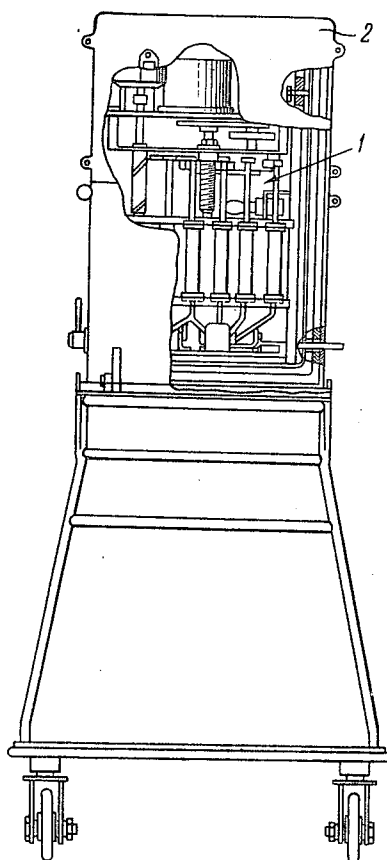
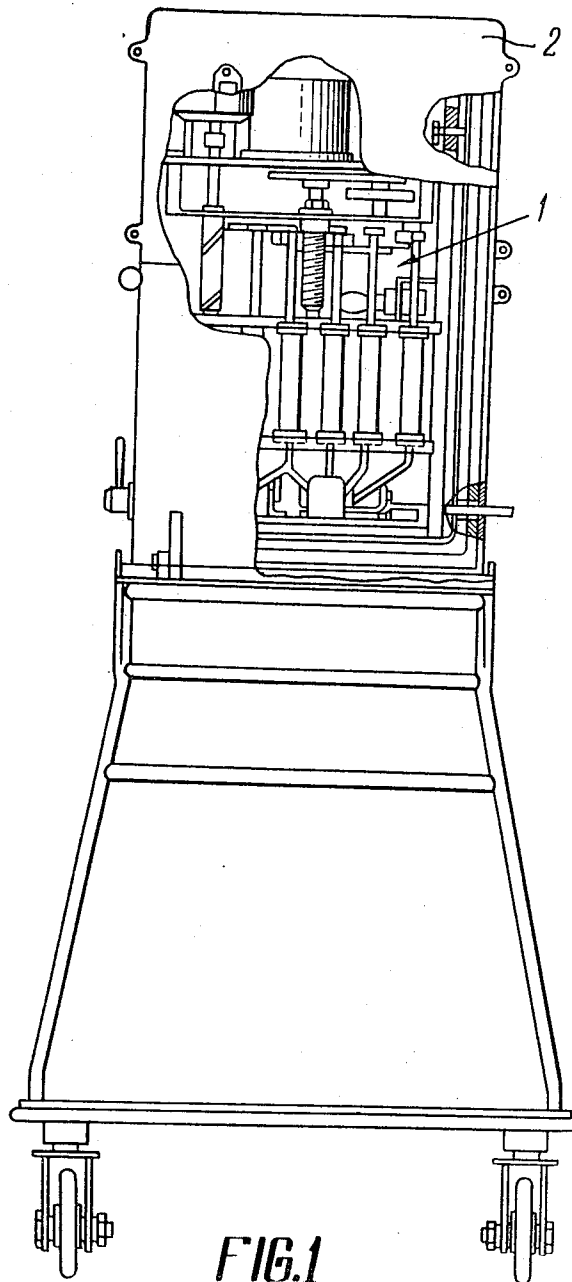


[54] **RADIOACTIVE SOLUTIONS INJECTOR
FOR LYMPHATIC SYSTEMS**[75] Inventors: **Nickolai Nikolaevich Alexandrov;**
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BSSR, Minsk, U.S.S.R.[22] Filed: **March 24, 1970**[21] Appl. No.: **22,324**[52] U.S. Cl.**128/214 R, 128/218 R, 128/DIG. 1**[51] Int. Cl.**A61m 05/00**[58] Field of Search.....**128/DIG. 1**
128/214 R, 218 A, 218 R[56] **References Cited****UNITED STATES PATENTS**2,786,468 3/1957 Singer et al. **128/DIG. 1**
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2,734,504 2/1956 Crescas et al.**120/218***Primary Examiner*—Joseph S. Reich*Attorney*—Waters, Roditi, Schwartz and Nissen[57] **ABSTRACT**

An apparatus for injecting radioactive solutions into the lymphatic system, comprising at least one syringe for discharging the contents thereof; a conduit for communicating the interior of the syringe with the patient's lymphatic vessel, a system of auxiliary syringes and multiway valves used to alternatively communicate the interior of the first syringe with the auxiliary syringes and with a patient's lymphatic vessel; the apparatus being also provided with a remote control system controlling the rate of procedure of injecting the radioactive solutions.

2 Claims, 4 Drawing Figures



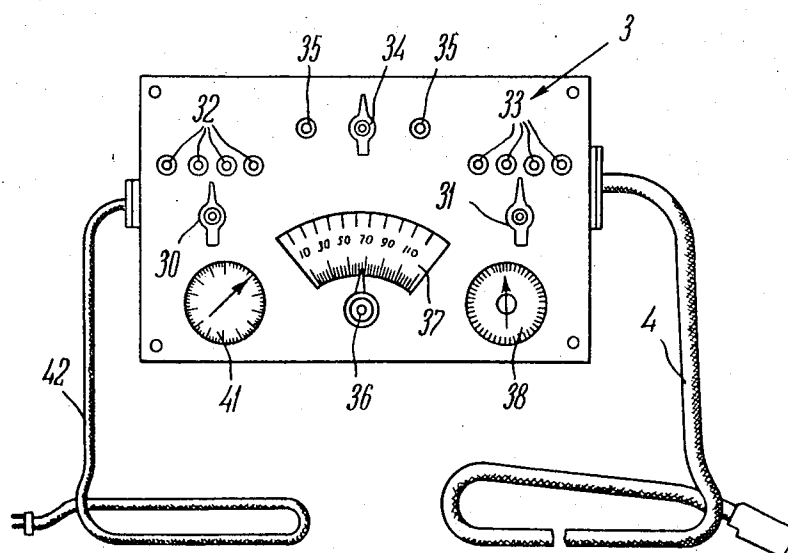


FIG. 2

FIG.3

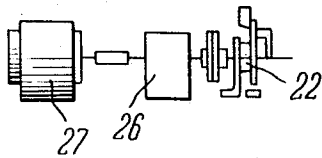
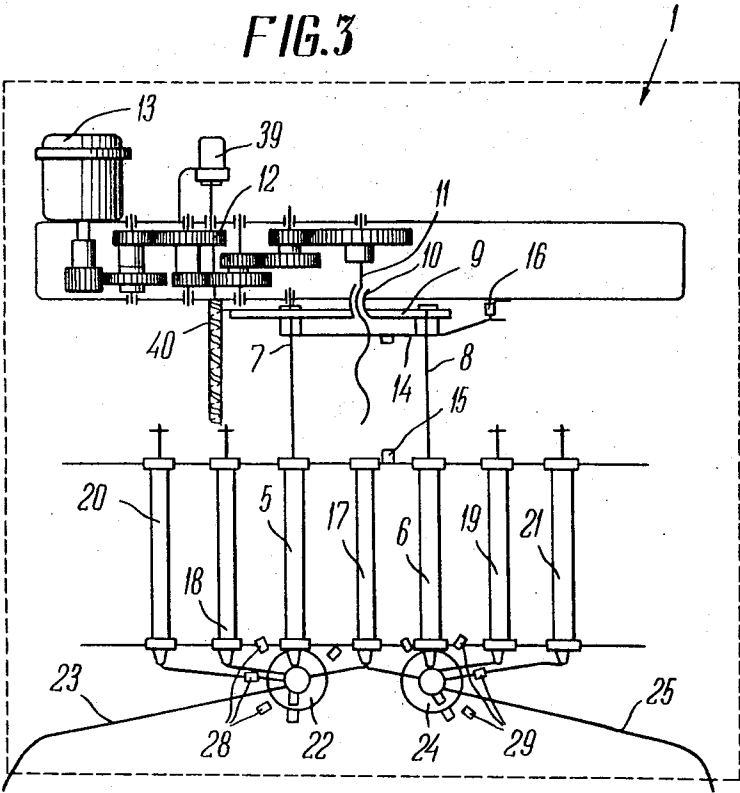


FIG.4

RADIOACTIVE SOLUTIONS INJECTOR FOR LYMPHATIC SYSTEMS

The present invention relates to medical radiology and, more particularly, to apparatus for injecting radioactive solutions into an organism, preferably into the lymphatic system. The present apparatus may be also used for intracavity and intratissue injection of isotopes, as well as for the infusion thereof into the arterial system, and for lymphography.

The present apparatus can be most successfully used for intralymphatic-vessel injection which, due to the danger of rupturing extremely fine lymphatic vessels, requires a slow introduction of a radioactive solution into a patient and, therefore, necessitates a prolonged stay of the doctor in the zone of radiation.

Known in the art is an apparatus for injecting radioactive solutions into the lymphatic system, comprising a syringe having a protective covering, the piston of the syringe being connected with a drive adapted to have a forward motion imparted thereto. When using this apparatus, the syringe must be filled with a solution and an isotope must be manually dissolved therein.

After it is filled with a radioactive solution, the syringe is inserted into the body of the apparatus. Then, an electric motor is switched on to move the rod of the syringe piston forward so as to inject the solution through the syringe needle into the lymphatic vessel. At the end of the procedure of injecting the solution, the apparatus is automatically switched off.

However, the prior-art apparatus requires that the doctor remains during the course of its operation directly in the zone of radiation, without affording him protection against radioactive radiation, since it does not provide for remote control over the procedure of injecting radioactive solutions which permits the obtaining of necessary information from a safe place, for instance, the remote control with respect to the amount of the isotope being injected and the rate of the injection. Although the radioactive substance is in itself shielded to a certain extent in this apparatus by the protective covering of the syringe, having walls which are capable of absorbing β -particles, the danger still remains since during the course of injecting a radioactive solution the patient himself becomes a source of radiation. Additionally, when using radioactive solutions with mixed γ - and β -radiation, for example, when injecting the 198-colloid gold widely used for treating malignant tumors, which produces up to 10 percent of γ -radiation, the protective covering of the syringe does not shield the doctor from the γ -radiation.

Furthermore, the fact that the conventional apparatus is provided with only one syringe does not permit it to inject radioactive solutions simultaneously into both of the patient's extremities, which may be necessary in a number of cases.

The conventional apparatus does not provide for a single action filling up of the syringe with radioactive solutions and subsequent remote-controlled dissolving of an isotope in an amount sufficient for several patients, which would minimize the number of contacts with the source of radiation. Since the single syringe used in the apparatus must be refilled for every patient, or for the patient's other extremity, the doctor's hands, the tools and other materials used for this purpose are frequently contaminated with radioactive substances.

It is an object of the present invention to eliminate the afore-mentioned disadvantages.

The present invention has for its objective the provision of an apparatus for injecting radioactive solutions into organism, that would completely provide for a remote operative control, as well as control over separate filling stages and over the entire procedure of injecting radioactive solutions, and thereby solving the problem of radiation safety for medical personnel.

This object is accomplished by means of an apparatus for injecting radioactive solutions into an organism, preferably into the lymphatic system of patients comprising at least one syringe having a piston connected for having a drive to imparted thereto a reciprocating motion, conduit means for communicating the interior of the syringe with a lymphatic vessel, which includes a system of auxiliary syringes and multiple valves used to alternately communicate the syringe interior with the auxiliary syringes and with the conduit means connecting the syringe with a lymphatic vessel, and also including a system providing for the remote control operation over the procedure of injecting radioactive solutions.

It is generally advantageous to constitute the system of remote control operation over the procedure of injecting radioactive solutions as a control device monitoring the amount of radioactive solution being injected into the patient, and the rate of its introduction.

The following description of an exemplary embodiment of the present invention is given with reference to the accompanying drawings, in which:

FIG. 1 shows an elevational view, partially in section, of an actuating mechanism for an apparatus for injecting radioactive solutions into an organism, according to the present invention;

FIG. 2 shows a plain view of a control board of an apparatus for injecting radioactive solutions into organism, according to the present invention;

FIG. 3 is a diagrammatic schematic view of an actuating mechanism for an apparatus for injecting radioactive solutions into organism, according to the present invention; and

FIG. 4 shows a diagram of a drive means for a multiple valve of the actuating mechanism, according to the present invention.

An apparatus for injecting radioactive solutions into organism comprises an actuating mechanism 1 (FIG. 1) enclosed in a lead casing 2. One of the walls of the lead casing 2 is provided with a window (not shown in the drawing) covered with lead glass and used to permit observations. The actuating mechanism 1 is coupled with a control board 3 (FIG. 2) by means of an electric cable 4. The actuating mechanism 1 (FIGS. 1,3) comprises syringes 5 and 6 (FIG. 3) and rods 7 and 8 whose respective pistons are connected to a bracket 9. Secured to the bracket 9 is a nut 10 which interacts with an actuating screw 11 which, through the intermediary of a reducing gear 12, is coupled with a reversible electric motor 13.

Also secured to the bracket 9 is a plate 14 which, after the pistons of the syringes 5 and 6 have reached their extreme positions, is adapted to respectively contact switches 15 or 16.

The actuating mechanism 1 is provided with the following auxiliary syringes: a syringe 17 for receiving a radioactive solution, syringes 18 and 19 for a novocaine solution and syringes 20 and 21 for a colloid solution. The mechanism is also equipped with a four-

way valve 22 which is used to alternately communicate the syringe 5 with the syringes 17, 18, 20 or which a pipe 23, and a four-way valve 24 which is used to alternately communicate the syringe 6 with the syringes 17, 19, 21 or with a pipe 25. The pipes 23 and 25 are used as conduit means for connecting the syringes 5 and 6 with a patient's lymphatic vessels, and for receiving a quantity of radioactive solution from a supply source.

The four-way valve 22 is connected by means of a reducing gear 26 (FIG. 4) with an electric motor 27, the four-way valve 24 being provided with an analogous drive. The four-way valves 22 and 24 (FIG. 3) are also respectively provided with switches 28 and 29 which may be used to stop the four-way valves 22 and 24 in predetermined operative positions.

The control board 3 (FIG. 2) is provided with switches 30 and 31. The switch 30 is electrically connected with the terminal switch 28 (FIG. 3), and the switch 31 (FIG. 2) with the terminal switch 29 (FIG. 3), by means of which the four-way valves 22 and 24 are set into a required position: the four-way valve 22 (FIG. 3) under the action of electric motor 27 (FIG. 4), and the four-way valve 24 under the action of a similar electric motor (not shown in the drawing). In order to effect control which determines the position of the four-way valves 22 and 24, signal lamps 32 and 33 are mounted on the control board (FIG. 2). The switches 30 and 31, the terminal switches 28 and 29 (FIG. 3), the electric motor 27 (FIG. 2) and the electric motor for the valve 24, as well as the signal lamps 32 and 33 (FIG. 2), constitute control elements for determining the position of the multiple valves 22 and 24 (FIG. 3).

The control board 3 (FIG. 2) also includes a switch 34 which is used to start the reversible electric motor 13 (FIG. 3), and to switch on the signal lamps 35 (FIG. 2), both of which are electrically connected with the terminal switches 15 and 16 (FIG. 3), and indicate when the pistons of the syringes 5 and 6 have reached their extreme operative positions. Mounted on the control board 3 (FIG. 2) is a rheostat 36 which controls the voltage supplied to the winding of the reversible electric motor 13 (FIG. 3) in order to vary the speed of movement of the pistons of the syringes 5 and 6, and, consequently, the rate of feeding the solutions. The rheostat 36 (FIG. 2) is provided with a double scale 37 indicating the voltage present in the winding of the electric motor 13 (FIG. 3) and the rate of feeding the solution corresponding thereto.

The control board 3 (FIG. 2) also includes a selsyn-receiver 38 having a scale, which is electrically connected with a selsyn-transmitter 39 (FIG. 3), mechanically connected with a turnable roller 40 having a screw slot interacting with an extension on the bracket 9. Thus, each particular position of the selsyn-receiver 38 (FIG. 2) indicator arrow corresponds to a corresponding operative position of the pistons of the syringes 5 and 6. The selsyn-receiver 38 scale is graduated according to volume units so as to make it possible to always determine the amount of the solution present in the syringes 5 and 6 (FIG. 3). The control board 3 (FIG. 2) has a clock 41 mounted thereon, which is interlocked with the reversible electric motor 13 (FIG. 3) in such a manner that they are simultaneously switched on and off thereby providing for a determination of the

actual rate of feed of the solution through evaluation of the readings of the clock 41 (FIG. 2) and of the selsyn-receiver 38.

The switch 34, signal lamps 35, rheostat 36, clock 41, selsyn-receiver 38 and selsyn-transmitter 39 (FIG. 3) including a turnable roller 40, as well as the terminal switches 15 and 16, constitute a control unit or device for controlling the amount and rate of the radioactive solution being injected into the patients.

The electric power is supplied to the control board 3 (FIG. 2) by means of a suitable power cable 42.

The actuating mechanism 1 (FIG. 1) is disposed in proximity to the patient, whereas the control board 3 (FIG. 2) may be removed to a safe distance with respect to the patient, thereby eliminating the danger of the attending personnel being subjected to radiation.

Observations of the operation of the actuating mechanism 1 (FIG. 1) may be carried out with the assistance of a TV transmitter (not shown in the drawing) which may be installed opposite the window provided in the lead casing 2.

The apparatus for injecting radioactive solutions into the lymphatic system functions as follows:

After the syringes 18, 19 (FIG. 3) are filled up with the novocaine solution and the syringes 20 and 21—with the colloide solution, the actuating mechanism 1 (FIG. 1) is transported into a room where radioactive isotopes are stored.

By turning the switches 30 and 31 (FIG. 2) the four-way valves 22 and 24 (FIG. 3) are set in operative positions when the syringes 5 and 6 are connected respectively with the pipes 23 and 25, whereupon the pipes 23 and 25 are lowered into a tank containing radioactive isotopes. By turning the switch 34 (FIG. 2) into a desired direction, the reversible electric motor 13 (FIG. 3) is started, providing suction to allow the syringes 5 and 6 to aspirate a required amount of isotopes.

Subsequently, by turning the four-way valves 22 and 24 into other predetermined operative positions, the syringes 5 and 6 are connected with the syringe 17 into which the entire quantity of the aspirated isotopes is then conveyed. If need be, the isotope may be dissolved in a non-active solution contained in the syringes 20 and 21 until a required specific activity is obtained, which is effected by aspirating the solution into the syringes 5 and 6 and subsequently conveying or purging the latter into the syringe 17. All of the aforementioned operations are carried out by remote control operation.

The actuating mechanism 1 (FIG. 1) is then brought to a patient who has previously had catheters or needles introduced into his lymphatic vessels, and the catheters or needles are then connected to the pipes 23 and 25 (FIG. 3).

After this the procedure of injecting the radioactive isotope into the patient's lymphatic system is started, with the procedure being, controlled by a doctor who remains at the control board 3 (FIG. 2) in a radiation-proof environment. The four-way valves 22 and 24 (FIG. 3) are set into the position whereby the syringes 5 and 6 are respectively connected with the pipes 23 and 25, and, a required rate of feeding the solution is obtained by the setting of the rheostat 36 (FIG. 2), whereupon the reversible electric motor 13 (FIG. 3) is started. The novocaine solution, which has been previ-

ously transferred in a required amount, from the syringes 18 and 19 into the syringes 5 and 6, is conveyed through the pipes 23 and 25 into the patient's lymphatic system.

During this time, the reversible electric motor 13 rotates, in response to the rotation of the reducing gear 12, the actuating screw 11 within the nut 10, while the bracket 9 slides in a longitudinal direction, and with the bracket 9 being connected with the pistons of the syringes 5 and 6. The bracket 9 interacts with a screw slot in the turnable roller 40 whose rotation is transmitted to the selsyn-transmitter 39. The output of the latter is connected to the input of the selsyn-receiver 38 (FIG. 2) on the control board 3. The indicator arrow of the selsyn-receiver 38 moves synchronously with the motion of the pistons of the syringes 5 and 6 (FIG. 3) so as to thereby provide information about the amount of the solution being injected.

When the pistons of the syringes 5 and 6 attain their extreme lower positions, the terminal switch 15 is contacted so as to be actuated, and consequently the electric motor 13 is automatically switched off.

The information about the completion of the solution injection is then transmitted to the control board 3 (FIG. 2) by a lighting up of the respective signal lamp 35.

With the sequence of the novocaine injection completed, a required amount of the radioactive solution is aspirated from the syringe 17 into the syringes 5 and 6 (FIG. 3), the valves 22 and 24 having been previously set into respective operative position. The indicator arrow of the selsyn-receiver 38 (FIG. 2) arrow is then closely watched, with the arrow moving synchronously with the pistons of the syringes 5 and 6 (FIG. 3) and thereby indicating the number of milliliters of the radioactive solution that have been aspirated therein.

The required rate of injecting the radioactive solution is preset by means of the rheostat 36 (FIG. 2). The initial data of the indicator arrow of the scale, which is connected with the selsyn-receiver 38 and which indicates the level of the isotope solution in the syringes 5 and 6 (FIG. 3), are noted. The four-way valves 22 and 24 are set into the position whereby the syringes 5 and 6 are connected with the pipes 23 and 25. With the information having been noted about the displacement of the four-way valves 22 and 24 into the required position through signal lamps 32 and 33 (FIG. 3), the reversible electric motor 13 (FIG. 3) is started.

The isotope solution is fed into the lymphatic system, and the arrows of the scale of the selsyn-receiver 38 (FIG. 2) indicate the amount of the solution being injected, whereas the arrow on the face of the clock 41 shows the time during which the radioactive solution

has been injected, with both readings providing information on the actual rate of the introduction of the solution.

With the procedure of injecting the radioactive solution now being completed, the novocaine solution is aspirated into the syringes 5 and 6 (FIG. 3) from the syringes 18 and 19, and the portion of the radioactive solution remaining in the pipes 23 and 25 is washed out into the patient's lymphatic vessels.

After the process of injecting the radioactive solution is completed, the actuating mechanism 1 (FIG. 1) may be brought to another patient.

The above-described embodiment of the proposed apparatus employs two syringes, which corresponds to the number of a patient's legs, the solution being injected simultaneously into both legs. However, the apparatus of the invention may employ any number of syringes, depending upon the number of the patients who are to be subjected to simultaneous treatment.

Thus the present apparatus allows precise proportioning of the isotope to be injected, which is previously dissolved in a non-active solution so as to obtain a required specific activity; provides for an introduction and feed rate for the solution, and makes it possible to control the rate by watching the amounts of the solution in the primary syringes and auxiliary syringes, all the manipulations of the actuating mechanism of the apparatus being effected by means of remote control apparatus operated out from a safe and remote environment.

The apparatus provided by the invention may be also successfully used for proportioned pouring of radioactive solutions, the remote control operation of the actuating mechanism reliably protecting the operator from the emission radiation.

What is claimed is:

1. An apparatus for injecting radioactive solutions into organisms, such as the lymphatic system of a patient; comprising at least one syringe having a barrel having discharge means therein; drive means connected to said discharge means for imparting movement thereto; conduit means for interconnecting said syringe barrel with the lymphatic vessels of a patient, a plurality of auxiliary syringes having solutions therein, multi-directional valve means connected to said syringe and to said auxiliary syringes, said valve means being adapted to connect said syringe with said auxiliary syringes and alternatively with said conduit means; and remote control means adapted to effect control over the rate of flow of said radioactive solution to said patient.

2. An apparatus as claimed in claim 1, wherein said remote control means comprises means determining the operative position of said valve means.

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