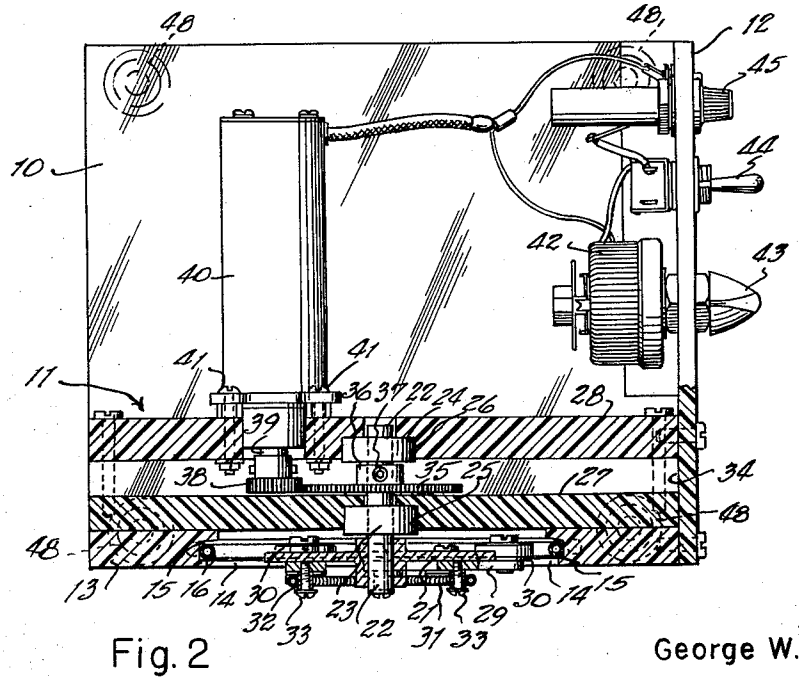

Fig. 2

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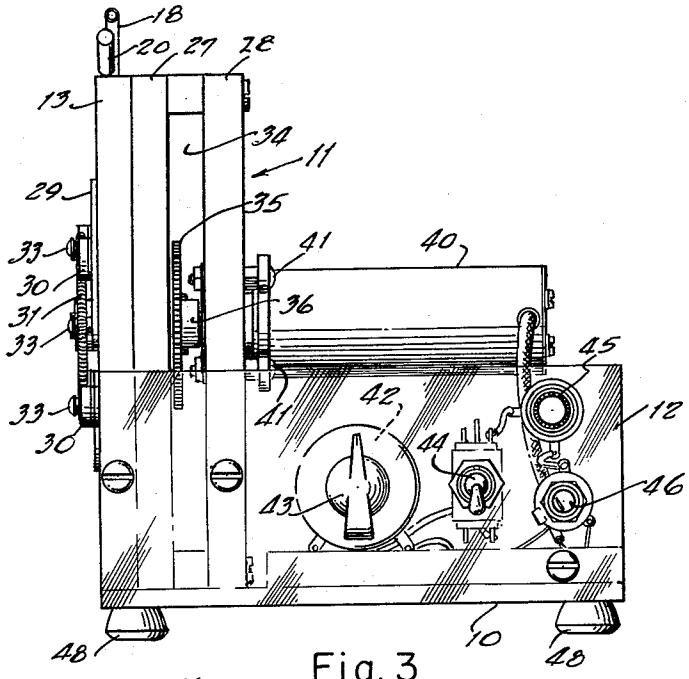

Fig. 3

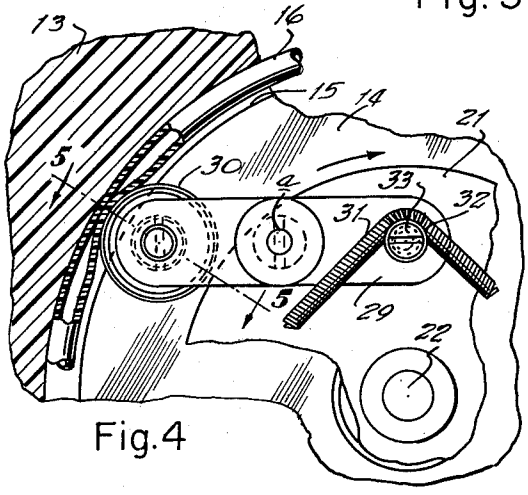

Fig. 4

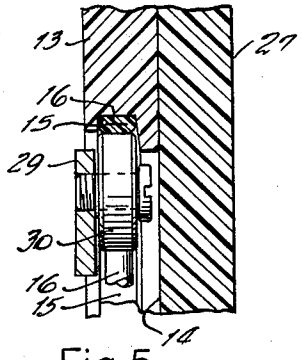

Fig. 5

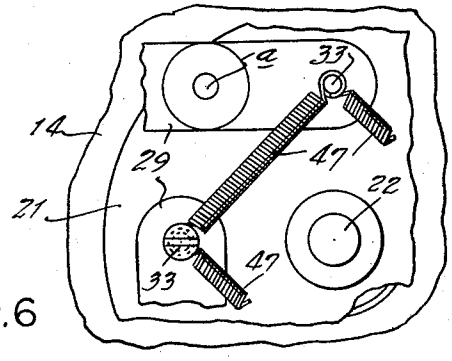

Fig. 6

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3,137,242

INFUSION PUMP

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3 Claims. (Cl. 103—152)

This invention relates to fluid pumps of the type generally referred to as infusion pumps, and it has particular reference to surgical pumps utilized to inject fluid intravenously in the treatment of diseases, such as cancer, malnutrition, and the like, and the infusion of blood plasma, and other fluids into the blood stream.

A prime object of the invention resides in the provision of a pump by which a medicament, such as methotrexate, can be injected into the arteries, in the treatment of malignant diseases, from a reservoir at predetermined rates and pressures without contamination.

Pumps of the type described have been in general use for several years, and include such elements as radially arranged tensioned rollers in an annular chamber and engaging a flexible tube to induce a fluid flow for a variety of purposes. However, such known devices are lacking in many of the features which will become apparent in the improvements hereinafter described, particularly in respect to the extreme accuracy and precision necessary in the application of such improvements in the treatment of diseases.

An important object of the invention is that of providing a pump of the character described in which fluids, such as medicaments, can be injected into the arterial system from a reservoir in carefully measured quantities at constant pressures, and regulated in accordance with blood pressures encountered.

A further object of the invention resides in the provision of an infusion pump having a variable speed, which is highly desirable in the treatment of malignancies, such as cancer, due to the necessity for extreme accuracy in the injection of carefully measured quantities of medicaments during prolonged periods of time.

It is also an object of the invention to provide an infusion pump which is simple in design and structure, and thoroughly dependable in operation, and by which any type of liquids can be transmitted thereby in a constant, uninterrupted flow, without the intermittent surging and pulsations attributable to many conventional pumps designed for similar purposes.

Broadly, the invention contemplates the provision of a fluid pump by which various types of liquids can be moved in accurately measured quantities, at various constant speeds, depending upon the pressures required, and without subjecting the liquid products to contamination, utilizing a flexible conduit which can be maintained under accurately predetermined and constant pressure.

While the foregoing objects are paramount, other and lesser objects will become manifest as the description proceeds, taken in connection with the appended drawings wherein:

FIGURE 1 is a front elevational view of a pump embodying the invention, showing the tensioned roller arms operating in an annular recess.

FIGURE 2 is a transverse sectional view, on line 2—2 of FIGURE 1, through the gear housing and the annular roller recess, illustrating the variable speed motor, the rheostat control and the gear assembly.

FIGURE 3 is a side elevational view of the invention, showing the motor and control knobs.

FIGURE 4 is an enlarged fragmentary illustration of one of the roller arms, and roller impinging the flexible tube, the latter and the housing being shown partially in section.

FIGURE 5 is a fragmentary sectional view, on line 5—5 of FIGURE 4, showing a roller compressing the tube in the groove formed peripherally of the annular recess in the housing, and

FIGURE 6 fragmentarily illustrates a modified arrangement of tensioning springs for the roller arms.

Accordingly, referring to the drawings, apparatus embodying the invention is mounted on a base member **10** having a relatively thin housing **11** supported vertically along one side, as shown in FIGURES 1, 2 and 3. A panel **12** is arranged along an edge of the base **10** at right angles to the housing **11**, and these elements are preferably formed of a plastic material.

Formed in the face plate **13** on the housing **11** is a circular opening **14** about the inner surface of which is defined a channel **15** adapted to receive a flexible compressible tube **16** of plastic, or other suitable material, as shown best in FIGURES 1 and 4. A pair of grooves **17** are formed in the face plate **13** of the housing **11** which communicate with the channel **15** and extend vertically into the top of the face plate **13**, as illustrated in FIGURE 1, and receive the inlet and outlet portions **18** and **19** of the tube **16** which are retained in the grooves **17** by pins **20**, or other suitable devices.

A disk **21** is mounted for rotation concentrically of the circular recess or opening **14** on a shaft **22** which is supported in bearings **23** and **24** pressed into annular recesses **25** and **26**, respectively, in the front and rear walls **27** and **28** of the housing **11**, as shown in FIGURE 2. A plurality of arms **29** are pivoted at *a* intermediate their ends about the disk **21** near its perimeter, and are equidistantly spaced, and each arm **29** has a roller **30** pivoted to its outer end adapted to engage and compress the tube **16** under the tension of an endless pull spring **31**, in the manner shown in FIGURE 1.

The inner end of each of the arms **29**, opposite the roller **30** thereon, has a pulley **32** pivotally attached thereto and rotates on a screw **33**, and the spring **31**, which is in the form of a belt, is passed over each of the pulleys **32** and exerts an equal tension on the arms **29**, whose fulcrums *a* are intermediate their ends, whereby the rollers **30** are caused to bear against the tube **16** with equal predetermined pressure. The disk **21** is rotated clockwise, as indicated by the arrow, so that fluid from a reservoir (not shown) entering that portion of the tube **16** through the inlet portion **18**, is moved around that portion of the tube **16** lying in the circular channel **15** by the pressure of the rollers **30** thereon, and out through the outlet portion **19** of the tube **16** in a constant, non-pulsating flow.

In the space **34** defined between the front and rear walls **27** and **28** is a relatively large gear **35** arranged in the shaft **22**, and is secured to the latter by an integral collar **36** through the medium of a set screw **37**, as shown in FIGURE 2. The gear **35** is meshed with a smaller gear **38** on the shaft **39** of a motor **40** mounted by screws **41** on the back of the rear wall **28** of the housing **11**.

The motor **40** is of the variable speed type and is controlled by a rheostat **42** on the panel **12** through the knob **43**. A manual switch **44** is connected into the motor circuit and is also mounted on the panel **12**, as well as a fuse **46** and a jack plug receptacle **46** by which the motor circuit is connected through a transformer (not shown) to a service outlet.

It is very important that the motor **40** be capable of variable speeds, and accurately controlled, in order that it may be readily adjusted to operate the pump at the proper speed to suit the type and rate of medication required to be injected or infused into the arterial system of a patient. It is also important that the speed of the motor **40** be constant when the rheostat **42** is properly adjusted.

In FIGURE 6 is a fragmentarily illustrated in a modified arrangement of the spring tensioning means for the arms **29** by which the rollers **30** are held in engagement with the tube **16**. In this structure a plurality of individual springs **47** are provided whose ends are secured to the screws **33** on the inner ends of the arms **29**. This arrangement, while capable of maintaining a constant pressure on the tube **16** when each spring **47** has a uniform pull, the endless spring **31** is more dependable for uniformity and flexibility, particularly since the rollers **32** will provide for equalization of tension between the arms **29** and pressure on the tube **16** will not be relaxed at any point due to weakening of a spring **47** by fatigue or other cause.

The assembly is adapted to be supported on a table surface by legs **48** attached to the base **10**, or may be suspended on a rack or other supporting means, and completely enclosed in a cabinet of any suitable design.

The invention, while described with great particularity, is capable of certain changes and modifications from time to time, by persons skilled in the art, without departing from the spirit and intent thereof or the scope of the appended claims.

What is claimed is:

1. In an infusion pump for medicaments having a base plate and a pair of vertical parallel walls along one side defining a housing, and a vertical panel arranged along an end of said base at right angles to said housing, the combination comprising, a face panel on the outer wall of said housing having a circular recess therein and a groove formed peripherally of said recess, a flexible tube arranged in said groove and having fluid inlet and outlet ends, a circular disk rotatively mounted concentrically of said recess, a plurality of arms pivotally attached intermediate their ends to said disk about the periphery thereof, and a roller pivoted to the outer end of each of said arms engageable with said tube in said groove to compress said tube progressively about said groove, a pulley pivoted on the inner end of each of said arms, an endless pull spring collectively embracing said pulleys connecting the inner ends of said arms for exerting tension thereon, and a variable speed motor for rotating said disk and said arms thereon.

2. In an infusion pump of medicaments, having a base, a housing having a circular recess in its outer wall, a peripheral groove in said recess, and a variable speed motor for driving said pump, the structure comprising, a disk rotatably mounted concentrically of said recess, a flexible flow tube adapted to lie in said peripheral groove in said recess, a plurality of arms spaced about the said disk and pivoted thereto intermediate their ends whereby their longitudinal axes are tangential to the axis of said disk, a roller attached to the outer end of each of said arms and engaging said flexible tube to compress the same progressively about said groove, a pulley pivotally arranged on the inner end of each of said arms, and an endless pull spring arranged about said pulleys whereby to exert pressure on said tube.

3. An infusion pump for injecting medicaments into the arterial system, a base element, and a housing thereon having a circular recess in a wall thereof, and a groove formed peripherally of said recess, and a compressible tube arranged in the groove in said recess having connection with a fluid source, the improvements comprising, a disk rotatable concentrically of said recess and having means for rotating the same, a plurality of arms pivoted intermediate their ends about the outer edge of said disk, each having a roller pivoted to its outer end and engageable with said tube, a pulley on the inner end of each of said arms opposite said rollers, and a pull spring arranged about said pulleys operatively connecting the inner ends of said arms and exerting collective tension thereon whereby said rollers progressively compress said tube along said groove.

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