DE LA TRANSFUSION DU SANG

By: Dr LOUIS JULLIEN (1875)

A TRANSLATION OF PAGES 252-287 OF THIS BOOK BY PHIL LEAROYD

'DES PROCÉDÉS ET DES INSTRUMENTS' (Processes and Instruments)

A copy of the book 'Blood Transfusion' by Louis Jullien, published in Paris [by J.B. Balliere] can be viewed of downloaded from the following sites:

https://wellcomecollection.org/works/bvcssjmd

https://books.google.co.uk/books/about/De_la_transfusion_du_sang.html?id=uv0nHAu-86sC&redir_esc=y

NOTE: I have also translated the 'Historical Section' of this book (pages 1-46) into English – see separate document.

This 329 page book does contain a 'Table of Contents' but it has been added at the end of book on a page that does not even have a number. I have however reproduced this and included it before the translation to give an idea of what topics are covered within the book. The chapter 'Processes and Instruments', like others, does not contain any references immediately related to the text. Instead, in his introduction, the author requests that the reader consult the extensive bibliography (pages 311-329) at the end of the book as the source of any additional information they may require. I have included a copy of this extensive bibliography (as printed) after the translation.

With regard to describing different types of transfusion equipment designed and marketed by physicians and equipment makers, this chapter is similar to that included in three other books of the same period, i.e. by Ladislao von Belina-Swiontkowski (1869), Joseph Roussel (1876) and Pierre Cyprien Oré (1876). In fact, some of the wording and terminology used by Jullien is very similar (sometimes identical) to that used by Oré in his book, published a year later.

Jullien starts the chapter by identifying the 'ideal' requirement of using as little instrumentation to achieve a blood transfusion as possible, thereby reducing the possibility of initiating coagulation of the donor blood or of infusing air into the patient's veins. He recognises that the best way of achieving this is to use a direct or immediate technique and then goes on to describe some of the devices used to achieve this, including those produced by Oré, giving a good explanation of why he modified his early equipment. He discusses the use of the 'vulgar syringe' as one of the simplest methods of direct transfusion, arguing that it should be used to both collect the blood directly from the donor's vein as well as to inject the blood into the patient's vein, and not as an intermediate transfusion device where the donor blood is first collected into a vessel.

In utilising this argument he discusses the problems of contact activation of the donor blood by a foreign surface in indirect techniques resulting in coagulation, commenting on the belief popular at that time that this can be affected both by temperature (i.e. the need to keep the blood warm) and the time that the donor blood is in contact with a foreign surface.

The author is selective in providing illustrations of some devices that results in somewhat confusing and complex descriptions of some of the items of transfusion equipment, for example those produced by Roussel, Bougard and Sotteau. The author does however benefit from the fact that unlike other authors he is not 'promoting' his own transfusion equipment and as such appears to provide a more balanced critique of some of the devises presented, especially those of Belina, Mathieu and Collin.

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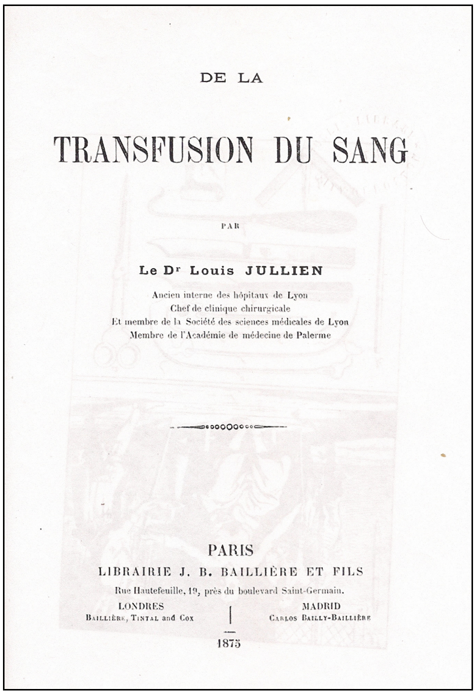
I have translated this section of Louis Jullien's book from the original French into English in the hope that the content may be appreciated by a wider audience. Whilst

I am obviously aware that instantaneous computer-generated translation is possible, this process struggles with specialist terminology and also produces a ‘colloquial style’ not always representative of the original text. I have purposely produced this translation to be ‘un-interpreted’, in that I wanted to maintain the author’s original meaning / wording as much as possible. As with any translation the wording may be purposely or inadvertently altered to ‘make it read better’ but in doing so there has to be an element of personal interpretation involving something on the lines of ‘I believe that this is what the author is actually trying to say’. I wanted to avoid that as much as possible and try to present what the author actually wrote and as such the reader may find that the English text does not ‘flow’ as well as it could.

Although I have taken great care not to misrepresent the author’s original wording I cannot guarantee that this work does not contain ‘translational errors’ and the reader is recommended to check specific details against the original French text. I have in a small number of places included words or comments in square brackets to explain a particular term or word used by the author.

LOUIS JULLIEN – BIOGRAPHICAL INFORMATION

Remarkably little has been published about the life of Dr Louis Jullien. He was born in Lyon on the 19th August 1850 and graduated as a Doctor of Medicine in 1873. He became an Associate Professor in Nancy in 1875 and was the surgeon at Saint-Lazare prison for women in Paris. A became a specialist in venereal disease and was the author of numerous publications on the subject of sexually transmissible diseases and associated subjects. He died in Paris on the 21st December 1913.


DE LA

TRANSFUSION DU SANG

PAR

Le Dr Louis JULLIEN

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1875

Title page of De la Transfusion du Sang (1875)
(Image credit: Wellcome Collection)

Dr Louis Jullien (1850-1913)
(Image credit: Wikimedia Commons)

PROCESSES AND INSTRUMENTS

The complete description of all the instruments which have been proposed for the practice of transfusion would go far beyond the limits of this work, we do not pretend to undertake it; we will limit ourselves to indicating the general principles that presided over their construction and the advantage that can be drawn from them depending on the circumstances.

And first, let's say it immediately, the ideal of transfusion would be to pass the blood directly from one vessel to another, interposing as few instruments as possible. Attempts have been made to achieve this in direct or immediate transfusion. Collecting the blood and carrying it in the transfusion vessel through a greater or lesser number of devices, but without removing it from contact with air, constitutes the indirect or mediated transfusion process.

§ 1. DIRECT TRANSFUSION

The simplest of all the devices intended for direct transfusion is undoubtedly the tube armed with two cannulas. Historically, experimenters have resorted to it, and we have related how King and Lower fitted [quill] pen pipes end to end to form the direct channel between the two vascular openings. But this device, I need not point out, rude in its construction, irregular in its operation, having all the disadvantage of representing a rigid tube, had to undergo modifications. I will proceed from simple to compound.

The simple rubber tube, the tube as Parinaud used it in the case he was kind enough to communicate to me, offers the great advantage of presenting in the greater part of its extent a polished surface and approaching by its diameter, as well as by its physical properties, of the interior conformation of the vessels. This consideration is not indifferent, if one remembers that Glénard deduced from his experiments that the foreign body, the exclusive provocateur of coagulation, "is all the more effective that by its physical structure, it moves further away from that of the vascular walls." At the most, we would reproach this very simple apparatus with the addition, in its middle, of a glass tube whose presence inside the light there determines an irregularity liable to cause the deposition of fibrinous coagulum. The manual is very simple. The vein of the transfusant [sic] is opened by means of a trocar, after prior preparation of the arm as for bleeding. A similar trocar being introduced into the vein of the patient, and the blood having shown itself at the opening of each of the cannulas of these trocars, it suffices only to unite these two orifices by the tube made as short as possible, beginning the fix at first on the side from which the current leaves so that a first jet of blood sweeps all the air trapped in the tubular cavity.

However, there is one point on which we should insist. I am talking about the introduction of these cannulas. Most often, the sleeve of the trocar forms, half a centimetre from the tip of the latter, a circular rim, which is very inconvenient when the puncture is performed. This inconvenience has not escaped Mr. Nicaise during the transfusion that he has practiced, and it is to this stop that he believes he ought to attribute the accidental injection of blood into the cellular tissue. The surgeon will therefore now have to use a trocar similar to that of the Dieulafoy devices. Once this trocar has been placed in the vein, it will be easy to introduce a blunt mandrel extending beyond it, which allows the instrument to be pushed and to be inserted to a certain depth; after which the mandrel will be withdrawn and the injection will be carried out easily, without having to fear extravasates and thrombi.

To the rubber tube is attached another successful combination, I mean the possibility of interrupting the current at will, by a simple pressure on the walls of the tube, much greater certainly than the interposition of taps, as in the apparatus of Oré. It is not moreover, the only improvement that has been introduced into this apparatus whose simplicity, at the beginning, tempted all those who were concerned with this question: Moncoq, Oré and Mathieu.

Oré and Mathieu tried to call the force of suction to their aid, to precipitate the blood flow.

Oré's device consists of a rubber bulge, from which three tubes terminate with copper taps with valves. Both taps end in tapered cannulas. One is joined to a rubber tube, which at its other end offers a glass tube. The latter, being placed in the mouth, served to create a vacuum in the device, by suction. It was moreover, once the cannulas arranged as has been said previously, to serve, as a result of repeated aspirations, to bring the blood more quickly into the bulb, which, seized with the hand, could be more quickly emptied using compression.

"From the first application," says Oré, "I soon realized that this device was inconvenient. The blood was indeed getting into the bulb faster, but once there, the suction continuing, the liquid went up into the aspiration tube and flowed badly through the pipe. I understood that this aspirator tube was placed too far from the point where the blood should come out. I had to modify it. In the new device, I placed the aspirator tube near the cannula that enters the vein of the animal I wanted to transfuse. It allowed me to create a vacuum, therefore to call the blood, and to accelerate its movement. It offered me serious advantages, but nevertheless it still did not realize my hopes; I have therefore replaced it with the following apparatus, which has worked in almost all my experiments, and which has given me very fine results.

"This device consists of a rubber pouch, ovoid in shape and with walls strong enough to prevent it from sagging under atmospheric pressure. On each side of this pouch fit two metal parts, screwed one on the other and separated by a valve. One of the valves opens from outside to inside; the other opens from inside out, so that the liquid, arriving in the apparatus by a tube, lifts the first, fills the pocket and passes into the other tube by lifting the second valve. From this, it is easy to imagine that the two valves act in opposite directions.

From the two metal pieces that support the valves, starts a rubber tube terminated by a copper tap and a cannula. Here is the manual for this instrument:

After having opened one of the taps, we close the other and we press on the pouch so as to expel through the tube all the air it contains, which is prevented from returning to the device by immediately closing a tap. Then the cannula is placed in the vein of the animal which is to supply the blood. With the tap open, blood rushes into the pouch, which it fills. The pressure exerted on it causes it to flow into the tube terminated by a cannula introduced into the vein of the subject on whom the transfusion is performed; the valve on the opposite side rises to let the blood in, but the pressure exerted on the rubber pouch is sufficient to close this valve and allow it to oppose the return of the liquid."

Next to this device let us place the one that Mr. Mathieu built in 1853 and whose figure opposite sufficiently explains the mechanism and functions.

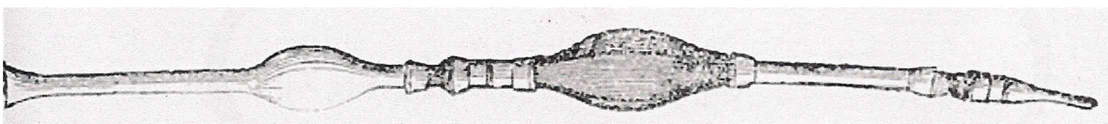

Fig. 1

We could make two criticisms of these instruments: (1) of not providing information on the quantity of blood injected; (2) not to keep absolutely safe from the mixing of air with blood. I am well aware that the first of these objections can be answered by weighing the patients, but whatever Mr. Collin (d'Alfort) may have said, this process is not practical. Here are the changes made to the first devices in order to remove these imperfections.

Professor Robin presented to the Académie des Sciences, in 1867, an instrument designed by Dr. Roussel (of Geneva), and manufactured by Messrs. Robert and Collin.

This instrument is based on two new ideas: 1) surround the blood sample with a sleeve that is empty of air and impermeable to air; 2) bleeding under water, expelling the blood in a channel full of water and empty of air, directly and hermetically connecting the vein that gives to the recipient.

This instrument contains several new and important parts which are: 1) The annular external suction cup, and the blood sample, brought into play by a continuous-action pump, and traversed by a tube bringing water inside the instrument, the spring lancet and cursor adjusting its course, mobile to be directed against the vein hidden in the instrument, and making the bleeding in the water, sheltered from any contact with the air; 2) the flexible, passive pouch, terminated by a metal ring, fitting frictionally to the suction cup, forming a reservoir (like the atrium of the heart) for the blood supplied by the vein; 3) the active pump, sucking and pressing, simulating the heart ventricle (taken with the Maisonneuve instrument); 4) the flexible bag, net, passive and active, making the stream of transfused blood regular, as is regular and continuous the venous current which is to receive it; 5) the dropper, through the tube from which the water fills the transfusion unit and expels the air from it before bleeding, with which again the surgeon can introduce a medicinal liquid into the blood stream.

This apparatus did not have all the success to which it was entitled in France; the complication of its mechanism is undoubtedly not foreign, but according to its author it is unanimously adopted in Germany and in Russia.

A commission appointed to compare and judge the various devices, after numerous operations and experiments, presented on 19th January 1874, a report signed Neudorfer, declared “that the Roussel transfuser achieved the ideal of a practical device for the direct transfusion of blood, and that it must be seriously introduced into the arsenal of military surgery.”

Finally, very recently, Mr. de Kosloff, medical director of the Russian army, called for a competition of all the methods and all the transfusion devices, all of which were experienced and comparatively judged; competition in which Gesellius, Heyfelder, Rautenberg, Korgeniewsky, Krassowsky, Kadé, Eichwald, Busch, Benezet, Froben, Pélikan, Rieter, Pilz, Hirch, Roussel and many others, already familiar with transfusion, worked.

Roussel’s transfuser emerged victorious from the fight.

Another device intended to prevent the introduction of air, and at the same time to give the exact measure of the quantity of blood injected, is that which Mr. Collin built in 1874, on the indications of Noel. It was presented to the Academy of Medicine by Mr. Broca on 13th July 1874 (Fig. 2).

I will only say two words about the construction and operation of this device. It is a sort of suction and pressure pump, represented by a rubber tube making a complete turn inside a metal cylinder. A roller set in motion by a crank flattens this tube and determines both the suction and the discharge, at the same time as a counter device indicates the quantity of liquid set in motion.

This apparatus, very ingenious to be sure, has not yet been used, but appears called we believe, to render more serviceable to hydraulics than to surgery.

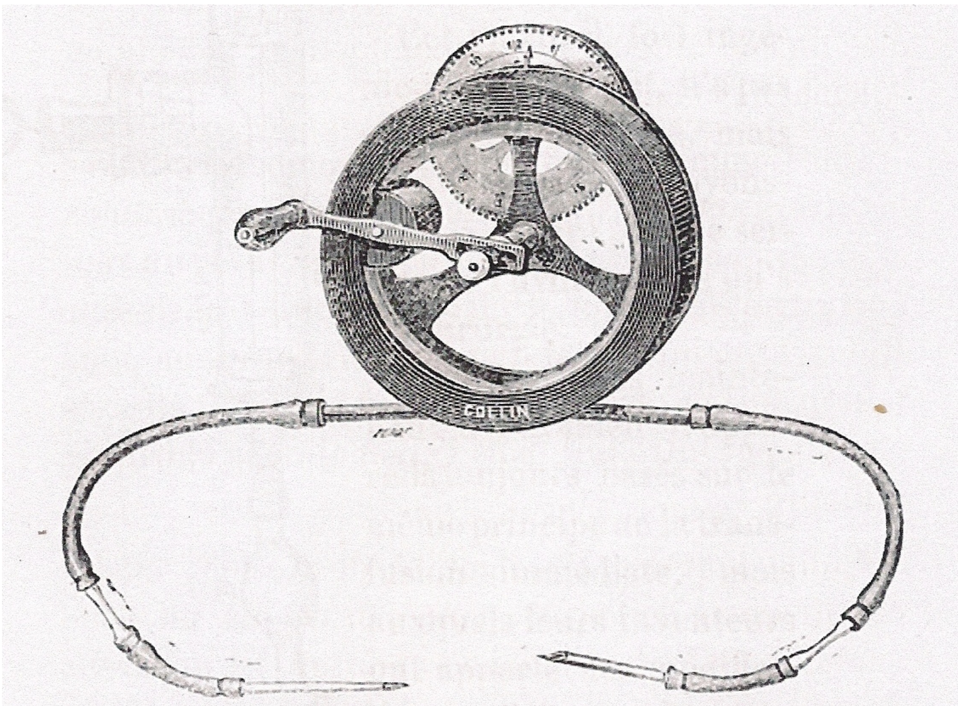

Fig. 2

We now come to the examination of devices still based on the same principle of immediate transfusion, but to which their inventors have made modifications such that the blood, to go from one vessel to another, passes through a series of containers of various volumes and substances.

The oldest of all these devices, which today has little more than historical value, belongs to Mr. Mathieu, who, as early as 1853, had taken the question of transfusion to heart, and each year presented to the public new improvements (Fig. 3).

The principle is easily understood: a pump body, adapted perpendicularly on the middle of a glass tube, is used to practice suction on one side, and discharge on the other. The glass tube is itself contained in a large sleeve which is filled with hot water.

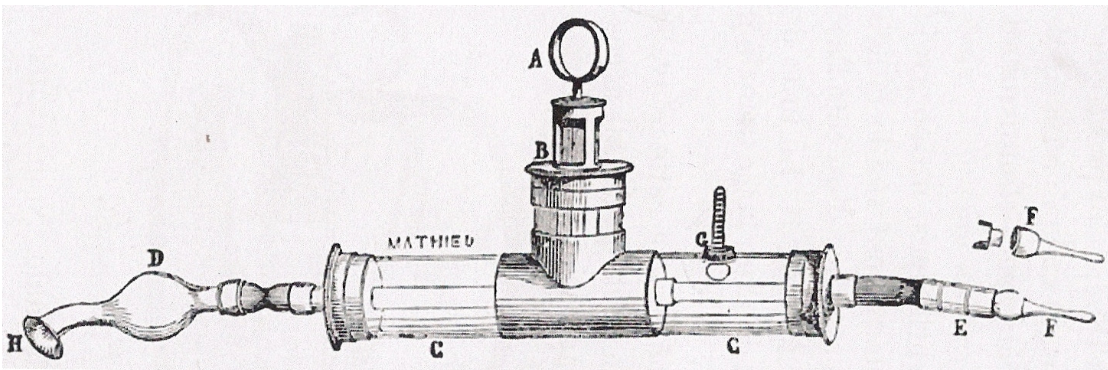

Fig. 3

At the time when Mr. Mathieu found this new modification, it was believed, in fact, that it was necessary, in order to obviate coagulation, to maintain the blood at normal temperature. We have seen what change has taken place in ideas since Oré's experiences.

We will compare Mathieu's transfuser with the one presented more recently by Mr. Collin (Fig. 4). We will be forgiven for not dwelling on the details of the mechanism, very ingenious, that the skilful builder has lavished there. My readers will easily understand how it works, thanks to the attached drawing.

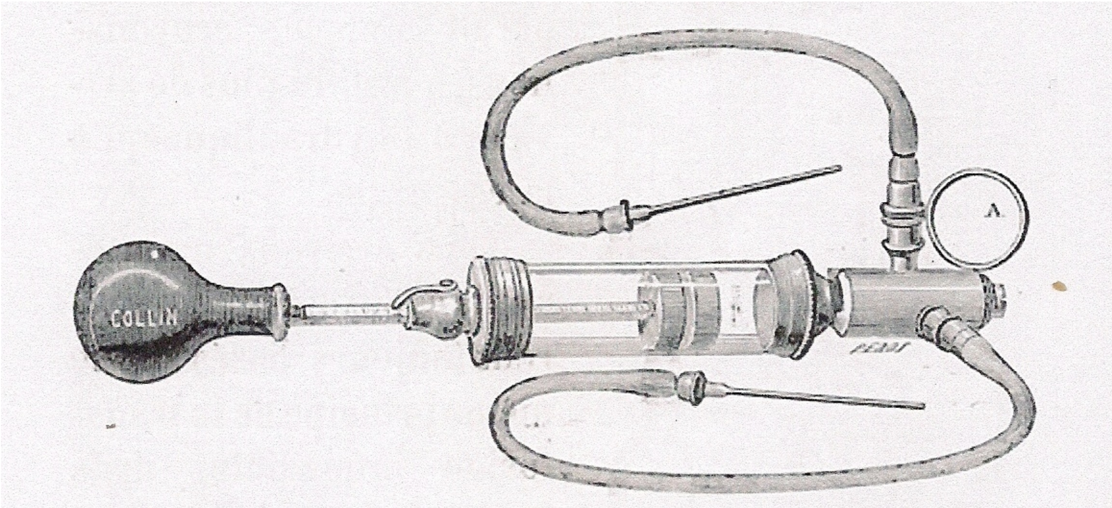

Fig. 4

In 1862, Mr. Moncoq's hematophore appeared (Fig. 5).

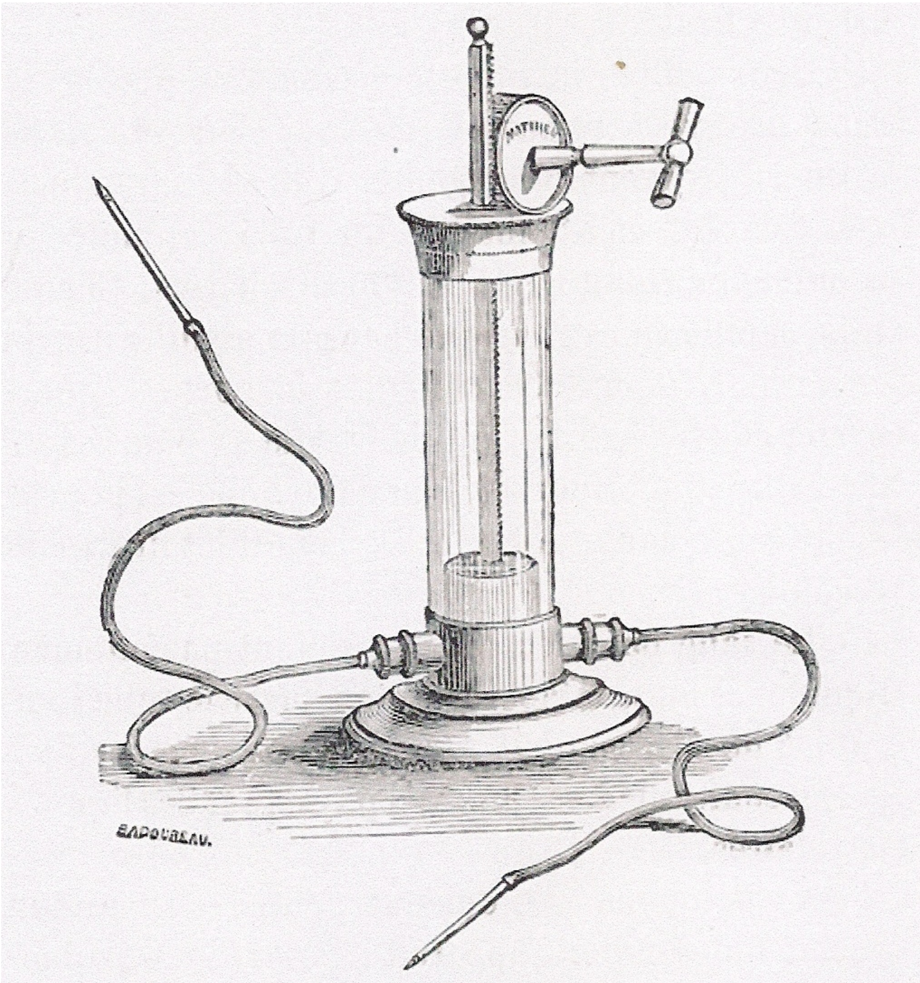

Fig. 5

The author describes it in these terms:

"The theory of this device is entirely physical, and it seemed to me, from the beginning, all the more perfect as it is simpler: the middle part of this intermediate circulating instrument is a small graduated glass cylinder, playing the role of an artificial ventricle, in which a full piston forms the systole and the diastole, by its reciprocating movements of rise and fall; you can graduate the piston rod, instead of graduating the glass, which is easier.

Two very sensitive small valves, placed in the opposite direction to the lower part of the artificial ventricle, serve to direct the blood flow. A rubber capillary tube ends at these valves, 15 to 20 centimetres long. Each capillary tube is terminated by a curved silver needle, a channelled needle on its convex part, at 15 millimetres from its point, an opening that ends the channel with which it is pierced; the complete device is supplied with spare straight needles.

The blood in the vessels being perfectly liquid, if its instant contact with the unorganized tube did not coagulate it, should flow through the apparatus according to the physical laws of ordinary liquids."

Now this is how, in the author's mind, the device should function: given two animals immobilized for the transfusion, we prick with the needle the vein of the animal that is to receive the blood, so that the opening of the canal which it carries on its convex face, after having crossed the vein at two points, comes out, the point of the needle directed towards the side of the heart.

With the second needle, we prick the vein of the animal that is to give blood in the same way, with the difference that the opening of the needle is in the very centre of the vein and plunges into the blood stream, the tip directed from the side opposite to the heart.

The two needles being thus arranged, if one makes the diastole in the glass cylinder by raising the piston, the first effect of the vacuum that one produces is to open from outside inwards the valve, which is pressed first by a few air bubbles contained in the tube, and immediately by the rushing blood.

If we then do the systole by lowering the plunger, we expel the blood and the air from the ventricle, and everything comes out through the opening of the second needle. From then on all the air is expelled from the apparatus, and by bringing the opening of this second needle back to the centre of the vein which is to receive the blood, the current is established, and it only remains to activate the ventricle, each systole of which drives out a flood of blood is proportional to the movement imparted to the piston, a flood of blood that can be evaluated by the graduation in grams of the glass cylinder.

As we have just studied, this instrument constituted a great progress, it was stable, portable and very easy to handle; but it has the disadvantage common to most of those based on the principle of direct transfusion, it required the introduction of a cannula into the vein of the transfusing subject.

"Now, as early as 1863, after my various experiments in animals," says Mr. Moncoq, "I understood that the previous apparatus had to be modified for the transfusion of blood in humans, the goal of my research. I had learned that the operations carried out on veins required certain precautions in order not to expose to phlebitis.

"I understood therefore that any man would easily give a little blood to save another man, but that it was necessary to remove all danger from the generous man willing to make this sacrifice. In an animal, one can without inconvenience for a physiological experiment, insert a fine channelled needle in the vein that is to give blood. But in healthy men, apart from the fact that this operation would be painful, it would not be without danger, it would expose to phlebitis."

We will see, in the next chapter, how Mr. Moncoq succeeded in overcoming this difficulty.

§ 2 – MEDIATE TRANSFUSION

The simplest of all the devices intended to practice indirect transfusion is undoubtedly that of Casse, of which the following description is made.

This apparatus is extremely simple; it consists of an elongated cylindrical glass container, 30 centimetres long, with a diameter of about 3 centimetres, and graduated. At each of its ends, a piece of glass tube 3 centimetres long is welded; the top one is intended to receive a funnel, through which we pour the blood to be transfused; the lower one, narrower, engages in a rubber tube, terminated by a nozzle provided with a trocar cannula, intended to penetrate into the vein.

A further nozzle welded at an acute angle to the cannula is attached to the lower end of the rubber tube terminating, at its other end, in the lower tube of the main container. When the trocar is in the vein, the mandrel is withdrawn beyond the point of insertion of the oblique nozzle; the part of the cannula situated in front of this point then becomes free and communication is established between the receptacle containing the blood to be introduced and the vein of the transfused person.

If you want to stop the transfusion, you just have to move the trocar forward to interrupt communication. If, on the contrary, one wishes to make it more active, one has only to raise the apparatus, so as to stretch the rubber hose vertically and thus increase the height of the pressure column. With this device, the blood is no longer injected, but passes into the vein of the transfused, merging, so to speak, with the proper circulation, without jerking or strain of any kind.

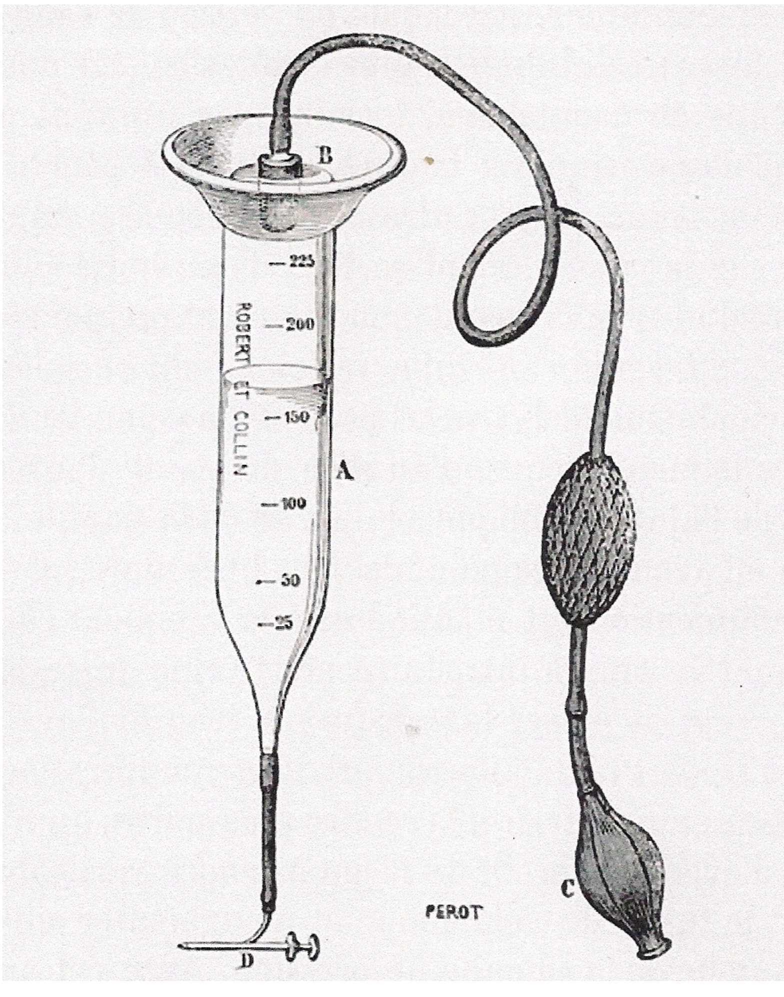

Fig. 6

Belina's apparatus (Fig. 6) consists of: 1) an inverted cylindrical flask *A*, 20 centimetres high and 5 centimetres in diameter. This flask ends at the bottom with a neck 4 millimetres in diameter. At the top, built into the shape of a funnel, is the hole, *B*, 1 centimetre in diameter. This flask can hold 225 grams from zero to 225 degrees; above 225 degrees, a chamber remains that will contain air; 2) a compressed air pump *C*, made up of two rubber balloons joined together, and terminating in a hose also made of rubber (this pump is constructed in the same way as the Richardson local anaesthesia machine); 3) a trocar *D*, made up of two silver tubes and a stylet. The first pipe, two centimetres long, discharges almost at a right angle, with a slight inclination, into the other pipe, 5 centimetres long; the diameter of the two pipes is approximately 2 millimetres. The stylet, fitted with a small button-shaped handle, fits smoothly with the hose. The tip, triangular in shape, protrudes 5 millimetres from the opening of said pipe. At the orifice of the trocar there is a spring that relaxes when the stylet is withdrawn into a groove on the shaft thereof, and in this way prevents it from being withdrawn further.

The three parts fit together as follows: the hole, *B*, is filled by a perforated rubber stopper, which itself contains an ivory cannula protruding outward in the form of a button. This button is covered with thick gauze, folded in half, to stop dust and organic germs suspended in the air. This button fits the end of the pump's rubber hose.

The neck of the flask is joined with the trocar tube terminated in a button by a black rubber tube, 12 centimetres long by 4 centimetres in diameter.

In order to avoid too great a variation in the temperature of the blood, especially if one is obliged to inject very slowly, the vial may be provided with a woollen cover; a notch has been made there that allows the quantity of blood supplied to the patient to be seen on the metric scale engraved on the flask.

What results did Mr. Belina obtain with his device? It is rather difficult to get a fair idea of it, since, if Mr. Belina believed to prove that all the patients operated on by a procedure other than his own are dead, his adversaries have endeavoured to demonstrate that the successes cited by this surgeon occurred despite his intervention.

The principle of the syringe must seem easily applicable to the operation which concerns us. Many have sought in fact by modifications and number of additional pieces to make it suitable for transfusion. But, before reviewing their attempts, it seems interesting to us to show what can be done with the vulgar instrument that every doctor has in his hands. I give the floor here to Mr. Desgranges, whose fortunate boldness we have reported above:

“The syringe, by its cylindrical shape, has smaller walls than another vessel of the same capacity; by its depth, it leaves the blood in contact with the air only over a small area; and as soon as the piston is placed and the interior air expelled, the blood is perfectly isolated from the atmosphere.

The small volume of the instrument, the ease of immersing it in a vase of hot water, wrapping it in compresses that retain heat, everything contributes to maintaining a good temperature. If we reflect that the average blood level in humans is +36°C., we can establish in principle that the instrument needs a temperature of +40°C., in order to lose inevitable caloric during the operation.

The syringe would lose many of these advantages if the direct blood collection was neglected. We strictly forbid the use of an intermediate vessel. What is the use of resorting to it when we want to inject pure blood, and we have already said that this method alone deserves to be preserved. The intermediate vessel not only complicates the operation by the necessity and the embarrassment of keeping it heated; it also increases the extent of the relations between blood and inert walls.

Finally, the shallowness of this vessel and its large surface promote the action of air on the blood and, very harmful thing, the coagulation of fibrin. As long as there is nothing to prevent blood from directly entering the syringe, why not do it? Why extend the distance to be covered? Why do circuits when you can walk straight?

In summary then, we say that it is easy to receive the blood directly into the syringe; that obviously by this process the points of contact between the blood and metallic bodies are reduced; that the harmful action of the air is smeared almost to nothing, and the chances of fibrin coagulation diminished as much as possible."

Mr. Sotteau devised a very ingenious apparatus so arranged that the reservoir intended to collect the blood is surrounded by hot water; a pump body placed in the middle of the reservoir serves to inject blood into the veins.

Another older device, dating back to Blundell, transmits blood from one subject to another even more directly. It consists of an elastic rod, fitted with a reservoir with a tap at one end, and a cannula curved at right angles, also fitted with a tap at the other. The reservoir is provided with a clamp or a screw intended to fix it to a chair placed on the bed, the cannula is screwed on a bracelet placed on the patient's arm.

"Mr. Sotteau's apparatus," says Mr. Desgranges, "which is only Mr. Blundell's modified device, is composed of two concentric reservoirs; the outside contains hot water, the interior is equipped with a small pump that must suck the blood accumulated in this reservoir and push it into the venous system. To preserve the blood from contact with the air in the inner reservoir, Mr. Sotteau imagined placing a cork washer there, through which the vertical pump passed, so that there was a kind of cover which rises as the blood collects. The blood arrives in the reservoir by a small pipe whose free end, flared in a funnel, must be applied on the bleeding; it leaves it by another duct adjoining, on one side, to the pump body, free by the other end, which can be adjusted to a cannula previously inserted into the vein. When the inner reservoir contains enough blood, the pump is started; but the tube is not fitted to the cannula until after having expelled all the air from the system and having seen the blood coming out. Let us add that two valves movable in opposite directions give the blood free access from the reservoir to the pump, from the pump to the last duct, but oppose a retrograde course."

"Mr. Sotteau, when he described his apparatus, had not yet tried it, since he cites no facts and only suggests it on the occasion of the transfusion performed by Mr. Lane. Well, thus constructed, this apparatus does not have all the advantages that its author believes; in fact, it has all the disadvantages of Blundell's. The flared portion of the tube cannot be applied directly to the bleeding; there is a reason against it. The compression that this funnel would exert on the vein, between the capillaries and the bleeding, would be sufficient beyond that to stop the flow of blood, it would have to be kept away from the arm, and therefore the blood no longer being preserved from contact with the air, this first advantage of the apparatus vanishes. Another reason that could be put forward is that, in the absence of a very good bleeding, it is indispensable to direct the jet of blood, to maintain the parallelism of the cutaneous and venous incisions. Now, with a funnel applied to the opening, how to make sure that the blood flows well, how to answer that it does not drool down the arm? The cork washer is unnecessary or embarrassing. If it slides very lightly against the pump and the walls of the inner reservoir, it cannot be claimed that it preserves the blood from contact with air, that all access is closed to this fluid. If one wants to get an idea of the precautions it takes to stop the gas, just throw a little garlic on the industrial machines where this goal is fulfilled. If we accept that the washer slides with a certain friction, it will be absolutely necessary that the tube that receives the blood from the bleeding is lengthened, otherwise the column of blood would not exert a pressure capable of lifting it. So the washer becomes embarrassing, in that it forces an increase the length of the pipes, to multiply the inert surfaces that touch the blood. In addition, the longer the pipes, the more difficult it is to keep them at a good temperature; the more the blood clots or changes, the more the chances of not being able to complete the operation. To inject the desired quantity of blood, a single stroke of the piston is not enough, the valve clearance proves it. Now who answers us that the piston, when going up, will not let as much air pass from above as it sucks blood from below. For it to be otherwise, we would need a perfect instrument, or else means a series of much too complicated accessory. Certainly, any prudent surgeon will not run the risk of repeatedly injecting quantities of air almost equal to the mass of the blood. We therefore reject this apparatus in an absolute manner; we only adopt the independent cannula placed in the vein."

Mr. Bougard devised and made available a simpler apparatus, unquestionably better, although not exempt from all reproach. It consists of a small conical cannula that is first placed in the vein of the anaemic person. The blood from the bleeding falls directly into a triangular shaped container, in order to avoid the swirling of the liquid, and carrying an elastic tube terminated at its free end by a simple opening that adapts to the cannula. A small tap allows the blood to flow from the container into the tube at the operator's discretion. The whole system is kept at a good temperature by means of compresses soaked in hot water, and the adaptation of the tube to the cannula should take place only after the expulsion of the air.

Thus constructed, this apparatus has succeeded, but it is not indispensible; it even has no real advantage over the hydrocele syringe. In addition, without shortening the operation, it has the drawback of increasing the ratios between the blood and the inert walls, given the required length of the pipe; to leave the blood in the air throughout the operation, which is not a condition to look for; finally, and without taking into account the greater difficulty there is in handling it, it demands that the person who supplies the blood be higher than the one who receives it, otherwise the liquid would not flow for want of sufficient pressure. This remark is serious when one considers that, to prevent syncope, which would cut short the operation, it is prudent, even necessary to make the person who is to be bled seated, and that the arm of a seated person is hardly at the height of a bed.

Most of these criticisms do not apply to the syringe that Mr. Mathieu built in 1855 on the advice of Professor Pajot.

It is a syringe, the pump body of which is of very strong glass walls; the two ends are made of metal and interconnected by two side rods to the pump body, provided with a graduation that gives the measure of the liquid contained. At the end of the pump body adjacent to the handle, a funnel is mounted on a friction collar, which communicates with the interior of the pump. A hole on the same neck is intended to leave a free exit to the air, when the blood of the transfusing subject enters the syringe through the funnel; as soon as the instrument is loaded, a small movement of rotation is made to the collar, and these two communications are intercepted; the piston is then pushed while holding the instrument in the vertical position; in this way it is purged of air when immediately the cannula is placed in a small ivory tube that has previously been placed in the vein, and which serves as a conductor for the injected liquid.

However, in 1863, Mr. Moncoq had his lateral funnel device built.

It is, as we will see, in reality only a modification of his previous device. The exit tube and needle remain the same. There is also no difference in the middle part, in the crystal heart intermediate to the two subjects, which is, we can say, the important part of the apparatus. There is no difference except in the mode of entry of blood into the crystal heart, in the middle part.

The funnel, which is intended to receive the blood to be transfused, must be made of a slightly strong crystal. We understand that, in this funnel, the blood will trickle down, and that only a small quantity will be needed outside the vessels to fill the bottom of this vessel. This funnel is also perfectly transparent; it is easy to judge the level of the blood and its perfect liquidity. Its entry through the valve into the crystal heart is done in the same way as in the apparatus described above, by making the diastole by the elevation of the piston. The blood is also released in the same way, making the systole by lowering the piston. The first systole has the effect of expelling the air through an outlet valve and soon through the needle. As soon as the liquid comes out of the needle, the device is primed and full of liquid.

The piston rod is also graduated, and always allows blood in its passage.

Looking at this apparatus, it is easy to see the advantages it presents for mediate transfusion; it is important to support these considerations:

1. The introduction of air into the vein of the subject who is to receive the blood is impossible, because the operator judges perfectly the liquid level in the lateral funnel and can stop when he wants, and also because the graduated piston has never descended to the bottom of the crystal cylinder.
2. Finally, this apparatus with a lateral funnel, with the preceding advantages, also adds this one that is immense, that is, the distance between the two subjects can be very short.

Consequently, we have the two great advantages desirable for a good transfusion: we avoid, without fail, the introduction of air by the way in which we operate the plunger that is not completely lowered; and the coagulation of the blood is avoided by the short path that separates the inlet of the blood from its outlet of the apparatus, by the instantaneousness of the passage.

It had been a year since this new improvement by Mr. Moncoq had been presented to the scientific world, when Mr. Mathieu built a new device (Fig. 7.).

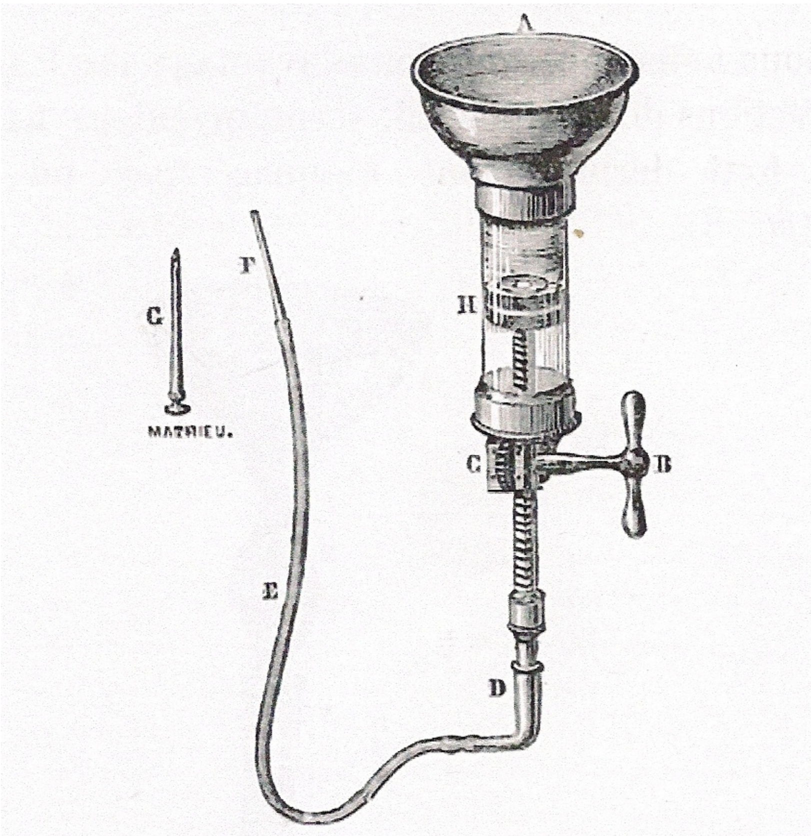

Fig. 7

It consists of an inverted pump body H surmounted by a funnel A, at the bottom, the perforated piston throughout its length communicates with an elastic tube E, carrying at its end a small nozzle F intended to penetrate into the cannula of the small trocar G that is previously placed in the vein.

The game of this device is easy to understand. The supplied blood is received in the funnel; the middle piston is moved by key B, is driven into the pump body and naturally passes through the hollow rod of the piston to arrive at the cannula F in the vein of the recipient.

We would dwell more on the imperfections of this device, if its inventor had not recently replaced it by another (Fig. 8).

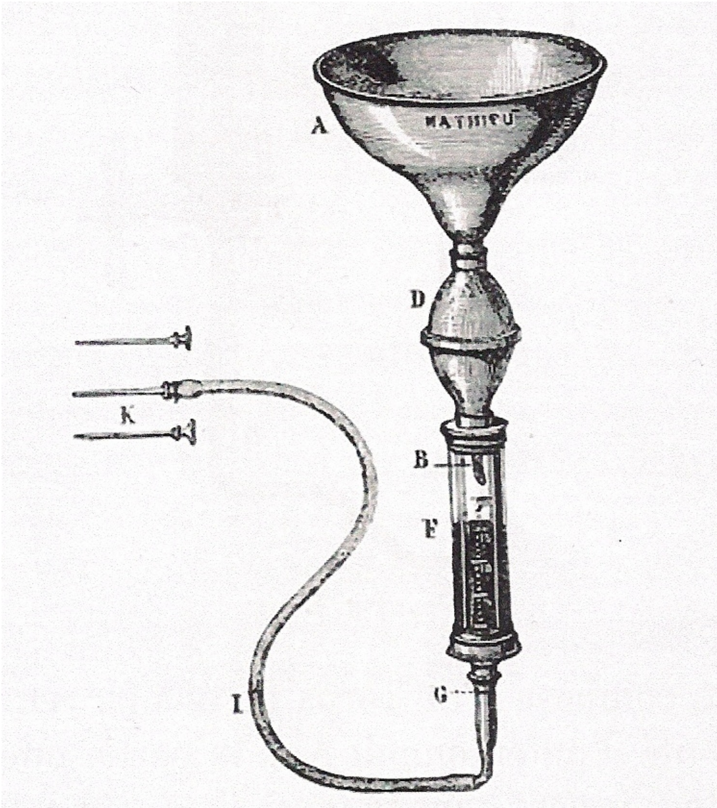

Fig. 8

The latter is a combination of Mathieu's first device and the previous one. The piston is, by means of an ingenious mechanism, replaced by a rubber ball which, by a valve system, passes the blood from funnel A into the pump body F. When the quantity of blood collected in the funnel is exhausted, tube B, fitted with reed valves, gives a characteristic warning whistle.

The only criticism we will make with this instrument is that it contains too many rubber parts liable to deteriorate.

The instruments built by Mr. Collin seem to us to be immune from this kind of reproach. The first model (Fig. 9), adopted by the medical corps for the service of the armed forces, is operated as follows:

1. Place the container under the bleeding of the person offering his blood;
2. Pass the index finger of the left hand through ring A;
3. The bar that bears the name of the inventor being placed at the top, aspirate blood up to half of the pump body, then expel it abruptly to make the air disappear;
4. The apparatus is filled by pulling the piston to the top of its stroke;

5. Give the piston a twist from left to right to close the inlet tube and open the outlet one;
6. Gently push the plunger to pass the blood into the patient's arm;
7. Twist the piston from right to left (in the opposite direction to the first), to put the pump body back in communication with the receptacle and allow suction again.

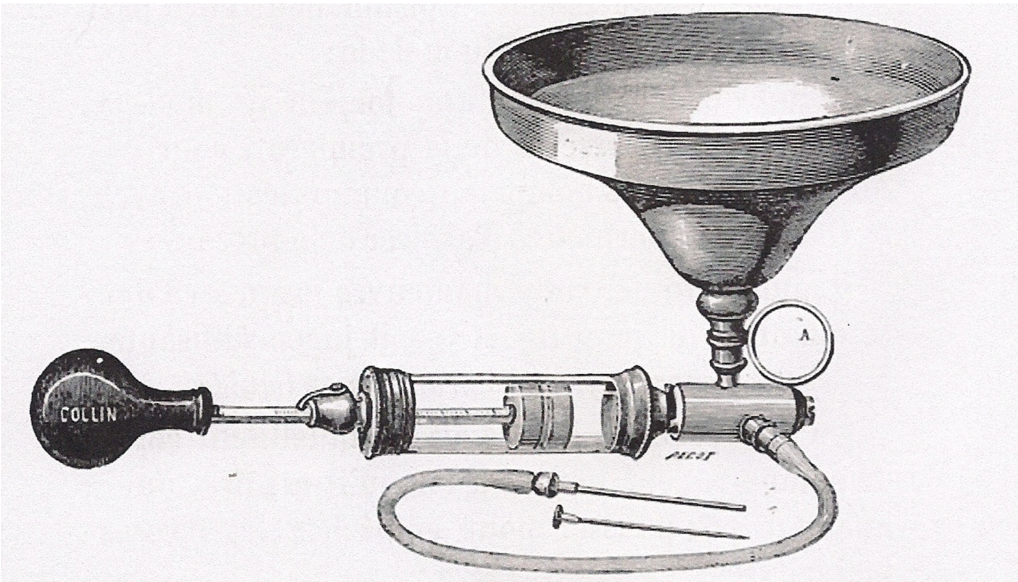

Fig. 9

This manoeuvre should be continued until the quantity of blood injected is judged sufficient; the pump body contains 10 grams of liquid.

A spring attached to the manual end of the pump housing holds the piston when it is pulled and then when pushed to prevent misuse.

To put the device in communication with the patient's arm:

1. The trocar of the instrument is inserted from bottom to top into the vein;
2. The pointed stem of the trocar is withdrawn and replaced by a blunt rod that forms a tip with the cannula and allows the latter to penetrate more deeply without damaging the walls of the vein;
3. As the rubber tube is purged of air, place the cannula that ends it in that of the trocar, where it fits by friction; then, following the instructions given above, the transfusion is performed.

Arm-to-arm transfusion can be done with this device by replacing the container with a second rubber tube.

This apparatus works without taps and without the valves which, sometimes, are unfaithful in the middle of an operation, and which, in any case, one is obliged to change for each transfusion; being constructed of metal and crystal, it can last a great number of years without deteriorating.

Mr. Collin's second model (Fig. 10) consists of: 1) a bowl; 2) a pump body; 3) a distribution chamber; 4) a tube; 5) a trocar.

The bowl, with a capacity of about 300 grams of blood, is shaped like a flared funnel, with retractable and rounded walls; the depth is 10½ centimetres, the widest diameter 15 centimetres. It is made of thin nickel-plated metal; it is this that the operator's left hand grasps, so that the blood it contains is not exposed to any oscillations that could cause or activate coagulation.

The pump body is built under conditions of exceptional simplicity. It is a regularly calibrated glass tube 8 centimetres long, equipped at both ends with two metal frames that ensure its strength and which are not in any circumstance in contact with the blood. Its outer circumference is 8 centimetres. Its capacity is exactly 10 cubic centimetres. The piston, also very simple, full, with gentle friction in the pump body, is constructed so as to present the blood liquid with a perfectly regular surface.

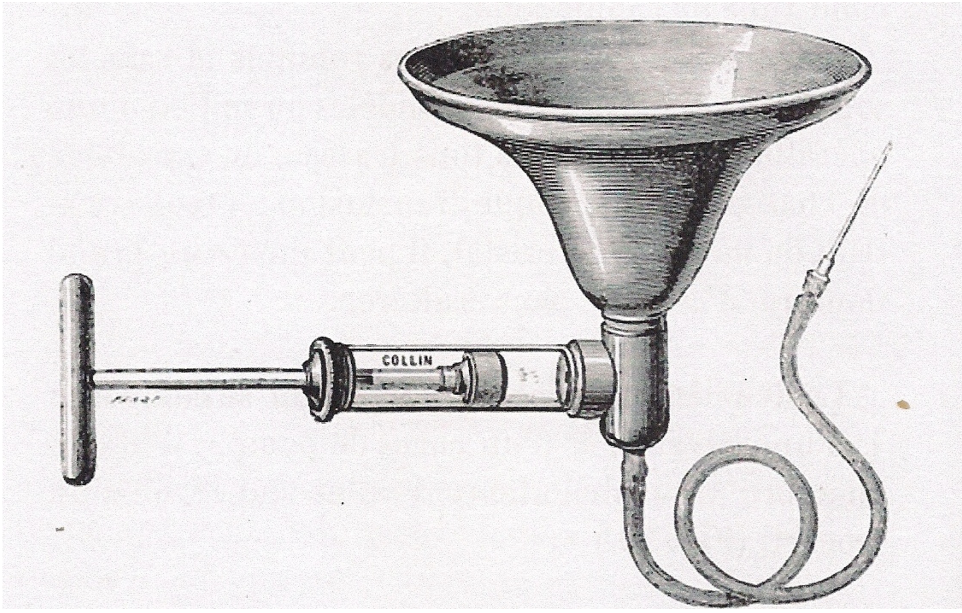

Fig. 10

Distribution chamber: Blood is drawn from the bowl into the pump, and pumped back from the pump into the tube without having to undergo contact with any valves. Experience has shown that any valve or valve, by multiplying the contact surfaces and presenting the blood with edges and ridges, has the effect of producing coagulation of the blood. The purpose of the distribution chamber is precisely to make this cause of coagulation impossible. It is formed on a cylindrical space located in the continuation of the axis of the bowl and communicating, through three equal openings, with the bowl, with the pump and with the transfusion tube; it contains a spherical, regular, hard rubber, or hollow aluminium ball, the density of which has been calculated and recognized to be lower than the density of blood (1.055).

This ball therefore floats on the blood of the chamber. When the piston is aspirated, the blood going down in the pump body moves it, but it immediately returns to its original position; during the stride it prevents the blood from entering the bowl; blood can only follow the path of the transfusion tube.

This mechanism offers an advantage far more serious than that of simplicity; it makes it impossible, whatever one does to propel air into the vein. It is easily understood that, since the ball only plays the role of valve on the condition that it floats, as soon as the bowl, and consequently the distribution chamber, which is strictly speaking only the bottom, becomes empty of blood, the ball will fall by itself in the lower part and will automatically apply to the opening of the transfusion tube. The pump will be able to suck in air, but it will deliver it by the only free way: the opening of the bowl. The ball, which, as long as the device was loaded with blood, prevented the back flow of blood into the bowl, prevents, as soon as the device is empty, the back flow of air into the veins.

This result is obtained by the use of a force more constant than the tap and the valves, an invariable force: gravity.

The tube and trocar are no different from those that were part of various models that we have performed before stopping at this one.

This transfuser was presented to the Academy of Medicine (meeting of 8th December 1874) by Professor Béhier, with the following note that we borrow from the reports:

"The transfusion operation presents two types of dangers, the seriousness of which has hitherto hampered the attempts of doctors: 1) formation and projection of clots; 2) introduction of air into the veins; the first of these dangers seems to have been made impossible by the provision of the transfuser that Mr. Collin presented six months ago to the Surgical Society: the elimination of valves and taps, the absence of rubber, made the operation easy and harmless, as experience has shown elsewhere. There remained the danger of the introduction of air; it was undoubtedly avoided with care. Mr. Collin has endeavoured to make these accidents independent of a false operating procedure; the instrument he presents automatically prevents the introduction of air into the veins. The propelled blood fills an incessantly renewed chamber or reservoir; a float, made of unalterable substance, lowers as soon as the liquid is used up. This float, lighter than blood and heavier than air, remains above the expenditure tube and opposes the passage of air which always escapes, whatever we do, through the upper opening."

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