

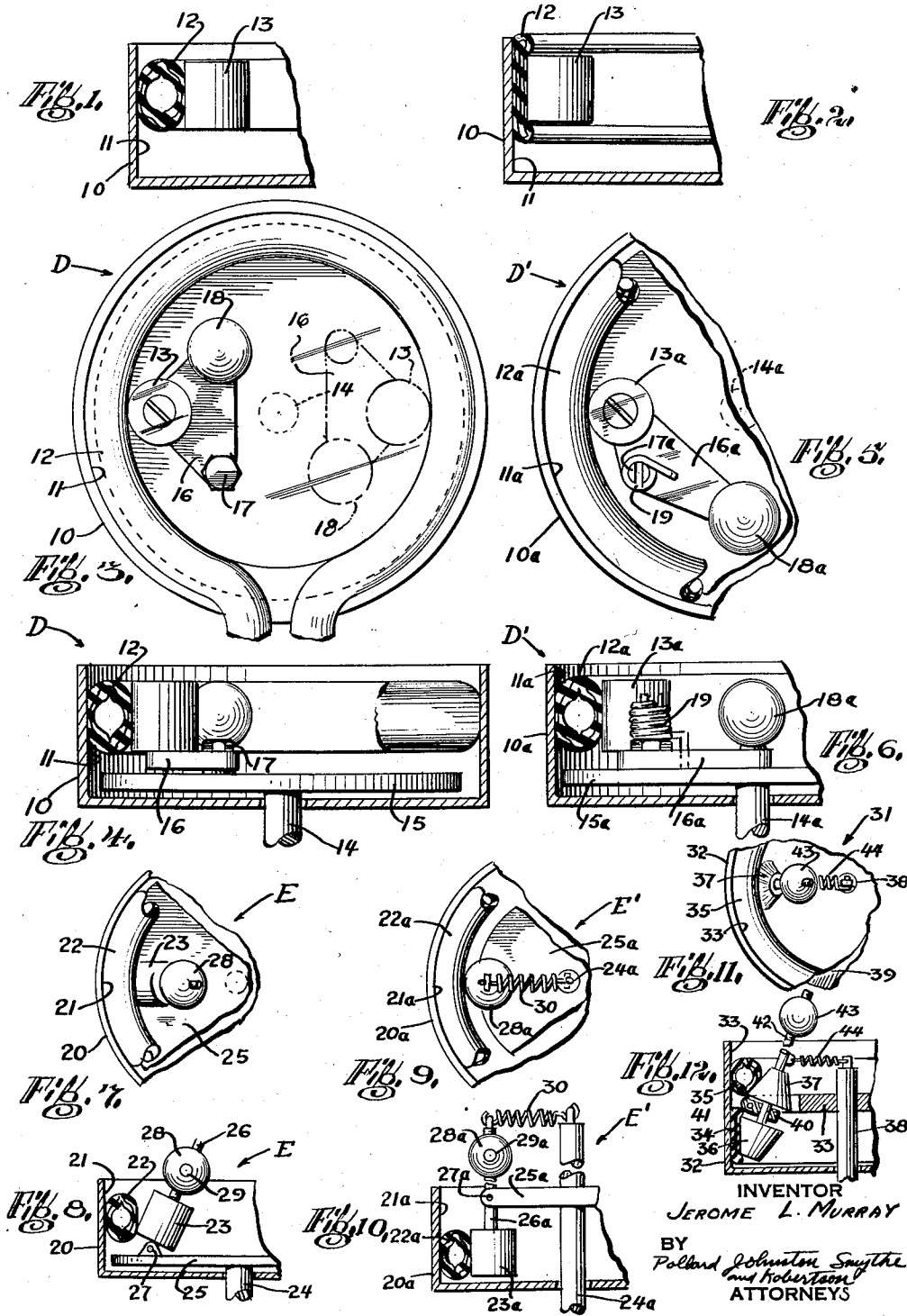
March 15, 1960

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2,928,353

FLUID PRESSURE DEVICES

Filed Dec. 19, 1955



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2,928,353

FLUID PRESSURE DEVICES

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Application December 19, 1955, Serial No. 553,984

19 Claims. (Cl. 103—149)

The present invention relates to flexible tube fluid pressure devices, and more particularly is directed to improvements in devices of the kind having a resilient tube section and presser means movable along the tube section to locally flatten or reduce the cross-sectional area of the latter, so that the device can be employed as a fluid pump when the presser means is driven along the tube section.

Although flexible tube fluid pressure devices of the described character have been proposed and many variations and modifications based upon the same general principles have been suggested, all of such prior devices have provided a uniform degree of local flattening of the resilient tube section without regard to the speed of movement of the presser means along the tube section, and, therefore, the same operating efficiency is obtained at all speeds. However, in many applications of flexible tube fluid pressure devices of the described character, it is desirable to either increase or decrease the degree of flattening of the tube section by the pressure means as the speed of movement of the latter is increased. For example, considering the situation where the presser means is driven along the tube section by an electric motor to pump fluid through the tube section and the notoriously low starting torque of most electric motors makes it desirable to avoid the application of a high load to the motor until the latter has accelerated to its normal operating speed. It is apparent that, at low motor speeds and hence during slow movement of the presser means along the tube section, the latter should be only slightly flattened and, as the motor accelerates and correspondingly increases the speed of movement of the presser means along the tube section, the degree of flattening of the tube section should also be increased. Each will finally provide maximum operating efficiency of the pump without overloading the motor during starting of the latter. Conversely, where it is necessary to provide a pump delivering fluid at a constant rate independent of the speed at which the pump is driven, the tube section has to be flattened to a relatively large degree during movement of the presser means along the tube section at relatively slow speeds, and, as the speed of movement of the presser means increases, the degree of flattening of the tube section needs to be proportionately diminished.

Accordingly, it is an object of the present invention to provide flexible tube pressure fluid devices of the described character wherein the degree of flattening of the tube section by the presser means is varied in accordance with changes in the speed of movement of the presser means along the tube section.

Another object is to provide flexible tube pressure fluid devices of the kind including a rigid casing having an arcuate surface against which the flexible tube is disposed and a roller or rollers movable along the flexible tube and pressing radially against the latter to locally flatten the tube against the arcuate surface, and wherein the radial pressure of the roller or rollers against the flexible tube, and hence the flattening of the latter, is

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centrifugally controlled so as to vary in accordance with changes in the speed of movement of the roller or rollers along the tube.

In one aspect of the invention, the presser means for locally flattening the flexible tube against the arcuate surface of the casing includes a disc or rotor rotatable about an axis of rotation concentric with the arcuate surface, at least one rockable arm or bell-crank mounted in the disc adjacent the periphery of the latter for rocking about an axis parallel to the axis of rotation of the disc, a presser roller rotatable on the bell-crank to act radially against the flexible tube disposed along the arcuate surface, and a mass positioned on the bell-crank so that, as the disc is rotated, the centrifugal force acting on the mass tends to rock the bell-crank in the direction for increasing the flattening of the flexible tube by the related roller. In a modification of the above arrangement, the mass on the bell-crank is disposed so that centrifugal force acting thereon tends to rock the bell-crank in the direction for decreasing the flattening of the flexible tube by the roller, and resilient means is interposed between the bell-crank and disc urging the bell-crank in the direction for pressing the roller radially against the flexible tube whereby, when rotation of the disc commences, the resilient means determines the initial degree of flattening of the flexible tube and, as the speed of rotation of the disc increases, the centrifugal force acting on the mass correspondingly decreases the degree of flattening of the flexible tube.

In another aspect of the invention, the support for each roller and the related mass is in the form of an elongated arm mounted on the rotor for rocking relative to the latter in a radial plane, and the mass is adjustable along the support arm to vary the effect of centrifugal force upon the pressure of the roller against the flexible tube. With such an arrangement, both the roller and mass can be disposed on the support arm at the same side of the rocking axis of the latter so that rotation of the rotor at an increasing speed correspondingly increases the degree of flattening of the flexible tube, or the roller and mass can be disposed on the support arm with the rocking axis of the latter located therebetween, so that, as the rotational speed of the rotor is increased, the centrifugal force acting on the mass decreases the radial pressure of the roller against the flexible tube.

In still another aspect of the invention, two parallel flexible tubes are disposed along the arcuate surface of the casing and the rotor carries pairs of rollers acting radially against the related tubes to simultaneously effect local flattening of the latter as the rotor rotates. Each pair of rollers is rockably mounted on the rotor and associated with a mass so that, as the rotational speed, and hence the centrifugal force acting on the mass, are increased, the pressure of one roller against its flexible tube is increased and the pressure of the other roller against its tube is decreased.

The presser rollers can be carried on various shaped rockable arms or on movable supports, and the term "bell-crank" is meant to include the same.

The above, and other, objects, features and advantages of the invention will be apparent in the following detailed description of illustrative embodiments which is to be read in connection with the accompanying drawings forming a part hereof, and wherein:

Fig. 1 is a fragmentary, radial sectional view of a flexible tube pressure fluid device showing a condition of flattening of the flexible tube section to a small degree;

Fig. 2 is a view similar to Fig. 1, but showing the flattening of the flexible tube section to a large degree;

Fig. 3 is a plan view of a flexible tube pressure fluid device embodying the present invention;

Fig. 4 is a side elevational view, partly broken away and in section, of the device of Fig. 3;

Fig. 5 is a fragmentary view of another embodiment of the invention;

Fig. 6 is a fragmentary side elevational view, partly broken away and in section, but of the embodiment of the invention shown in Fig. 5;

Fig. 7 is a view similar to Fig. 5, but of still another embodiment of the invention;

Fig. 8 is a view similar to Fig. 6, but of the embodiment of the invention shown in Fig. 7;

Fig. 9 is a view similar to Fig. 5, but of still another embodiment of the invention;

Fig. 10 is a view similar to Fig. 6, but of the embodiment of the invention shown in Fig. 9;

Fig. 11 is a view similar to Fig. 5, but of a further embodiment of the invention; and

Fig. 12 is a view similar to Fig. 6, but of the embodiment of Fig. 11.

Referring to the drawings in detail, and initially to Figs. 1 and 2 thereof, which generally illustrate the elements of a flexible tube pressure fluid device of the kind with which the present invention is concerned, it will be seen that such device includes a rigid casing 10 defining a surface 11, which is arcuate in the illustrated device, a flexible tube 12 lying against the surface 11 and having one of its ends connected to a source or supply (not shown) of fluid, and a presser roller 13 operative to more or less flatten the tube 12 against the surface 11 at a location which is made to travel along the flexible tube by driving the roller 13 along a path parallel to the surface 11.

Preferably, as is more fully discussed in my co-pending application for United States Letters Patent, Serial No. 525,296, filed July 29, 1955 the flexible tube 12 has a fabric layer of suitably flexible and heat resistant yarn embedded in the body thereof between inner and outer layers which may be formed of natural or synthetic rubber or of any other suitably flexible, resilient and fluid impervious material so that the fabric layer takes much of the stress imposed on the tube 12 during the repeated flattening of the latter and further permits the designing of the tube to facilitate the complete closing thereof when it is fully flattened, as in Fig. 2, and to prevent the cracking, or other fatigue failure, of the tube at the locations where it is sharply bent in being flattened. Thus, as seen in Fig. 1, the wall of the flexible tube 12 preferably has relatively thin portions at diametrically opposed locations, while the tube is gradually thickened radially inward at the opposite sides of the above mentioned thin portions so that, when the tube is flattened in the direction normal to the diametrical plane through the thin wall portions, the tube can fold at the thin wall portions with the thickened wall portions, at the opposite sides of the latter, riding against each other to permit complete closing of the interior of the tube without the development of high stresses in the tube wall, particularly where the latter is folded.

It is apparent that, if the radial gap between the surface 11 of the rigid casing 10 and the surface of the roller 13 is only slightly smaller than the normal cross-sectional diameter of the tube 12, as in Fig. 1, the flexible tube will be flattened to only a small degree as the roller 13 moves therealong. On the other hand, if such gap is equal to the flattened thickness of the tube 12, the roller 13 will effect complete flattening of the flexible tube as it moves along the latter, as in Fig. 2.

If a flexible tube pressure fluid device of the described character is employed as a pump for fluid supplied to one end of the tube 12, it is apparent that, for a given speed of movement of the roller 13 along the tube 12, the pumping action will be much greater with the roller 13 arranged relative to the surface 11 as in Fig. 2, to effect complete flattening of the tube, than with the roller 13

spaced relatively far from the surface 11, as in Fig. 1, to effect only slight flattening of the tube 12.

In accordance with the present invention, the presser roller 13 is mounted for generally radial movement toward and away from the surface 11 of the rigid casing, thereby to vary the flattening of the flexible tube 12 therebetween, and such generally radial movement of the roller 13 is effected in response to the speed of movement of the presser roller along the flexible tube.

In the flexible tube pressure fluid device embodying this invention and generally identified by the letter D in Figs. 3 and 4, the structure supporting the presser roller 13 for movement along the flexible tube 12 includes a rotatable shaft 14 concentric with the arcuate surface 11 of rigid casing 10, a rotor 15 fixed to the shaft 14 and rotating with the latter in a plane perpendicular to the axis of the shaft, and a bell-crank 16 pivoted on the rotor 15, as at 17, for movement in a plane parallel to the rotor. The roller 13 is mounted on the bell-crank 16 at a location spaced from the latter's pivot 17 for rotation about an axis parallel to the axis of the shaft 14 and is moved toward the surface 11 of the casing by counter-clockwise movement of the bell-crank 16, as viewed in Fig. 3, while the contrary, or clockwise, movement of the bell-crank relative to the rotor moves the roller 13 away from the surface 11. Also mounted on the bell-crank 16, at the same side of the pivot 17 as the roller 13, is a mass or weight 18 which is subjected to centrifugal force, as the rotor 16 rotates, and tends to pivot the bell-crank 16 in the counter-clockwise direction, as viewed in Fig. 3. Thus, when the rotor 15 rotates at a relatively low speed, the roller 13 will be urged radially outward toward the surface 11 with a relatively small force to effect only slight flattening of the tube 12, and as the rotational speed of the rotor increases, the radially outward force of the roller 13 against the tube 12 correspondingly increases until it is sufficient to effect complete flattening of the flexible tube.

If the device D of Figs. 3 and 4 is employed as a pump, the shaft 14 is driven, for example, by an electric motor (not shown) connected thereto, and the movement of the roller 13 along the tube 12 is effective to pump fluid through the latter from a supply (not shown) connected to one end of the flexible tube to a point of use (not shown) connected with the other end of the flexible tube. Since only slight flattening of the flexible tube is effected at low rotor speeds, overloading of the motor driving the shaft 14 will be avoided during starting of the motor and, as the motor approaches its usual operating speed, the increased centrifugal force acting on the mass 18 moves the roller 13 radially outward to then effect complete flattening of the flexible tube for achieving the maximum operating of the pump.

Referring now to Figs. 5 and 6 of the drawings, a flexible tube pressure fluid device embodying the present invention is there illustrated and generally identified by the letter D'. The device D' is in many respects similar to the device D described in connection with Figs. 3 and 4 except that, contrary to the latter, the device D' decreases the degree of flattening of the flexible tube by the presser roller as the speed of movement of the latter along the tube is increased. The several parts of the device D' are identified by the same reference numerals employed in connection with the device D, but with the letter "a" appended thereto, and include a rigid casing 10a having an arcuate surface 11a against which the flexible tube 12a is disposed, and a roller 13a movable along the flexible tube and adapted to more or less flatten the latter against the surface 11a. The structure supporting the roller 13a includes a shaft 14a concentric with the surface 11a, a rotor 15a fixed on the shaft 14a, and a bell-crank 16a pivoted, as at 17a, on the rotor 15a. The pivot 17a for the bell-crank 16a is disposed intermediate the ends of the latter, as seen on Fig. 5, and the roller 13a is mounted rotatably on one end of the bell-crank, while a mass or weight 18a is mounted on the opposite end of the bell-

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crank so that, as the rotor 15a rotates, centrifugal force acting on the mass 18a tends to move the roller 13a radially inward away from the flexible tube 12a.

In order to provide for initial flattening of the tube 12a by the roller 13a, the device D' further includes resilient means, for example, in the form of a torsion spring 19 arranged around the pivot 17a and operatively interposed between the rotor 15a and the bell-crank 16a, to yieldably urge the latter in the direction for moving the roller 13a radially outward against the tube 12a, that is, in the counter-clockwise direction, as viewed on Fig. 5.

Thus, when the shaft 14a and rotor 15a are at rest, the spring 19 causes the roller 13a to completely flatten the tube 12a against the surface 11a and, as the rotational speed of the shaft 14a increases, the centrifugal force acting on the mass 18a works against the action of the spring 19 and correspondingly decreases the degree of flattening of the tube 12a.

If the device D' of Figs. 5 and 6 is employed as a pump, the variation of the degree of flattening of the flexible tube 12a inversely with changes in the speed of movement of the roller 13a along the tube makes it possible to achieve a substantially constant rate of fluid output independent of variations in the speed at which the shaft 14a is driven.

It is apparent that the effect of the speed of movement of the presser roller along the flexible tube upon the degree of flattening of the latter can be altered in the embodiments of Figs. 3 and 4 and Figs. 5 and 6, respectively, either by replacing the masses 18 and 18a with heavier or lighter masses, or by locating such masses at larger or smaller distances from the pivots of their respective bell-cranks 16 and 16a. However, in Figs. 7 and 8 and Figs. 9 and 10, respectively, embodiments of the present invention are illustrated, wherein the desired changes in the effect of speed of movement of the presser roller along the flexible tube upon the degree of flattening of the latter can be effected by suitable adjustments, and without requiring any changes or replacements in the several parts.

In Figs. 7 and 8, the device embodying the present invention is generally identified by the letter E and includes a rigid casing 20 defining an arcuate surface 21 along which a flexible tube 22 is arranged, and a presser roller 23 movable along the tube 22 and operative to more or less flatten the latter. The structure supporting the roller 23 includes a shaft 24 concentric with the surface 21 and carrying a rotor 25 which is rotatable with the shaft 24 in a plane normal to the axis of the shaft. A support arm 26 is pivoted at one end, as at 27, on the rotor 25 for swinging relative to the latter about an axis which lies in a plane parallel to that of the rotor and extends at right angles to a radius from the axis of shaft 24 so that the arm 26 swings in a radial plane extending through the axis of rotation of the shaft and the rotor 25. The roller 23 is rotatably mounted on the pivoted support arm 26 and the latter also carries a mass or weight 28, which is preferably adjustable along the arm 26 toward and away from the pivoting axis of the latter. Such adjustment may be achieved by threading the outer portion of the arm 26 and providing the mass 28 with a tapped bore, to receive the threaded arm, and with a set screw 29 (Fig. 8) operative to lock the mass in its adjusted position along the support arm 26.

With the arrangement of Figs. 7 and 8, as the rotational speed of the shaft 24 increases, the centrifugal force acting on the weight 28 causes the support arm 26 to rock in the counter-clockwise direction, as viewed on Fig. 8, and thereby urges the roller 23 radially outward against the tube 22 for increasing the degree of flattening of the latter. Since the degree of flattening of the tube 22 is dependent upon the force with which the roller 23 is urged radially outward, the degree of flattening of the tube for any particular rotational speed can be varied merely by adjusting the mass 28 along the arm 26 to either increase or decrease the movement arm with which the centrifugal force from the mass 28

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acts about the pivot 27. Apart from the above mentioned adjustability, the device E of Figs. 7 and 8 operates in the same manner as the device D described in connection with Figs. 3 and 4.

The device illustrated in Figs. 9 and 10 and generally identified by the reference letter E' operates in the same manner as the device D' of Figs. 5 and 6, but the degree of flattening of the flexible tube effected at any rotational speed of the rotor is adjustable in the same way as has been described in connection with the device E of Figs. 7 and 8. Thus, the device E' will be seen to include a rigid casing 20a defining an arcuate surface 21a, a flexible tube 22a disposed against the surface 21a, a presser roller 23a movable along the flexible tube, a rotatable shaft 24a concentric with the arcuate surface 21a and carrying a rotor 25a, and an elongated support arm 26a pivoted, as at 27a, on the rotor 25a and carrying both the roller 23a and a mass 28a that is adjustable along a threaded portion of the arm 26a and held in its adjusted position by a set screw 29a. In the device E', the roller 23a and the mass 28a are disposed at opposite sides of the pivot 27a of the arm 26a so that the centrifugal force acting on the mass 28a tends to move the arm 26a in the direction displacing the roller 23a radially inward away from the flexible tube 22a, thereby reducing the degree of flattening of the flexible tube as the rotational speed of the shaft 24a and rotor 25a is increased. In order to provide initial flattening of the flexible tube, a tension spring 30 is connected between the arm 26a and the shaft 24a to urge the support arm in the clockwise direction, as viewed on Fig. 10, so that, when the shaft 24a is at rest, the spring 30 causes complete flattening of the tube 22a by the roller 23a and, as the rotational speed of the shaft increases, the centrifugal force acting on the mass 28a progressively overcomes the force of the spring and decreases the degree of flattening of the flexible tube.

Since the mass 28a is adjustable along the arm 26a toward and away from the pivot 27a, it is apparent that, as in the device E of Figs. 7 and 8, the effect of the centrifugal force acting on the mass upon the degree of flattening of the tube may be varied.

Referring now to Figs. 11 and 12 of the drawings, wherein still another embodiment of the present invention is illustrated and generally identified by the reference numeral 31, it will be seen that the device 31 includes a rigid casing 32 defining an arcuate surface 33. Two flexible tubes 34 and 35 extend parallel to each other along the arcuate surface 33 and are adapted to be locally flattened by presser rollers 36 and 37, respectively, as the latter are moved along the flexible tubes. The tubes 34 and 35 are connected at one end to sources (not shown) of fluid to be pumped, and the rollers 36 and 37 are controlled, in response to the speed of their movement along the flexible tubes, so that the volume of fluid delivered from the tube 34 decreases with increasing speed, while the volume of fluid delivered from the tube 35 increases with increasing speed.

In order to effect such control of the rollers 36 and 37, the supporting structure for the latter includes a rotated shaft 38 concentric with the surface 33 and carrying a rotor 39, an arm 40 pivoted, as at 41, on the rotor 39 for rocking in a radial plane, and an axle 42 carried by the pivoted arm 40 and extending normal to the latter, with the rollers 36 and 37 being rotatably mounted on the axle 42 at opposite sides of the arm 40 so that, when the latter rocks in the counter-clockwise direction, the roller 37 moves radially outward to increase the degree of flattening of the related tube 35 and the roller 36 moves radially inward to decrease the degree of flattening of the tube 34.

A mass or weight 43 is mounted on the axle 42 at the same side of the pivot 41 as the roller 37 and is preferably adjustable along the axle for varying the effect on rocking of the arm 40 of the centrifugal force acting

on the mass 43. Finally, a tension spring 44 is connected, at its opposite ends, to the axle 42 and shaft 38, respectively, to urge the axle 42 to the position shown on Fig. 12, where the roller 36 completely flattens the tube 34 and the roller 37 effects only slight flattening of the tube 35.

It is apparent that, as the rotational speed of the driven shaft 38 is increased, the centrifugal force acting on the mass 43 gradually overcomes the force exerted by the spring 44 and causes rocking of the axle 42 and arm 40 in the counter-clockwise direction about the pivot 41, thereby to progressively increase and decrease the volumes of fluid pumped through the tubes 35 and 34, respectively. Preferably, as seen in Fig. 12, the rollers 36 and 37 are of frusto-conical configuration so that, when each roller is disposed for complete flattening of the related tube, for example, the roller 36 with the axle 42 and arm 41 positioned as in Fig. 12, the surface of the roller, at its line of rolling contact with the related flexible tube, is parallel to the surface 33 of the casing.

It is apparent that, in all of the above described embodiments of the invention, each presser roller is yieldably urged, either by a spring force or by centrifugal force acting on a related mass in the direction for flattening the related flexible tube so that, if a sudden strong resistance develops to the flow of fluid from the flexible tube, the presser roller can deflect radially inward to relieve the flattening of the tube and thereby prevent damage to the device.

Further, in all of the described embodiments, the degree of flattening of the tube by the presser roller is varied in accordance with changes in the speed of movement of the roller along the related flexible tube. Further, the rollers may have contours as desired and the rockable or bell-crank shape lever can take various forms and configurations as needed.

It is to be understood that various changes and modifications may be effected in the illustrated forms without departing from the scope or spirit of the invention, except as defined in the appended claims.

What is claimed is:

1. In a flexible tube fluid pressure device; the combination including rigid casing means defining a backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, roller means movable along said backing surface and progressively flattening said tube between said roller means and backing surface, pivotally mounted supporting means for rotatably holding said roller means in a position spaced from the pivot point of said supporting means, and a separate mass mounted on said supporting means in a position spaced from said pivot point and responsive to changes in the speed of movement of said roller means along said backing surface to displace said roller means in the direction toward and away from said backing surface, thereby to vary the degree of flattening of said tube in accordance with said changes in the speed of movement of said roller means.

2. In a flexible tube fluid pressure device; the combination including rigid casing means defining a backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, roller means movable along said backing surface and progressively flattening said tube between said roller means and backing surface, pivotally mounted supporting means for rotatably holding said roller means in a position spaced from and on one side of the pivot point of said supporting means, and a separate mass mounted on said supporting means in a position spaced from and on said one side of said pivot point, said mass urging said roller means in the direction toward said backing surface with a force that increases with increases in the speed of movement of said roller means along said backing surface so that the degree of flattening of said flexible tube between said roller means and backing surface is increased

with said increases in the speed of movement of the roller means.

3. In a flexible tube fluid pressure device; the combination including rigid casing means defining a backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, roller means movable along said backing surface and progressively flattening said tube between said roller means and backing surface, means normally urging said roller means toward said backing surface, pivotally mounted supporting means for rotatably holding said roller means in a position spaced from and on one side of the pivot point of said supporting means, and a separate mass mounted on said supporting means in a position spaced from and on the other side of said pivot point, said mass moving said roller means in the direction away from said backing surface in response to increases in the speed of movement of said roller means along said backing surface, thereby to decrease the degree of flattening of said tube between said roller means and backing surface in accordance with said increases in the speed of movement of said roller means.

4. In a flexible tube fluid pressure device; the combination including rigid casing means defining a backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, roller means movable along said backing surface and progressively flattening said tube between said roller means and backing surface, yieldable means urging said roller means in the direction toward said backing surface so that said flexible tube is substantially completely flattened between said roller means and backing surface at the location of said roller means, pivotally mounted supporting means for rotatably holding said roller means in a position spaced from and on one side of the pivot point of said supporting means, and a separate mass mounted on said supporting means in a position spaced from and on the other side of said pivot point, said mass being responsive to the speed of movement of said roller means along said backing surface and opposing said yieldable means with a force that increases with increases in said speed of movement of the roller means so that, as said speed of movement of the roller means increases, the degree of flattening of said tube between said roller means and backing surface is correspondingly decreased.

5. In a flexible tube fluid pressure device; the combination including rigid casing means defining a backing surface, first and second flexible tubes lying against said backing surface and each adapted to be connected, at one end, to a supply of fluid, first and second roller means movable together along said backing surface and progressively flattening said first and second tubes, respectively, between said backing surface and the related roller means, pivotally mounted supporting means rotatably holding both of said roller means on opposite sides of and spaced from the pivot point of said supporting means, means for urging said supporting means in a direction to displace said first roller means toward said backing surface, and a separate mass mounted on said supporting means spaced from and on one side of said pivot point and responsive to changes in the speed of movement of said first and second roller means along said backing surface to displace said second roller means in the direction toward said backing surface as said speed of movement increases, thereby to oppositely vary the degrees of flattening of said first and second tubes in accordance with said changes in the speed of movement of said roller means.

6. In a flexible tube fluid pressure device; the combination including rigid casing means defining a backing surface, first and second flexible tubes lying against said backing surface and each adapted to be connected, at one end, to a supply of fluid, first and second roller means movable together along said backing surface and progres-

sively flattening said first and second tubes, respectively, between said backing surface and the related roller means, yieldable means urging said roller means toward said backing surface and urging said second roller means away from said backing surface so that said first and second tubes are substantially completely flattened and only slightly flattened at the locations of said first and second roller means, respectively, pivotally mounted supporting means for rotatably holding both of said roller means in a position spaced from and on opposite sides of the pivot point of said supporting means, and a separate mass mounted on said supporting means on the same side of said pivot point as said second roller means, said mass being responsive to the speed of movement of said roller means along said backing surface and opposing said yieldable means with a force that increases with increases in said speed of movement of the roller means so that, as said speed of movement of the roller means increases, the degrees of flattening of said first and second tubes are correspondingly decreased and increased, respectively.

7. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, support means rotatable about an axis concentric with said arcuate backing surface, roller means mounted on said support means for movement with the latter and movable generally radially with respect to said support means toward and away from said backing surface so that said flexible tube is progressively flattened by said roller means as said support means rotates, the degree of flattening of said tube depending upon the radial spacing of said roller means from said arcuate backing surface, and a separate mass mounted on said support means in a position spaced from said axis which is responsive to the centrifugal force generated by the rotational speed of the support means for varying said radial spacing of the roller means from the backing surface in response to changes in the rotational speed of said support means.

8. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, support means rotatable about an axis concentric with said arcuate backing surface, roller means mounted on said support means for movement with the latter and movable generally radially with respect to said support means toward and away from said backing surface so that said flexible tube is progressively flattened by said roller means as said support means rotates, the degree of flattening of said tube depending upon the radial spacing of said roller means from said arcuate backing surface, and a separate mass mounted on said support means in a position spaced from said axis and on the same side thereof as said roller means for urging said roller means radially toward said backing surface with a force that increases with increasing rotational speed of said support means so that the degree of flattening of said flexible tube between the roller means and backing surface is increased with said increasing rotational speed of the support means.

9. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, support means rotatable about an axis concentric with said arcuate backing surface, roller means mounted on said support means for movement with the latter and movable generally radially with respect to said support means toward and away from said backing surface so that said flexible tube is progressively flattened by said roller means as said support means rotates, the degree of flattening of said tube depending upon the radial spacing of said roller means

from said arcuate backing surface, yieldable means urging said roller means radially outward toward said backing surface to effect substantially complete flattening of said flexible tube at the location of said roller means, and centrifugally actuated means on said support means responsive to the speed of rotation of said support means and opposing said yieldable means with a force that increases with increases in said speed of rotation so that the degree of flattening of said flexible tube is decreased as said speed of rotation increases.

10. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, at least one flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, support means rotatable about an axis concentric with said arcuate backing surface, roller means mounted on said support means for movement with the latter and movable generally radially with respect to said support means toward and away from said backing surface so that said flexible tube is progressively flattened by said roller means as said support means rotates, the degree of flattening of said tube depending upon the radial spacing of said roller means from said arcuate backing surface, a mass rockably mounted on said support means and connected to said roller means so that rocking of said mass in response to the action of centrifugal force thereon is effective to vary the spacing of said roller means from said backing surface, and means adjustably positioning said mass with respect to its rocking axis so that the affect upon said roller means of the centrifugal force acting on said mass can be varied to control the degree of flattening of said flexible tube obtained with a particular speed of rotation of said support means.

11. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, first and second flexible tubes lying against said backing surface and each adapted to be connected, at one end, to a supply of fluid, support means rotatable about an axis concentric with said arcuate backing surface and having a rockable member thereon, first and second roller means mounted on said rockable member at opposite sides of the rocking axis of the latter for movement with said rotatable support means along said first and second tubes, respectively, and for generally radial movement in opposite directions toward and away from said backing surface so that said first and second tubes are progressively flattened between said first and second roller means, respectively, and said backing surface, the degrees of flattening of said tubes depending upon the radial spacing of the related roller means from said backing surface, yieldable means urging said rockable member in one direction so that said first tube is substantially completely flattened while said second tube is only slightly flattened, and a mass on said rockable member subjected to centrifugal force as said support means rotates to urge said rockable member in the opposite direction in opposition to said yieldable means so that, as the speed of rotation of said support means increases, the degrees of flattening of said first and second tubes are respectively decreased and increased.

12. In a flexible tube fluid pressure device; the combination according to claim 11, further including means adjustably positioning said mass with respect to the rocking axis of said rockable member so that, at any speed of rotation of said support means, the effectiveness of the centrifugal force acting on said mass in opposing said yieldable means may be varied, thereby to adjust the degrees of flattening of said first and second tubes at said particular speed of rotation.

13. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, a flexible tube lying against said backing surface and adapted to be connected, at one

end, to a supply of fluid, rotor means rotatable about an axis concentric with said arcuate backing surface, a bell-crank pivoted on said rotor means for rocking relative to the latter in a plane parallel to the plane of rotation of said rotor means, roller means mounted on said bell-crank at a location spaced from the rocking axis of the latter and rotatable about an axis parallel to said axis of the rotor means so that said roller means moves toward and away from said backing surface in response to rocking of said bell-crank and moves with said rotor means to progressively flatten said tube against said backing surface to an extent dependent upon the spacing of said roller means from the backing surface, and a separate mass mounted on said bell-crank at a location spaced from the rocking axis of the latter and subjected to centrifugal force in response to rotation of said rotor means for rocking said bell-crank and correspondingly varying the extent to which said tube is flattened by said roller means in accordance with changes in the rotational speed of said rotor means.

14. In a flexible tube fluid pressure device; the combination as in claim 13, wherein said separate mass and said roller means are located at the same side of said rocking axis of the bell-crank so that the centrifugal force acting on said mass urges said bell-crank in the direction moving said roller means toward said backing surface, thereby to increase the extent of flattening of said flexible tube as the rotational speed of said rotor means increases.

15. In a flexible tube fluid pressure device; the combination as in claim 13, further including resilient means urging said bell-crank to rock in the direction moving said roller means toward said backing surface to effect complete flattening of the flexible tube against the latter, and wherein said roller means and mass are located at opposite sides of said rocking axis of the bell-crank so that the centrifugal force acting on said mass opposes the action of said resilient means and the extent of flattening of said flexible tube is decreased as the rotational speed of said rotor means increases.

16. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, a flexible tube lying against said backing surface and adapted to be connected, at one end, to a supply of fluid, rotor means rotatable about an axis concentric with said backing surface, a support arm pivoted on said rotor means for swinging relative to the latter in a radial plane, roller means rotatable on said support arm and moving toward and away from said backing surface in response to swinging of said support arm and along said backing surface in response to rotation of said rotor means to progressively flatten said flexible tube against said backing surface to an extent dependent upon the spacing of said roller means from said backing surface, and a mass on said support arm adjustable along the latter toward and away from the swinging axis of the support arm and subjected to centrifugal force as said rotor means rotates to swing said support arm with an effect dependent upon the speed of rotation of the rotor means and the spacing of the mass from said swinging

axis so that the extent of flattening of said flexible tube varies with changes in said speed of rotation and the position of said mass along the support arm.

17. In a flexible tube fluid pressure device; the combination as in claim 16, wherein said swinging axis of the support arm is at one end of the latter with said roller means and mass being disposed at the same side of said swinging axis to increase the degree of flattening of said flexible tube as said speed of rotation of the rotor means increases.

18. In a flexible tube fluid pressure device; the combination as in claim 16, further including resilient means urging said support arm to swing in the direction moving said roller means toward said backing surface to effect substantially complete flattening of said flexible tube, and wherein said swinging axis of the support arm is disposed intermediate the ends of the latter with said roller means and mass at opposite sides of the swinging axis so that the centrifugal force acting on said mass opposes the action of said resilient means and, as the rotational speed of said rotor means increases, the degree of flattening of said flexible tube is correspondingly decreased.

19. In a flexible tube fluid pressure device; the combination including rigid casing means defining an arcuate backing surface, first and second flexible tubes arranged parallel to each other against said backing surface and each adapted for connection, at one end, to a supply of fluid, rotor means rotatable about an axis concentric with said backing surface and in a plane between said tubes, a support arm pivoted intermediate its ends on the periphery of said rotor means to swing relative to the latter in a radial plane, first and second roller means rotatably mounted on said support arm at opposite sides of the swinging axis of the latter to move oppositely toward and away from said backing surface in response to swinging of said support arm, said first and second roller means progressively flattening said first and second tubes, respectively, as said rotor means rotates, the degrees of flattening of said tubes depending upon the spacing of the related roller means from said backing surface, resilient means urging said support arm to swing in the direction moving said first roller means toward said backing surface for substantially completely flattening said first tube while said second tube is only slightly flattened by said second roller means, and a mass adjustable along said support arm at the same side of the latter's swinging axis as said second roller means and being subjected to centrifugal force in response to rotation of said rotor means for opposing the action of said resilient means and swinging said support arm in the direction for increasing and decreasing the degrees of flattening of said second and first flexible tubes, respectively, in response to increases in the rotational speed of said rotor means.

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