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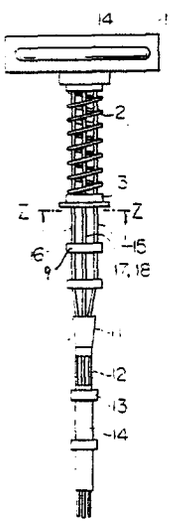
(54) Centrifugal separation case assembly.

(57) There is disclosed a centrifugal separation case assembly adapted to a continuous type centrifugal separation apparatus in which the twist of communication tube used for injection of the liquid, for example the blood, and for discharge of the separated components such as the red blood cell etc. is positively prevented, further, the complete separation and the short time separation can be realized using the separation case, and the rigidity of the tubes provided for the injection and discharge is improved (Fig. 3).

FIG. 3



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CENTRIFUGAL SEPARATION CASE ASSEMBLY

The present invention relates to a centrifugal separation case assembly for a continuous type centrifugal separator, and more particular to a centrifugal separation container adapted to wash the blood of the patient having blood disorders.

In case of blood disorders such as jaundice, for example, it is observed that plasma is contaminated and the blood washing process is usually carried out for the treatment of the jaundice by way of continuously removing the blood from the doner patient, centrifugally separating the contaminated plasma to be abandoned, and returning red blood cells with addition of plasma preparations of the body of the patient under conditions flow process. Also, this washing process is being used for the treatment of various blood disorders resulting from abnormalities within the plasma, in such cases as malignant peraprotenemias and hypercholesterolemia.

For a continuous type centrifugal separator which can be used for the blood washing process as above mentioned, it is required that a closed system is kept in a flow process between the blood vessel of the patient and a centrifugal case via a circulation channel of the tubes for the whole blood and the separated blood components. Otherwise, bacteria contamination may possibly occur to cause hazards to the health of the patient. Further, during the blood washing treatment, the some pain is given the patient, and therefore it is required that the blood washing treatment is performed in short time period. Therefore the most essential requirement for this type of a continuous centrifugal separator consists in an arrangement to ensure the completely closed system for the blood tubes.

Such a centrifugal liquid processor is shown in U.S.A Patent Application Serial No. 853,921 (corresponding to German Offenlegungsschrift DE 3613438), of which the assignee is the same as that of this application. In the above U.S. Application, in order to prevent the occurrence of the twist of the tubes connecting between a centrifugal separation case and an apparatus, a part of the tubes connecting between the centrifugal separation case and the apparatus is rotatably fixed a rotary table and the rotary table is rotated around a rotational center of the centrifugal separation case at speed which is a half of the speed of the centrifugal separation case. Further, the above centrifugal liquid processor is also shown in the Japanese Patent Application Laid-Open No. 120470/1976 (corresponding to U.S. Patent Serial Nos. 562,748 and 657,187). The mechanism and the structure of the above U.S. Patent Application Serial No. 853,921 are shown in Figs. 1 and 2.

In Fig. 1, reference numeral 71 denotes a rotation member for the centrifugal separation, which has a centrifugal separation case 72, an injection nozzle 73 through which the blood is injected into the centrifugal separation case, and a discharge nozzle group 74 through which the centrifugal-separated liquid is discharged, therein. The injection nozzle 73 and the discharge nozzle group 74 extend downward and are rotatably held at the edge of a tube-twist prevention table 75 with a holder 76 etc. thereafter, they are rotatably held by an arm 77 extending from the edge of the tube-twist prevention table 75 upward with a holder 78 and thereafter, they communicate with exterior through a protection tube 79 fixed on an upper fixing member 78 which is positioned on a rotational center axis of the rotation member 71. In the above arrangement, the tube-twist prevention table 75 is rotated in a direction same as that of the rotation member and at speed which is a half of that of the rotation member 71, the twist is not, as a whole, caused in the protection tube 79, injection nozzle 73, and the discharge nozzle 74, even if the rotation member rotates. However, the twist may be temporally generated in the holders 76 and 78 or the curved portion of the tube so that the twist vibration may be generated in the whole of the tube and as the result, the undesired force is given to the tube so that the tube may be destroyed.

Fig. 2 shows a cross-sectional view of the rotation member 71 shown in Fig. 1. In Fig. 2 a centrifugal separation case 72 is symmetrically arranged on the rotation member 71, and the injection nozzle 73 and the discharge nozzle group 74 are arranged to extend in the same direction from the rotational center of the centrifugal separation case 72. Therefore, the blood injected from the injection nozzle 73 may be directly discharged through the discharge nozzle 74 so that the separation is not completely performed and the high separation efficiency can be not obtained. Therefore, in the above separation apparatus, the continuously centrifugal separation of the blood, which has high safety and separation efficiency, can not be realized.

It is an object of the present invention to provide an improved centrifugal separation case for the continuous type centrifugal separation apparatus in which the above stated drawback, that is to say, the incompleteness in the blood separation, and the generation of the twist vibration causing the destroy of the tube, can be removed.

In order to remove the above drawbacks, a plurality of tube protectors are provided at plural positions of a tube system of the centrifugal separation apparatus and the tube system is partially integrated for integrally holding tube group extending from the centrifugal separation case. Further, the centrifugal separation case is formed to have a generally rectangular shape and both edges thereof are communicated with each other by communication pipes. More further, in the centrifugal separation case according to the present invention, the opening port of an injection nozzle for injecting the blood into the separation case and the opening port of a discharge nozzle for discharging the blood components are opposed each other through a rotation axis of the separator case so that the unseparated blood is not discharged from the discharge nozzles. Additionally, when the tubes included in said nozzle group are integrally held, the tubes are integrally held in the whole of the straight portion thereof so that the rigidity of the tube group is more improved.

Fig. 1 is a schematic perspective view of a centrifugal separation apparatus shown in U.S.P. Application U.S.S.N. 853,921;

Fig. 2 is a longitudinal sectional view of a centrifugal separation case used in the apparatus shown in Fig. 1;

Fig. 3 is a schematic view of the preferred embodiment according to the present invention;

Fig. 4 is a sectional enlarged view taken generally along the line Z-Z of Fig. 3;

Fig. 5 is a longitudinal view of an embodiment according to the present invention;

Fig. 6 is a sectional view taken generally along the line Z-Z of Fig. 5; and

Figs. 7 and 8 are respectively sectional views taken generally along the line X-X, and Y-Y of Fig. 6.

Referring to Figs. 3 to 8, an embodiment according to the present invention will be explained below.

Fig. 3 shows the whole structure of the continuous type centrifugal separation case assembly. The centrifugal separation case assembly comprises a centrifugal separation case 1, a nozzle group for injecting the blood into centrifugal separation case and discharging the separated blood components from the centrifugal separation case, a metal tube 3 rotatably held in the holder 76 provided on the tube-twist prevention table 75 as shown in Fig. 1, a spring 2 for positively removing the twist generated in the tube between the centrifugal separation case 1 and the metal tube 3, a tube protector 9 for integrally holding the tubes, a cover tube 12 for covering the tubes 15-18, and a fixing bushing 11 for causing the tubes to be integrally held in an introduction port of the cover tube 12. Further, the injection tube 15 is connected to the injection nozzle 5, and the discharge tubes 16, 17, and 18 are respectively connected to the discharge nozzles 6, 7, and 8.

The above parts of the embodiment will be explained below every parts.

(a) The centrifugal separation case 1

Fig. 5 is a plane view of the centrifugal separation case 1 according to the present invention. Figs 6 is a sectional view taken along the line Z-Z of Fig. 5. The centrifugal separation case 1, as shown in Figs. 5 and 6, has a generally rectangular solid shape. The blood injection nozzle 5 and the blood components discharge nozzles 6 and 7 extend to the opposite sides with respect to the rotational center of centrifugal separation case 1. These nozzles 5 to 8 extend to the outside of centrifugal separation case 1, passing through the inside of a shaft 4 provided on the rotational center. Further, semi-annular communication pipes are connected to the both sides of the centrifugal separation case 1 to communicate one side of the centrifugal separation case 1 with the other side thereof. These centrifugal separation case 1 and the communication pipes 14 are conveniently formed by utilizing a transparent plastic pipe having a desired size, for example, the outer periphery arc portion of the centrifugal separation case 1 can be formed by utilizing the pipe having inner diameter of 35 mm and outer diameter of 43 mm.

The distances from the rotational center to the opening ports of the injection nozzle 5 and the blood components discharge nozzles 6-8 depend on specific gravity of the blood to be injected and the kind of the components to be centrifugally separated from the injected blood. Therefore the distances thereof preferably can be changeably set in accordance with the desire of an operator. In the present embodiment, for example, the distance from the rotational center to the opening port of the blood injection nozzle 5 is set to be 40 mm, the distance from the rotational center to the red blood cell component discharge nozzle (the specific gravity of the red blood cell is the largest in the other blood components) is set to be 60 mm and the distance from the center to the white blood cell discharge nozzle is set to be 30 mm, and the blood platelet discharge nozzle extends upward the center axis so that the distance thereof is set to be 0 mm. Further, the height of each nozzle from the bottom surface of the centrifugal separation case 1 also depends on the specific gravity and the kind of the blood components to be separated. In the present embodiment, the heights of the blood injection nozzle and the red blood cell components

discharge nozzle 6 are the same as that of the center of communication pipe 14, the heights of the white blood cell and the blood platelet discharge nozzle 8 are shorter than that of the center of the communication pipe 14, and the plasma components nozzle 7 extends from the rotational center upward. The above relationships between the heights of the discharge nozzles are shown in Figs. 7 and 8, which are respectively sectional views taken generally along the line X-X and Y-Y of Fig. 4.

In the above arrangement, the reason that the opening ports of blood injection nozzle 5 and the blood components discharge nozzle 6-7 are directed in directions opposed to each other, is to prevent the centrifugal separation from being performed in only one side of the centrifugal separation case 1 with respect to the rotational center so that the centrifugal separation can be performed in the whole area of the centrifugal separation case 1. In the above arrangement, the separation efficiency can be improved and the discharge of the unseparated blood from the discharge nozzles can be prevented.

Thus the function of the communication pipe 14 will be explained below.

When the blood is injected into the centrifugal separation case through the injection nozzle 5 and the centrifugal separation case 1 rotates at high speed (about 3000 r.p.m. (600-1200G)), the plasma component having a small specific gravity is collected in the central portion of the case and the red blood component having a large specific gravity is collected in the periphery portion of the case by the centrifugal separation. And the collected red blood components at one side of the case moves to the other side of the case, passing through the communication pipe 14 and is discharged to the outside of the centrifugal separation case, passing through the red blood component discharge nozzle 6. The centrifugal separation performance is improved by employing the centrifugal separation case having a substantial rectangular solid, and since the both sides of the centrifugal separation case 1 are communicated with each other by the communication pipe 14, the desired blood component can be discharged from the centrifugal separation case by using the single discharge nozzle corresponding to each blood comoponent in the even case that the opening ports of the blood injection nozzle 5 and the blood component discharge nozzles 6-7 are positioned to be in opposide sides with respect to the rotational center.

(b) A metal tube 3 and a spring 2

The nozzle 5 for injecting the blood into the centrifugal separation case 1, and the nozzle 6-8 for discharging the separated blood components, as shown in Fig. 1, extend downward from the rotational center portion of the centrifugal separation case and thereafter, is rotatably held by the holder 76 provided on the twist-prevention table. When the centrifugal separation case rotates although in the apparatus shown in Fig. 1, the twist in the whole of pipe system (A-B-C-D) is not generated the twist may be temporally and partially generated in the portions of the pipe between A-B, B-C, and C-D. Therefore it is required to remove the partially generated twist to prevent the occurance of the twist in the tube. Especially, since the portion between A-B is curved and the speed of the centrifugal separation case is different from that of the twist-prevention table (on which a part of the tube is rotatably held), the twist in the portion between A-B may temporally be generated. The metal tube 3 is fixed to the tubes 15-18 and they, for example as shown in Fig. 4, are preferably fixed such that each tube are spaced from a rotational center 0 with the same distance and are disposed at a predetermined interval. The spring 2 is provided so as to surround the tubes 15-18 and one end of the spring 2 is fixed on the metal tube 3 and the other end is fixed on the centrifugal separation case. The metal tube is required to be rotatable to the holder 76 and therefore it is preferable that the holder 76 is a bearing and the metal tube 3 has a shape and the structure such that the metal tube 3 is fixed on an inner ring of the bearing of the holder 76. When the centrifugal separation case 1 does not rotates, the spring 3 is in the normal state. Thus, when the centrifugal separation case 1 starts rotating, although the twist temporally is generated in the portion of the tubes 15-18 between A-B, the twist also acts the spring 2 provided between the metal tube 3 and the centrifugal separation case 1. So, the spring 2 is twisted and the re-action of the spring 2 causes the twist generated between A-B to be positively removed so that the twist generated between A-B is removed before the twist affects the tubes. Although, in the above embodiment, the spring is provided only between A-B, also between the other portion, B-C, and C-D, the spring may be provided.

(c) A pipe protector 9, and a cover tube 12, a tube fixing bushing 11, and a cove tube protector 13.

The centrifugal power acts the portion of the tubes 15 to 18 between B-C-D. Therefore, it is not preferable to employ a twist removing mechanism having a large weight, such as the above metal tube or spring, to the portion between B-C-D. So, in the embodiment according to the present invention, the tube protector 9 is provided between B-C to increase the torsional strength of the tubes, and the cover tube 12 and tube fixing bushing 11 are provided between C-D for integrating the tubes 15-18 to increase the torsional strength of the tubes.

The number of the tube protector 9, an shown in Fig. 3, is basically two. The applicants, from an experiment, obtain the desired result in the case that the number of the tube protectors is between 1 to 20. The tubes 15-18 are arranged as shown in Fig. 4, that is to say, the arrangement is similar to that of the fixing of the tubes to the metal tube 3, and pass through the tube protector and fixed therein.

At least one of the tube protectors 9 may be substituted by the application of a chemically stable lubricant to the surface of said tube means.

Further, the fixing of the tubes 15-18 to the tube protector 9 is preferably performed under the condition that the parts of the centrifugal separation apparatus, such as the centrifugal separation case, the tubes etc. have been attached to the apparatus.

Next, since the tubes 15-18 are generally straight between C-D, the tubes 15-18 are inserted into the cover tube 12 and the cover tube 12 is rigidly fixed to the tubes 15-18 with the cover tube protector, in order to integrate the tubes. The cover tube 12 and the cover tube protector 13, may be made of vinyl-choride or silicon resin etc. Further it is preferable to provide a tube fixing-bushing 11 for integrally fixing the tubes in the introduction port of the cover tube 12 from which the tubes 15-18 are inserted. The material of the fixing bushing 11 may be the same as that of the cover tube protector 13. As explained above, since the tubes 15-18 are integrally fixed one another between B-C-D, the rigidity and the strength to the twist increase so that the destroy in the portion of the tubes can be prevented.

As explained above, between A-B the twist is positively removed and between B-C-D, the strength of the tubes increases and as the result, in the whole of the pipe system, the strength and the rigidity in the tubes increase so that the destroy of the tubes caused by the twist can be prevented.

Claims

1. A centrifugal separation case assembly for a continuous type centrifugal separation apparatus, comprising:
a centrifugal separation case;
a nozzle for injecting the blood into said centrifugal separation;
nozzle groups for discharging the blood components separated from said centrifugal separation case;
tube means connected to said nozzle and said nozzle group, liquid being injected into said centrifugal separation case through said tube means and liquid in said case being discharged therethrough; and
holder means for integrally holding said tube means extending from said centrifugal separation case, said integrally holding means being provided at plural positions in the system composed of said tube means.

2. An assembly according to claim 1, wherein said centrifugal separation case has a generally rectangular shape, a continuous communication tube connected to both sides of said centrifugal separation case, for communicating the both sides of said centrifugal separation case with each other, and said injection nozzle and said discharge nozzle group are provided at the opposite sides with respect to a rotational center of said centrifugal separation case.

3. An assembly according to claim 2 wherein at least one tube included in said nozzle group extends along a direction of the rotational center axis, and said centrifugal separation case is a single chamber.

4. An assembly according to any of claims 1 to 3, wherein said integrally holding means comprises metal tube means in the middle of the tube means connected to said nozzle group, and spring means provided between said metal tube means and said centrifugal separation case, and surrounding a part of said tube means, and both ends of said spring means respectively fixed on said metal tube means and said centrifugal separation case.

5. An assembly according to claim 4 wherein said integrally holding means further comprises at least one holding member for holding said tube means by the way of said tube means.

6. An assembly according to claim 5, wherein said integrally holding member is a tube having a predetermined length.

7. An assembly according to any of claims 4 to 6, wherein at least one of said integrally holding means is formed by the application of chemically stable lubricant to the surface of said tube means.

FIG. 1

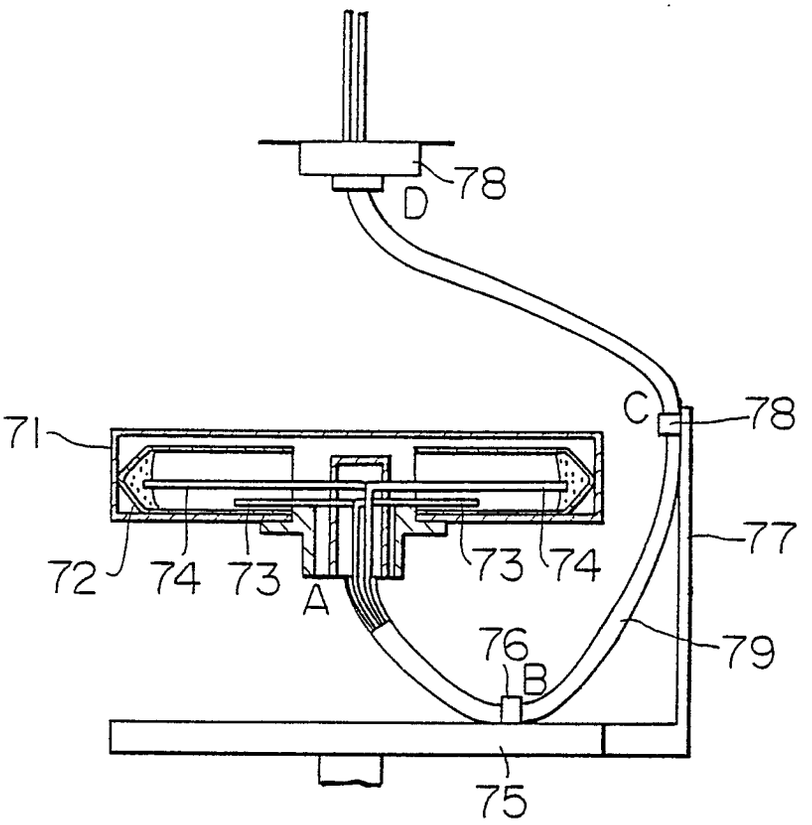

FIG. 2

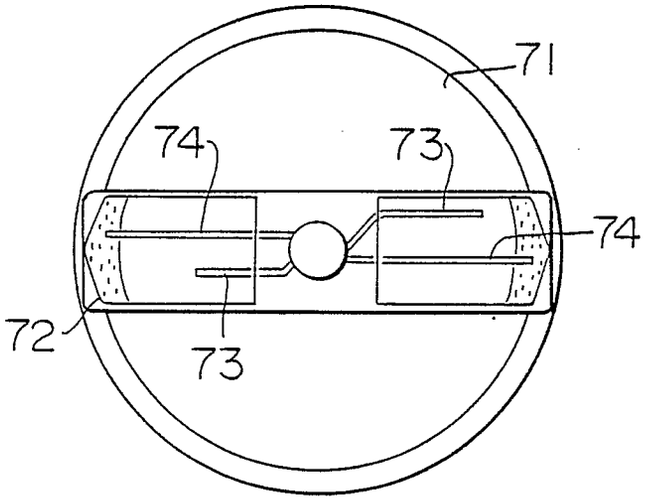

FIG. 3

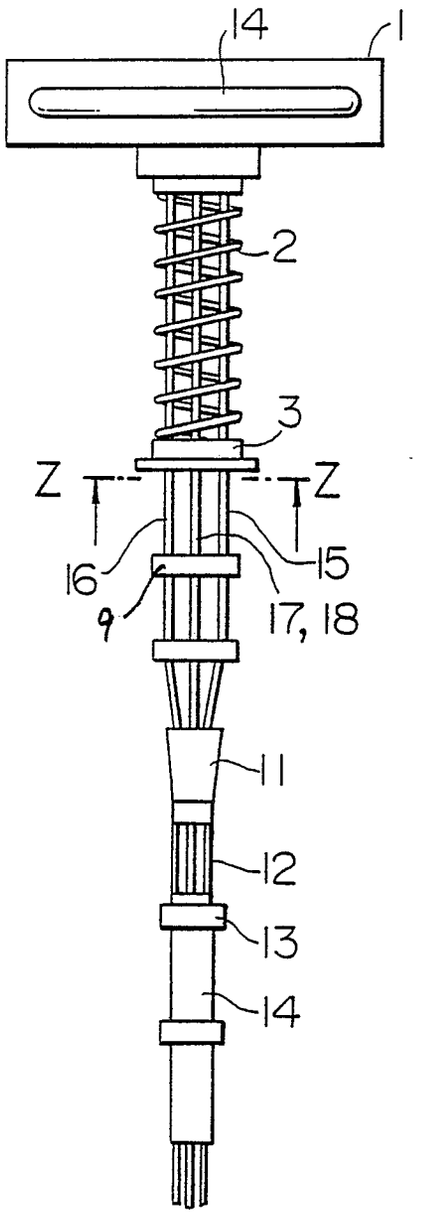

FIG. 4

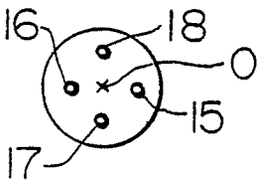

FIG. 5

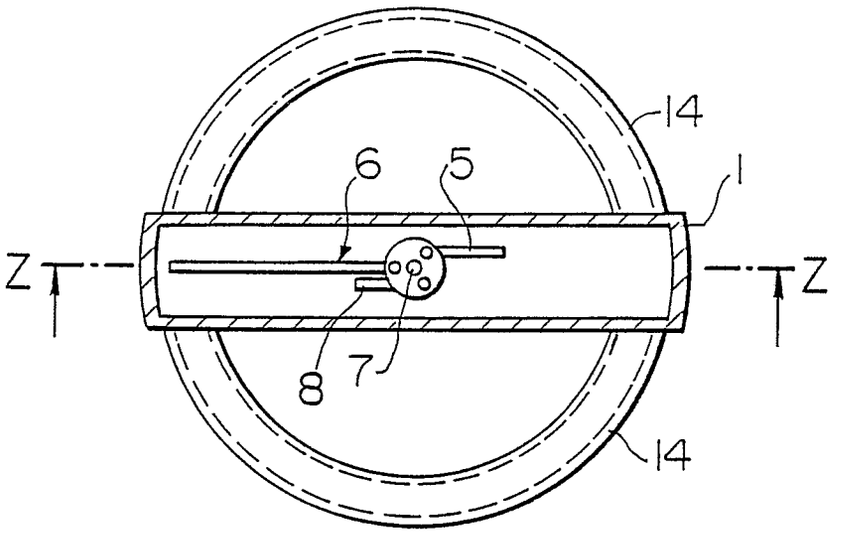

FIG. 6

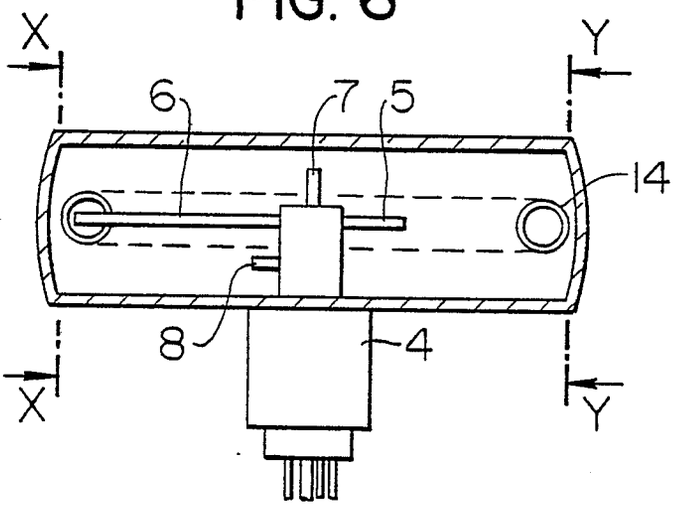

FIG. 7

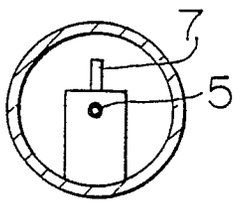

FIG. 8