This invention relates to improvements in a direct blood transfusion apparatus, and the primary objects of the invention are to provide an apparatus which will enable a continuous flow of blood from a donor to a recipient by the use of multiple syringes and a four-way valve; which will permit the transfusion of blood to be given in one half the time that required with the apparatus now in general use; that will retain only a relatively small amount of "dormant" blood, (or none at all by one type of valve) and retain this amount only one half as long as the instruments now in general use; and which will allow a small amount of sodium citrate or other solution to be mixed with the blood, to make the clotting time just long enough to prevent coagulation while the blood is passing through the instrument.

A further object is to provide an instrument of this character, which may be readily dismantled to facilitate cleaning, transportation or storage.

Another object is to furnish an apparatus of this character, which is of simple and inexpensive construction, and which will last indefinitely without the necessity of replacing parts.

With the foregoing objects outlined and with other objects which will appear as the description proceeds, my invention consists in the novel features hereinafter described in detail, illustrated in the accompanying drawing, and more particularly pointed out in the appended claims.

Referring to the drawing,

Fig. 1 is a plan view of the apparatus partly in horizontal section, and showing the parts in the position in which one of the syringes is delivering blood to the recipient, through a valve plug having four parts.

Fig. 2 is a similar view but showing the parts in the position which they occupy when the syringe is delivering blood to the recipient.

Fig. 3 is a vertical sectional view on the line 3-3 of Fig. 2.

Fig. 4 is a sectional view of the needle valve.

The apparatus shown in the drawing comprises a base or plate 2, to which is attached a four-way valve 9.

The casing 3 of the valve has an upstanding annular wall 4 forming a tapered bore, and there are four radial passageways 5, 6, 7 and 8, extending horizontally through the wall and arranged at about 90 degrees relatively to one another. In the use of the apparatus, the passageway 5 is connected with the recipient, the passageway 6, with the donor, the passageway 7 with one syringe 16, and the passageway 8 with the other syringe 17, and each of these passageways may be provided with a projecting nipple.

A plug 9 is rotatably mounted in the tapered bore and its periphery is tapered to accord with the wall of the bore, and a spring 10 is mounted on the wall 4 and bears against the plug to urge the same into the bore. The spring 10 may be replaced by a coil spring 19 surrounding a projection 20 of the plug 9 and held in place and tension applied by set nut 21. A handle 11 is firmly secured to the plug to permit the same to be rotated.

As best shown in Figs. 1 and 2, the plug is provided with two curved ports 12 and 13, the ends of which are 90 degrees apart, so as to cooperate with the passageways of the casing, and the plug is also provided with crossed ports 14 and 15, whose ends are 90 degrees apart in order that they may register with the passageways of the casing when the plug is turned into the position shown in Fig. 2. At this time it will be noted that all of the ports of the plug are always out of communication.

When the parts are in the position shown in Fig. 1, the blood will be flowing from the donor through passageway 6, port 13 and passageway 8 to the right hand Luer syringe 16, and from the left hand Luer syringe 17, through passageway 7, port 12 and passageway 5 to the recipient. On the other hand, when the parts are in the position shown in Fig. 2, blood will be flowing from the donor through passageway 6, port 14 and passageway 7 to the syringe 17, and from syringe 16, through passageway 8, port 15 and passageway 5 to the recipient. To accomplish this result, and allow the blood to flow continuously, the pistons of the syringes are continuously reciprocated, but in the opposite directions.

It will be understood that the valve plug is to oscillate in unison with the strokes of the syringe pistons, and to facilitate the registration of the plug ports with the passageways of the casing, and to limit the movement of the plug, suitable stops are provided. Such means may include a recess cut in the upper portion of the casing 3, and having opposite abutments 18 engaging the handle 11.

To facilitate the addition of sodium citrate solution or the like to the blood while in transit, I arrange in the donor's pipe line, a valve structure 22 (Fig. 4) having a passageway 23 for the blood, and a port 24 for the introduction of the solution. This port 24 is controlled by a needle valve 25. The arrangement of the parts is such that where there is a short clothing of the donor's blood, that
is, less than three minutes, the needle valve 25 will allow as small amount of sodium citrate or other solution as is possible, to mix with the blood, to make the clotting time just long enough to prevent coagulation while the blood is passing through the instrument.

In operation the passageway 6 will be placed in communication with the donor, and the passageway 5 in communication with the recipient, and the valve plug 9 will be in the position shown in Fig. 1. Now, when the piston of syringe 16 moves outwardly to the position shown in Fig. 2, blood will be fed from the donor through passageway 6, port 13 and passageway 8, into the barrel of syringe 16, until the barrel is filled with blood. When the valve is shifted into the position shown in Fig. 2, and while the piston of syringe 16 is forcing blood from the syringe through passageway 8, port 15 and passageway 5 to the recipient, the piston of syringe 17 will be drawing blood from the donor through passageway 6, port 14 and passageway 7. Consequently, while the apparatus is in operation, blood will be continuously drawn from the donor and passed to the recipient. Furthermore, the structure is such that the only dormant blood during the transfusion will be that retained by ports of the valve plug, while those ports are not interposed in the lines through which the blood is flowing. However, as the apparatus will be operated continuously, it will be apparent that the dormant blood will only be retained in the ports for a short period of time, that is, the time period during which the blood is flowing through the other ports of the valve.

As to the advantages of the invention over the instruments now generally used, they may be summarized as follows:

1. A continuous flow of blood from donor to recipient.
2. The transfusion is given in half the time of a one-syringe instrument.
3. The amount of dormant blood in the ports 14, 15, or 12, 13, shown in Figs. 1 and 2, is less than two inches in length. Hence, there is only a very small amount that is liable to coagulate.
4. The amount of dormant blood in the one-syringe method is fifteen inches or more, depending on the length of the tubing connecting the syringe to the donor and to the recipient. Hence, there is not over one-fifteenth as much blood in my apparatus liable to coagulate, as shown in the valve of Figs. 1 and 2.
5. The dormant blood lies stagnant only half as long with the present instrument.
6. A simple means for changing the current of blood from one syringe to the other.
7. The syringes are of the Luer type in common use, hence new ones are quickly available in case of breakage.
8. The instrument can be employed for injecting any kind of fluid intravenously by connecting the passageway 6 to the container for the fluid that is to be injected.
9. The instrument can be readily sterilized, by boiling or other methods and this is facilitated by the use of removable parts.
10. A simple means for adding sodium citrate or other solution if necessary, in definite percentages, to the stream of blood, to prevent coagulation.
11. Few working parts to get out of order.

From the foregoing it is believed that the construction, operation and advantages of the invention may be readily understood by those skilled in the art, and I am aware that changes may be made in the details disclosed, without departing from the spirit of the invention, as expressed in the claims.

What I claim and desire to secure by Letters Patent is:

1. In an apparatus of the character described, a valve casing having an inlet passageway, an outlet passageway and a plurality of combined inlet and outlet passageways, syringe barrels in constant communication with said combined inlet and outlet passageways, pistons for said barrels, the pistons reciprocating in opposite directions by hand, and a valve plug cooperating with said casing and provided with two pairs of ports adapted when the plug is shifted, to alternately cooperate with said passageways for alternately placing said syringe in communication with said inlet passageway.

2. An apparatus as claimed in claim 1, in which the valve casing and plug have contacting frusto-conical surfaces.

3. An apparatus as claimed in claim 1, in which the plug is rotatably mounted in the valve casing, and is provided with means for yieldingly urging the plug into the casing.

4. An apparatus of the character described, comprising a base plate, a valve casing, said casing having four passageways spaced at 90 degrees relatively to one another, a rotatable plug detachably mounted in the casing and having two pairs of ports adapted when the plug is oscillated, to alternately place a pair of passageways in communication with the other pair of passageways, and syringes having barrels constantly communicating with a pair of said passageways.

5. In an apparatus of the character described, a base plate, a valve casing mounted on the base plate and having four passageways arranged at 90 degrees relatively to one another, a rotatable plug mounted in the casing and having a first pair of ports with their ends arranged at 90 degrees relatively to one another, said plug having a second pair of ports with their ends arranged at 90 degrees relatively to one another but spaced 45 degrees from the ends of the first pair of ports, all of the ports cooperating with said passageways, syringe barrels communicating with a pair of said passageways, and pistons reciprocating in said barrels, simultaneously in opposite directions by hand.

SINDEE MEEKER.