The present invention relates to the treatment of blood with oxygen or ozone and ultraviolet light, and to an apparatus for this purpose.

It is a main object of the invention to bring the blood in particularly close contact with the oxygen or ozone.

It is another main object of the invention to subject the blood to a thorough irradiation by ultraviolet light.

It is yet another object of the invention to prevent at will the mixing of the blood treated with blood yet untreated.

It is still another object of the invention to provide the possibility of circulation of the blood through the oxidizing and irradiation treatment, either from the outlet of the apparatus back to its inlet, or from the patient through the apparatus and back to the patient.

With these and other objects in view my improved apparatus for the oxidizing treatment of blood provides for introducing an oxidizing gas of the group consisting of oxygen and ozone into the blood, forming a foam of the blood and the said oxidizing gas, passing the said foam in a thin layer through ultraviolet radiation, and collecting the oxidized and irradiated blood as a liquid.

Preferably the said thin foam layer is allowed to purl over a sloping surface exposed to the said ultraviolet radiation, and preferably the blood is kept in motion by the action of the said oxidizing gas after having been collected as a liquid.

By the formation of foam a most intimate contact between the blood and the oxidizing gas is established whereby a thorough oxidation of the blood is effected, and by passing the blood foam in a thin layer through ultraviolet radiation too far reaching an absorption of said radiation by too thick a layer is obviated, and the danger that blood particles too far remote from the source of ultraviolet radiation may remain without irradiation is thereby avoided.

These and other objects and features of my said invention will be clearly understood from the following description of a preferred embodiment of my improved apparatus given by way of example with reference to the accompanying drawings, in which:

Figs. 1 and 2 are diagrammatical perspectives of the general arrangement of the apparatus for the treatment and dispensing of blood after the same has been treated.

Fig. 3 shows the apparatus for the treatment of the blood in a vertical section on a larger scale, and Fig. 4 is a section along the line III—III of Fig. 3.

On a movable table two compressed gas bottles 2 are arranged under the table top, which contain the oxygen or ozone to be introduced into the blood which has to be treated with ultraviolet rays. The oxygen or ozone is passed from the bottles 2 via a reduction valve 2a, pipe 31, pressure gauge 30 and pipe 32 into the upright pipes 3 through which it can arrive at the discharge sockets 3a and to the rubber hoses 35. The provision of two bottles has the purpose of always having a spare bottle handy. On the uprights 3 mounted on the table (in the embodiment illustrated there are two of them) devices for the treatment of the blood are mounted which are denoted 4 as a whole. They can be brought on the movable table 1 to the patient's bedside, and can be swung about the uprights 3 e.g. over his arm, and adjusted in height.

One of the said devices 4 is illustrated in a vertical section in Fig. 3. This device comprises two vessels 5, 6 arranged side by side and at least partly fused together, one of which, 5, serves for receiving the untreated blood while the other vessel, 6, serves to store the treated blood.

A pipe 7, through which the untreated blood enters, issues into the vessel 5. A socket 8, into which a non-return or excess pressure valve 9 is built, is connected to a pipe 3b (Fig. 1) coming from the oxygen or ozone bottles 2. A normally closed drain is denoted 10. In the interior of the vessel 5 a narrow vertical tube or raiser pipe 11 is arranged which flares out at its upper end in the shape of a funnel 12. This raiser pipe 11 penetrates through a sloping plate 13 which is supported at the lower end by brackets on the inner wall surface of the vessel 5 and extends into the vessel 6. The said raiser pipe 11 can for example be fused into one piece with the said plate 13. At least one projection 15 prevents the plate 13 from sliding off.

The vessel 6 is provided at its lower end with a discharge socket 16 from which a rubber hose 17 (Fig. 1) is passed to the patient. Into this rubber hose or into the vessel 6 oxygen can be passed, if desired, whereby the blood treated is constantly kept in motion and settling of the blood is thus prevented. To the hose 17 a turn-niquet 18, a drop counter 19, a glass grain filter 20, an air valve 21 and a vein-needle 22 are connected.

Above the two vessels 5 and 6, both of which are provided with scales 23 indicating their content, a hood 24 is arranged into which an ultraviolet ray emitter, for example a quartz low pressure burner 25, is built (Fig. 3).

Wires 27 feed electric current to the pressure burner. Below the burner 25, but above the vessels 5, 6 there is a quartz partition 26 which closes the latter against the access of air. Between the hood 24, the partition 26 and the outer wall of the vessels 5, 6 a filling 28 of sterilized gauze is provided which occupies the space 29 and prevents the penetration of aerobic spores from the atmospheric air. The said object could naturally be attained alternatively by a ground-in lid. Moreover, the burner may be used as a separate component of the apparatus, i.e. without a fixed connection with the quartz hood 26, so that this hood, equipped with an appropriate downward seal, could effect the screening against the ambient atmosphere.

The apparatus described operates as follows:

Untreated blood or even blood plasma is introduced through the pipe 7 into the vessel 5, the usual pressure reducing valve 2a of the bottle 2 in actual use (Fig. 1) is opened, and oxygen or ozone is introduced through the socket 8 from the tapping socket 3a. In the raiser pipe 11 (Fig. 3) which ends at a distance from and is thereby in communication with the lower end of the vessel 5, and accordingly fills in its lower part likewise with blood, the latter is mixed with oxygen or ozone, whereby foam bubbles are formed and a practically complete saturation with oxygen is established. From the flaring upper end 12 the blood foam emerges, which is then irradiated and sterilized by the ultraviolet ray emitter as the case may be. The ultraviolet ray emitter is a low pressure burner which practically develops near to no heat and has a radiant wave range of 1800 to 2600 Angstrom. The blood foam treated drips then off the plate 13 into the vessel 6 where it collapses again into liquid blood. The oxygen or ozone can escape through a pipe (not shown) connected to a socket 7a of the vessel 6, which is likewise protected by sterilized gauze.
from the access of air. The device described permits circulation of the blood. The same can then after discharge from the socket 16 be introduced again so often as desired through the pipe 7 into the vessel 5, and its treatment accordingly repeated.

As shown in Fig. 1, two such devices 4 are arranged on one and the same table in order that no interruption in the treatment may occur even in the case of accidents.

In the hood 24, 25 (Fig. 3) for example, additional oxygen inlets directed against the said blood foam generated by oxidizing gas introduced into the blood, may be provided in order to prevent an excessive formation of foam.

If desired, a pump or the like (not shown) may be provided in order to bring the blood in a closed circuit from the vessel 6 through the patient's body and again back into the vessel 5. Thereby it is made possible to normalize or to increase the oxygen quota.

In an analogous manner it is possible, to return the blood emerging from the vessel 6 once or repeatedly into the vessel 5 and thus to attain a multiple circulation of the blood.

The device described can also be used for blood transfusion in that the donor's blood is freed from carbon dioxide by the oxygen or ozone treatment, and at the same time is irradiated with ultraviolet rays and, if necessary, sterilized.

While Fig. 1 shows diagrammatically the injection of purified blood plasma introduced into the device, or of blood supplied directly from a blood donor, Fig. 2 shows how the patient's blood can be passed in a direct circulation through one of the devices. By means of the second device the same patient may receive additionally a transfusion of a donor's blood, as indicated in dotted lines.

Into the socket 8 of the vessel 5 additionally a glass bead filter is built which always generates foam bubbles of equal size with very thin walls and of predetermined size, whereby a practically complete ultraviolet irradiation is assured. The charging of the blood with oxygen or ozone to saturation with ultraviolet rays by means of the device according to the invention does not produce any differences in tension in the blood bodies, which has been proved by tests.

Any tendency of the blood to coagulate can be controlled and practically obviated by the addition of certain drugs such as Heparin (Liquemin Roche), a proprietary name.

While I have herein described and illustrated in the accompanying drawings what may be considered a typical and particularly useful example of my said invention, I wish it to be understood that I do not limit myself to the particular details and dimensions described and illustrated, for obvious modifications will occur to a person skilled in the art.