July 8, 1958 J. M. JAMES 2,842,124

BLOOD TRANSFUSION SYSTEM

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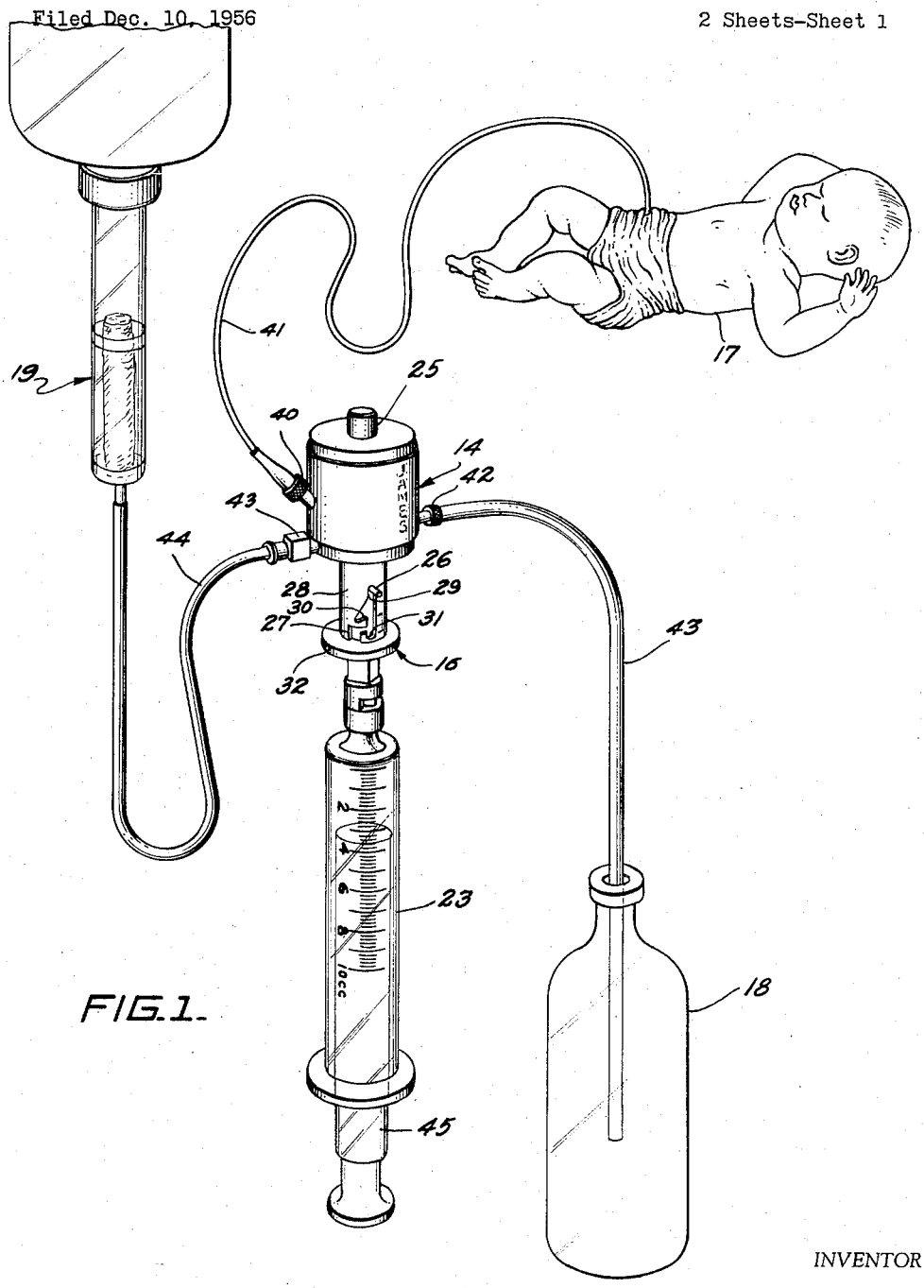


FIG. 1.

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FIG. 2

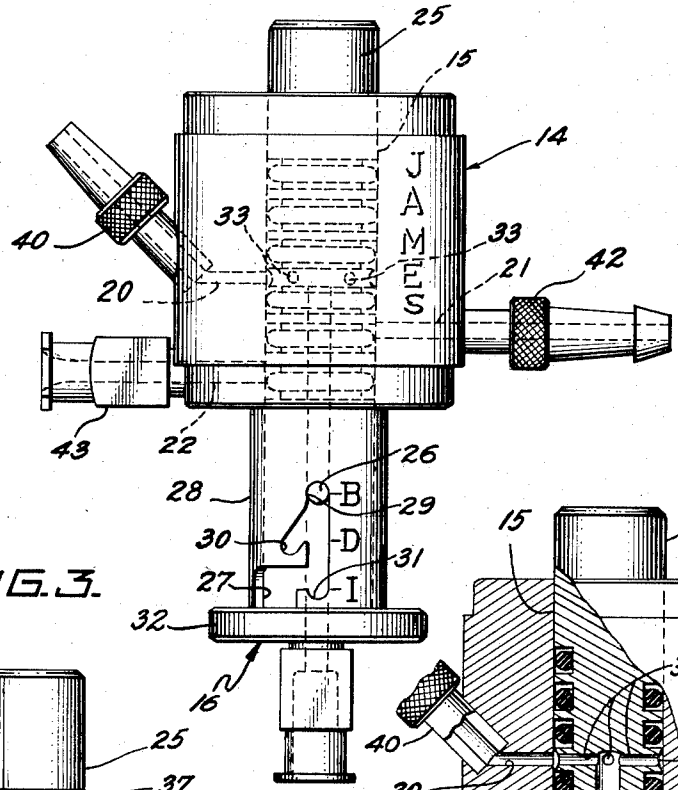
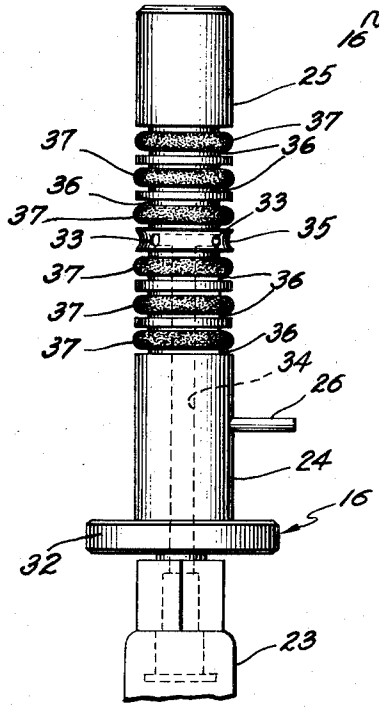



FIG. 3.



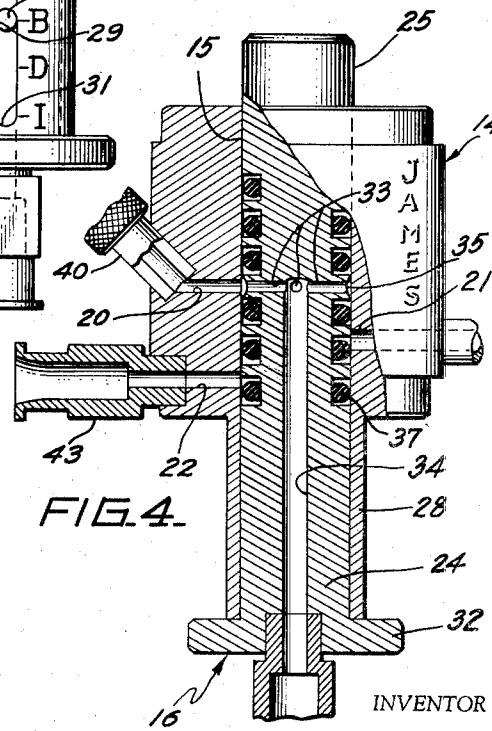




FIG. 4.

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2,842,124

# BLOOD TRANSFUSION SYSTEM

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3 Claims. (Cl. 128—214)

The purpose of my system is: (1) to simplify the mechanics of the therapy of *erythroblastosis fetalis*, (2) to reduce the morbidity and mortality inherent in the therapy, and (3) to render the sterilization and preparation of the necessary instruments less time consuming and less expensive.

*Erythroblastosis fetalis* is the result of the sensitization of an Rh negative mother to her Rh positive child inutero; that is, she forms an Rh antibody which finds its way into the blood stream and body fluids of her infant. This antibody causes the destruction of Rh positive red blood cells and results in the formation of Bilirubin, which is toxic to the newborn.

The basic concept of the therapy is fourfold. It consists, insofar as is possible, of the removal of Bilirubin, the removal of antibody, the removal of susceptible Rh positive red blood cells, and the replacement of these cells with non-susceptible Rh negative red blood cells.

Therapy consists of alternately removing small amounts of the infant's blood and replacing it with an equal amount of fresh Rh negative blood. After 40 or 50 such manipulations the blood volume of the infant is unchanged, but the Bilirubin, the antibody, and the susceptible Rh positive red blood cells are diluted to a tolerable concentration.

My system is designed to simplify the operation so that the operator may pay less attention to mechanics and pay more attention to the condition of his patient. My system does this in that there are only three fluid flow arrangements possible, as compared to nine possible combinations (only three of which are actually used) of the arrangement now generally used, known as the B–D system, which consists of two 3-way Becton-Dickens valves in series. My system also markedly reduces the very large and inefficient dead space of other systems generally used in the past and yet maintains equivalent simplicity.

My system is designed to prevent complications which result in increased morbidity and mortality. It is not possible with the new valve to connect the infant's vein to the donor blood supply nor is it possible to connect the vein to the discard receptacle. These two conditions are possible when using the systems known in the art and represent a very real danger. The danger is that if the infant is connected to the donor blood he will receive an unknown excess of blood, by way of gravity, or if connected to the discharge receptacle will lose an unknown amount of blood as the result of syphoning. Thus by an inadvertency in operation of prior art systems the infant's blood volume may be increased, resulting in congestive heart failure, or may be decreased, resulting in shock from blood loss, and the operator will have no good estimate of the deficit to make up or the excess to remove. In other words, when shock or congestive heart failure occurs, the operator is at a loss as to the amount of blood to give or remove to correct the danger.

My system prevents any inadvertent and uncontrolled



connection of the infant to the donor or to the discharge receptacle; the operator has the invaluable advantage of knowing that the only exchange of blood which can occur is when he causes same by operation of the syringe.

My invention also has the advantage of maintaining a system in which donor blood is not exposed to contamination by air as the result of continual changing of syringes, necessitated by the other commonly used arrangements.

This system comprises three conduit means which are connectible to the infant, a donor blood source, and a discharge receptacle. The other ends of the conduit means are connected to three separate passageways in a casing. A control assembly moves in the casing between three positions. The control assembly has a conduit system for conducting blood between a single passageway and a syringe. Means are provided for forming a sealed zone at the point of connection of the control assembly conduit system with a single passageway. Means are also provided for facilitating movement of the control assembly between the three passageways in a manner which prevents leakage and which aids the operator in safely conducting the transfusion.

The units of the system may be made out of various materials such as metals, plastics and the like.

Various other objects and meritorious features of the invention will be apparent from the following description taken in conjunction with the drawings wherein like numerals refer to like parts throughout the several figures and wherein:

Fig. 1 is a perspective view of my system for exchange blood transfusion;

Fig. 2 is a plan view of the central part of my system;

Fig. 3 is a plan view of the control assembly with a portion of the luer syringe being cut away; and

Fig. 4 is a plan view similar to that of Fig. 2 with a portion being cut away on a horizontal center plane.

As seen in Figs. 1–4, my invention includes a casing **14** which has a cylinder **15** in which is slidably mounted a control assembly **16** which may be positioned to enable the withdrawal of blood from a baby **17**, the discharge of the withdrawn blood into receptacle **18**, the withdrawal of donor blood from a donor blood bottle unit **19**, and injection of the donor blood into the baby.

The casing **14**, as seen in Figs. 2 and 4, has three passageways **20**, **21** and **22** from its outer surface to the wall of the cylinder, these passageways terminating at three longitudinally spaced positions on the wall of the cylinder **15** in accordance with predetermined design as will be further explained. The control assembly **16** comprises a luer syringe **23** at its outer end, a control device **24** at the intermediate portion, and a piston **25** at its inner end.

The luer syringe **3** is connected to the control device **24** by a suitable fitting of known design enabling simple and efficient connection and disconnection. The control device **24** includes a control pin **26** which operatively coacts with an open slot **27** in collar **28** to control the positioning of the piston **25** in the cylinder **15**. The collar **28** is preferably formed as an outward extension of the casing **14**. The open slot **27** at the outer end of the collar **28** extends longitudinally inwardly and is designed to provide three longitudinally spaced seats **29**, **30** and **31** for the control pin **26**. These seats **29**, **30** and **31** are spaced apart at predetermined longitudinal distances in conformity with the longitudinally spaced positions of the three passageways **20**, **21** and **22** at the cylinder wall **15**. The control device **24** also includes a ring **32** for facilitating hand movement of the control assembly **16**; this movement may also be accomplished by using the luer syringe **23** as a handle of the control assembly **16**.

In the preferred embodiment the cylinder **15** and piston **25** are round in cross section. The piston **25** has a transverse opening or transverse conduit **33** extending from its outer surface transversely inwardly and a longitudinal hole or longitudinal conduit **34** extending from the inner end of the transverse conduit **33** outwardly through the piston **25** and control device **24** to the syringe **23**. In the preferred embodiment shown, this longitudinal conduit **34** is centrally disposed in the piston **25**. A plurality of openings forming four transverse conduits **33** are provided in the piston **25** by drilling two holes completely through the piston **25** at right angles to each other. The four inner ends of the four transverse conduits **33** connect with the inner end of the longitudinal conduit **34**. The outer openings of the transverse conduits **33** lie in a single transverse plane normal to the longitudinal axis of the piston **25**. An annular transverse blood groove **35** is provided in the piston **25** in the same transverse plane as the four outer openings of the transverse conduits **33**, this blood groove **35** defining an annular channel for the flow of blood.

The piston **25** is also provided with sealing grooves **36** along its length on either side of the annular channel **35**, these grooves **36** being outer annular transverse grooves of suitable size for the receipt of O-rings **37** which sealingly engage the wall of the cylinder **15**. The longitudinal distance between a transverse conduit **33** and either closely adjacent O-ring **37** is less than the longitudinal distances at the cylinder wall **15** between adjacent passageways **20** and **21** or adjacent passageways **21** and **22** to provide a sealed zone around the selected passageway, such as passageway **20** as shown in Fig. 4. In this manner no interchange of blood can take place between the three passageways **20**, **21** and **22** unless the operator causes such interchange by moving the control assembly **16** from one position to another as indicated and controlled by the control pin **26** and pin seats **29**, **30** and **31**.

As seen in Figs. 1, 2 and 4, the casing **14** at the first passageway **20** is provided with a first fitting **40** over which is frictionally received an end of a flexible tube **41**; this tube **41** includes a polyethylene catheter (not shown) which canulizes the umbilical vein of the infant **17**. This provides a first conduit means whereby blood may be withdrawn from the baby, and a donor's blood may be delivered to the baby. A second conduit means is provided for discharging the baby's blood from the system into a container **18**, this including at second passageway **21** a second fitting **42** to which is connected a flexible tube **43** which conducts the blood to the container **18**. A third conduit means, connected to the third passageway **22**, is provided for withdrawing donor's blood from the donor blood bottle unit **19**, this including a third fitting **43** and tube **44**.

In operation, the polyethylene catheter on tube **41** is inserted into the infant's umbilical vein. With the control pin **26** in position marked "B" for baby, the plunger **45** of the luer syringe **23** is carefully pulled outwardly with a slight rotational action to withdraw 10 cc. (cubic centimeters) of blood from the baby into the syringe, the blood flowing through the first passageway **20** to the syringe. The control assembly **16** which includes the syringe **23** and piston **25** and control device **24** is then pulled longitudinally outwardly and rotated slightly to engage the control pin **26** in the second seat **30** identified as "D" for discharge in the collar **28**. The syringe plunger **45** is then pushed inwardly to cause discharge of the baby's blood through longitudinal conduit **34**, transverse conduits **33**, passageway **21** and through tube **43** into discharge receptacle **18**.

The control assembly **16** is then rotated back and moved outwardly until the control pin **26** seats in the third seat **31** identified as "I" for intake. This connects the syringe **23** through longitudinal conduit **34**, transverse conduits **33**, passageway **22** and tube **44** to the donor blood bottle unit **19**. Ten cc. of donor blood is then drawn into the syringe **23** by outward movement of the plunger **45**. The control assembly **16** is then moved longitudinally inwardly to seat control pin **26** at the first seat **29** identified by "B." This reestablishes the initial condition of the system, and the plunger **23** is moved inwardly to inject donor blood through transverse passageway **20** and tube **41** into the baby.

The process is then repeated about fifty times. The blood and plasma of the infant containing Bilirubin, Rh antibody 4 Rh positive red blood cells are thereby diluted approximately 80% with a blood and plasma containing no noxious substances.

It will be readily appreciated that this system accomplishes safely and effectively the required transfusion with equipment designed for easy and rapid disassembly. The parts of the system are effectively sterilized in standard sterilizers along with other surgical apparatus without special attention, this having been clearly established by actual use. Lubrication of moving surfaces is accomplished by applying the usual silicone lubricant used on other surgical instruments.

Various other modified forms of the invention will be apparent from the foregoing description and for that reason I wish to limit myself only within the scope of the appended claims.

I claim:

1. A system for blood exchange transfusion in infants having the disease of erythroblastosis comprising a casing having a cylinder therein and three passageways from the outer surface of said casing to longitudinally spaced positions on the wall of said cylinder, a control assembly slidably positioned for longitudinal movement in said cylinder, said control assembly having a syringe at its outer end, a control device intermediate its ends and a piston at its inner end positioned in said cylinder, said piston having an opening extending from its surface transversely inwardly and defining a transverse conduit, said piston and said control portion having a longitudinal hole defining a longitudinal conduit in fluid communication with said transverse conduit and said syringe, a control means mounted on said casing for operative coaction with said control device to connect selectively said syringe through said longitudinal conduit and said transverse conduit to one of said three passageways, said piston having spaced outer annular transverse grooves on opposite sides of and very near to said transverse conduit, O-rings positioned in said grooves and sealingly engaging the wall of said cylinder, the longitudinal distance between said transverse conduit and either closely adjacent O-ring being less than either longitudinal distance between adjacent passageways in the cylinder wall to provide a sealed zone around the selected passageway, first conduit means connected to one of said passageways for conducting a baby's blood from the baby and a donor's blood to the baby, second conduit means connected to the second of said passageways for discharging the baby's blood from the system, third conduit means connected to the third of said passageways for taking donor's blood into the system.

2. A system for blood exchange transfusion in infants having the disease of erythroblastosis as defined in claim 1 and wherein said piston has a plurality of openings forming a plurality of transverse conduits, the openings of the transverse conduits at the surface of said piston being in a single transverse plane, said piston having an annular transverse groove at said single transverse plane defining an annular channel.

3. A system for blood exchange transfusion in infants having the disease of erythroblastosis as defined in claim 1 and wherein said control device includes a control pin extending transversely outwardly from the intermediate portion of said control assembly and said control means comprises a collar connected to and extending longitudinally outwardly from said casing and sur-

rounding said intermediate portion of said control assembly, said collar having an open slot at its outer end extending longitudinally inwardly, said slot having three seats, said seats being longitudinally spaced in conformity with said longitudinally spaced positions of said three passageways to align said transverse conduit with the selected one of said three passageways when said control pin is positioned at a selected one of said three seats.



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