

April 23, 1929.

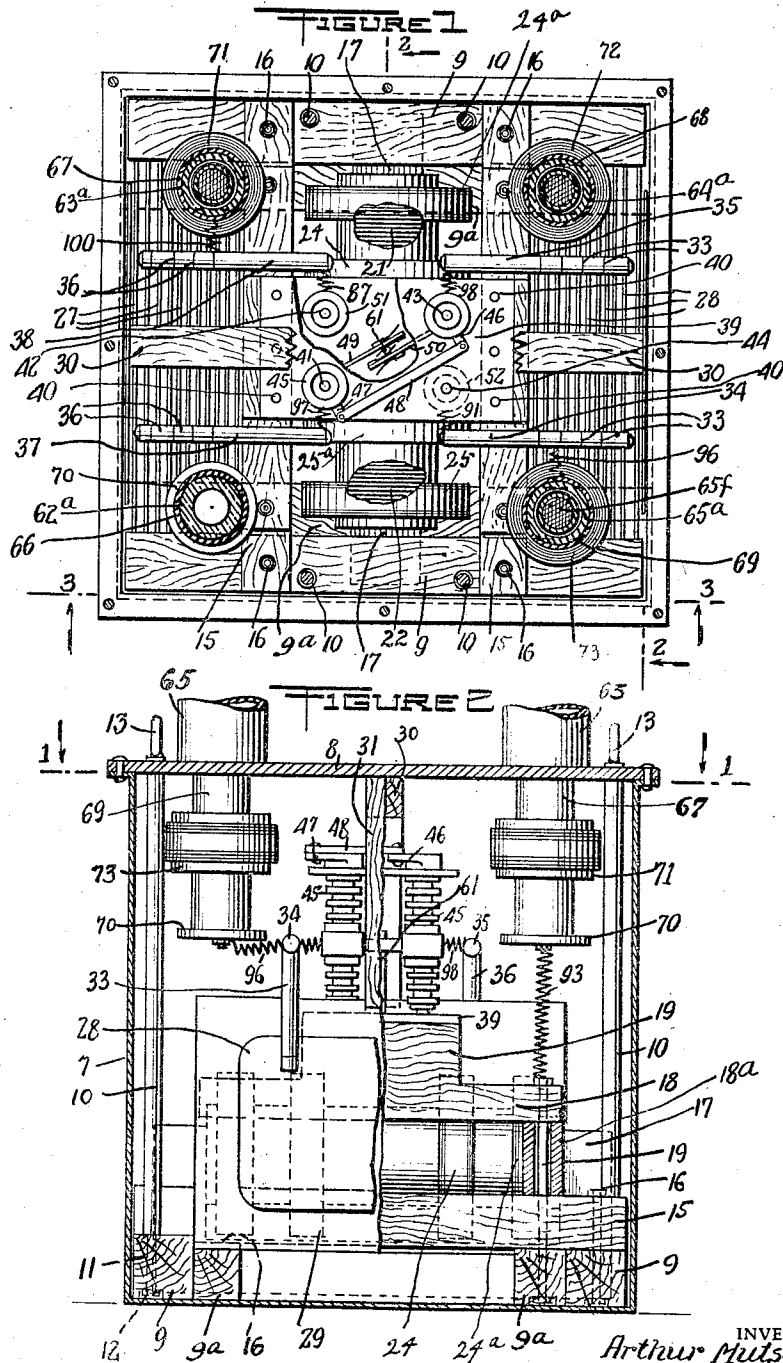
A. MUTSCHELLER

1,709,866

X-RAY APPARATUS

Filed April 30, 1927

3 Sheets-Sheet 1



April 23, 1929.

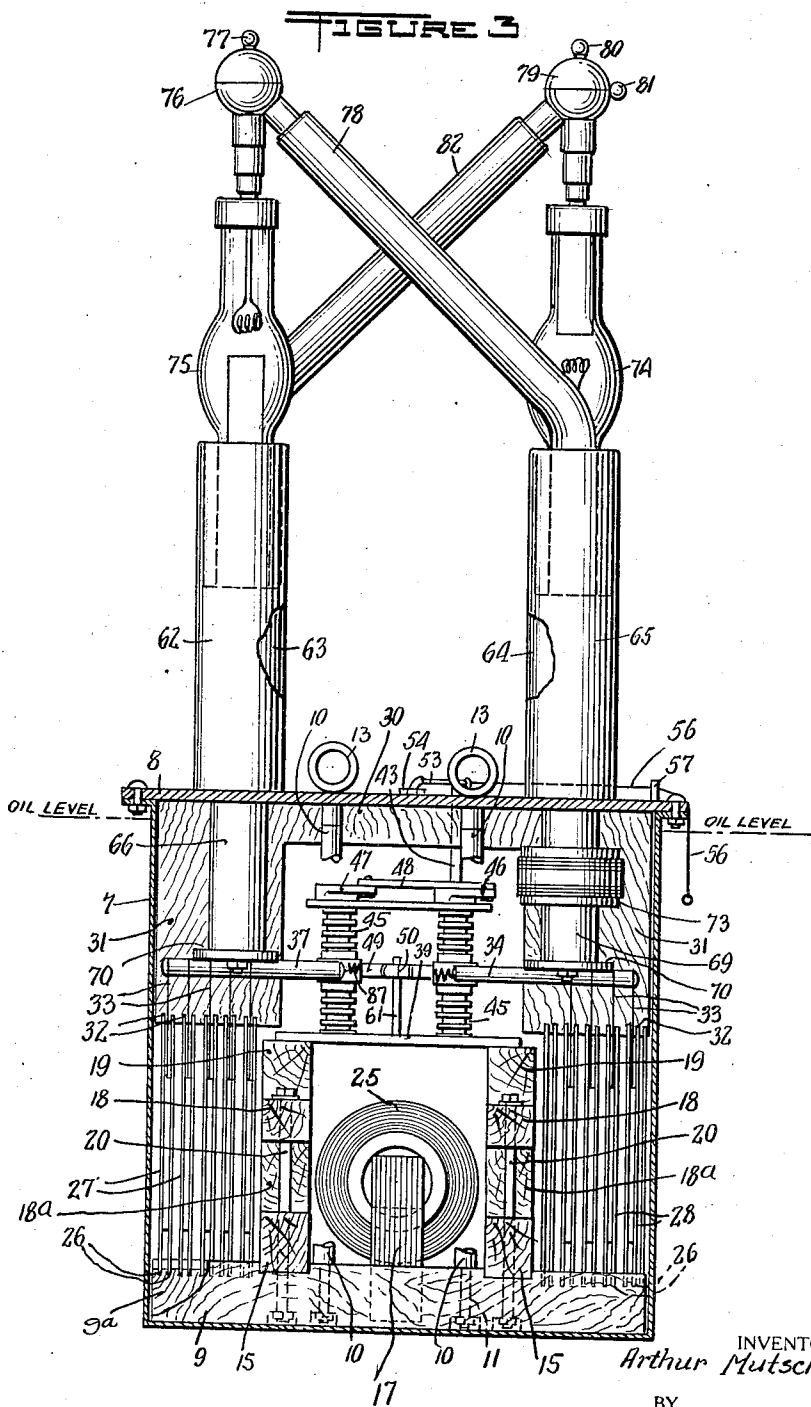
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X-RAY APPARATUS

Filed April 30, 1927

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April 23, 1929.

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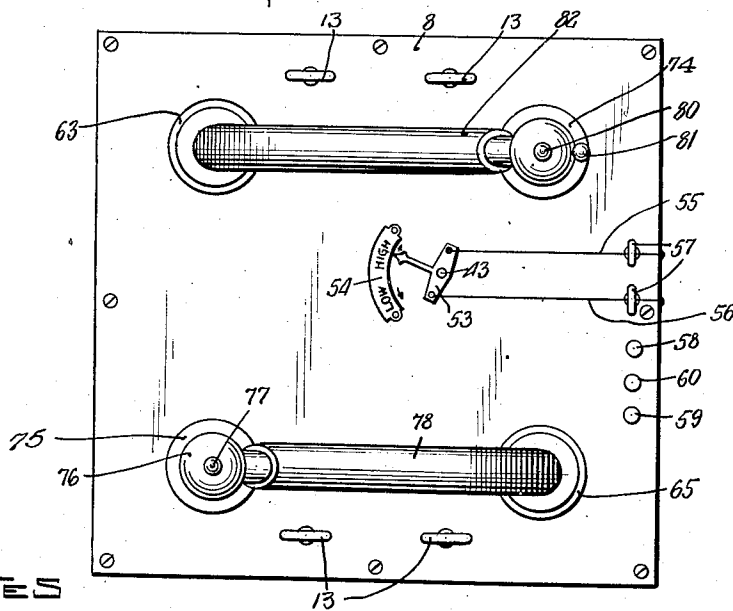
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X-RAY APPARATUS

Filed April 30, 1927

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FIGURE 4



FIGURES

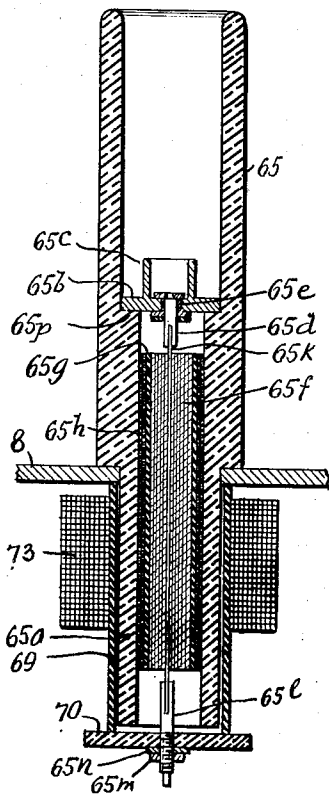
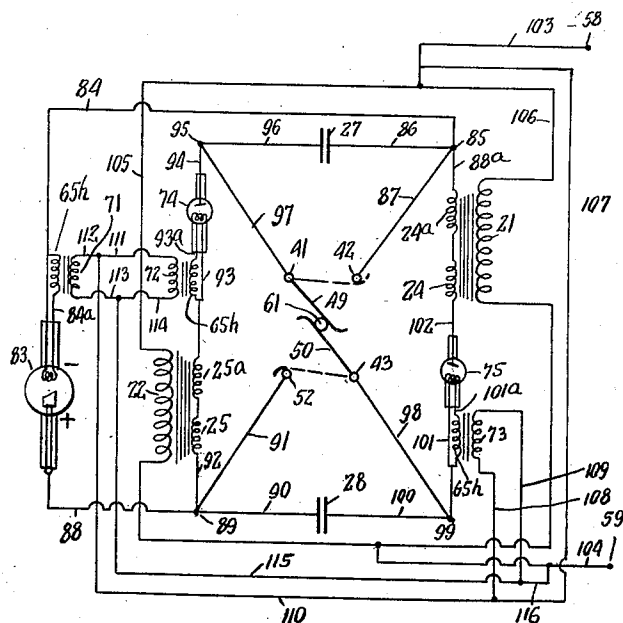


FIGURE 5



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UNITED STATES PATENT OFFICE.

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X-RAY APPARATUS.

Application filed April 30, 1927. Serial No. 187,793.

My invention relates to X-ray apparatus, and more particularly to a manner of housing and arranging the various electrical and mechanical components of an X-ray system wherein all the various parts are incorporated separate and distinct units, one or more of which may be used at a time.

Among the advantages attained by my invention are the following:

First, greater compactness of the entire apparatus.

Second, less danger from high voltages, combined with greater electrical efficiency, due to the use of shorter leads.

Third, better insulation, due to the complete immersion, in oil, of certain parts carrying high voltages, as against other parts carrying lower voltages.

Fourth, more thorough cooling, due to the immersion in oil of parts not heretofore so immersed, and which would otherwise become heated.

Fifth, certain constructional advantages, which reduce materially the cost of production.

Sixth, various other advantages, herein-after set forth more particularly at length.

My invention is concerned chiefly with X-ray machines of the valve tube rectifier type, such as those described in my pending applications, Serial No. 101,102, filed April 10, 1926, and Serial No. 136,420, filed September 20, 1926. In the machines described in each of my said applications a complete and self-contained X-ray unit, energized by currents supplied to it from an extrinsic source, furnishes rectified currents of high potential, suitable for energizing the main discharge circuit of an X-ray tube, and also furnishes low tension currents for heating the cathode filament of the X-ray tube, as well as the cathode filament of any valve tubes employed.

In the prior art there have been used X-ray apparatus comprising a high tension transformer, separately supported valve tubes and an X-ray tube, so combined as to develop high tension discharges of unitary direction through the X-ray tube. However, in the machines just mentioned, due to the necessity for using long leads between component parts, and to the requirement for individual

supports for each part, there are severe limitations upon the voltages and currents which may be safely developed for energizing an X-ray tube; and these limitations have restricted the use of these machines of the prior art.

An important feature of my invention is the arrangement of valve tubes, condensers, and a high tension transformer, the condensers and transformer being immersed in oil and housed within a casing of box-like form, this casing being provided with a cover, and the various valve tubes and certain other parts being mounted thereupon.

The cover just mentioned is also adapted for use with a change-over switch, also housed within the casing and so arranged that by operating the switch, the machine can be instantly set for series or parallel connections between certain parts, thus changing the operating conditions of the machine, all as described in my pending application for an X-ray machine, filed September 20, 1926, Serial No. 136,420.

I have found it to be practicable and very advantageous to mount certain transformers bodily within and upon the high tension insulators used in my mechanism, and to arrange these transformers, thus mounted, so that their principal component parts are wholly or partially immersed in the oil contained in the casing. The transformers thus contemplated are used for generating currents employed in heating the cathode filaments of the X-ray tube and various valve tubes, these valve tubes being mounted bodily upon the aforesaid cover of the casing, and connected with the transformers last mentioned, by very short leads.

Reference is made to the accompanying drawings forming a part of this specification, and in which like reference characters indicate like parts throughout the several figures.

Figure 1 is a view showing the oil tank serving as a housing and the mechanism contained therein, and is a section on the line 1—1 of Figure 2, looking in the direction indicated by the arrows.

Figure 2 is a section on the line 2—2 of Figure 1, looking in the direction indicated by the arrows.

Figure 3 is a section on the line 3—3 of Figure 1, looking in the direction indicated by the arrows.

Figure 4 is a plan view of the mechanism shown in Figure 3.

Figure 5 is a vertical section through one of the high tension insulators, and shows the transformer carried thereby.

Figure 6 is a diagram of the wiring.

A tank 7 serves the double purpose of an oil tank and a casing for containing most of the mechanism. This tank is provided with a cover 8, in the form of a flat plate, detachably fitted upon the tank and serving as a support for a portion of the mechanism.

Located within the bottom of the tank and spaced widely apart are a pair of pillow sills 9, 9, and extending upwardly from them are lifting posts 10. Each lifting post is provided with a neck portion 11 extending through a hole in the pillow sill, and secured by a nut 12, as indicated by dotted lines in Figure 2. The lifting posts each extend from bottom to top of the tank, and are each provided with an eye 13. There are four of these eyes, and they are useful in lifting out of the tank the mechanism therein contained, whenever this is desirable.

Disposed adjacent the pillow sills 9, 9, and parallel thereto, are foot sills 9^a of which there are two. Extending crosswise of the pillow sills 9, 9 and foot sills 9^a, 9^a are a pair of tie beams 15, 15, shown more particularly in Figure 3. These tie beams are secured to the pillow sills 9, 9 by means of bolts 16, as may be understood from Figures 1 and 2.

A transformer core is shown at 17, and rests upon the pillow sills 9, 9, as indicated in Figure 3. Disposed upon opposite sides of the transformer core are a pair of clamping blocks 18, 18, each provided with a relatively thick portion 19, as indicated more particularly in Figure 2.

Bolts 20 of the form shown in Figure 3 each extend through one of the clamping blocks 18, 18, and also through a spacing block 18^a, one of the tie beams 15, and one of the foot sills 9^a.

Mounted upon the transformer core 17, which is in this instance inclosed, are two distinct primary windings 21, 22, and encircling these windings are four secondary windings 24, 24^a, 25, 25^a. However, this particular type of transformer is not essential. The transformer can be made of any form known in the prior art.

Each foot sill 9^a, 9^a, is provided adjacent its ends with a number of slots 26, each preferably being a saw kerf, and relatively shallow. Fitted into the slots 26 and thus resting upon the foot sills 14 are a number of condenser plates 27, 28, so grouped as to constitute two distinct condensers, located adjacent opposite ends of the foot sills 9^a, 9^a.

Located within the upper portion of the

tank is a condenser block 30 of the form shown in Figure 3. It extends entirely across the tank, and is provided with a pair of downwardly extending portions 31, 31, formed to engage the upper edges of the condenser plates. For this purpose the downwardly extending portions 31, 31 are provided with slots 32, into which the upper edges of the condenser plates extend. Thus the condenser plates are firmly fixed in position, being held at both top and bottom.

Conductively connected with the condensers and extending upwardly therefrom are a number of metallic strips 33, 33, arranged in two sets as shown, and at the top connected with the condenser terminals appearing at 34, 35. Similarly, a number of condenser strips 36, 36, lead to the condenser terminals 37, 38, as shown in Figure 1.

Thus one condenser, made up of the plates 27, has its terminals 37 and 38, and the other condenser, made up of the plates 28, has its terminals 34 and 35.

A switch base 39, having the form of a plate, is mounted upon the clamping blocks 19, and by means of screws 40 is secured directly to the relatively thick portion 19 thereof.

Carried by the switch base 39 and extending upwardly therefrom is a rocking shaft 41 made of metal, a stationary post 42 also of metal, and an actuating shaft 43. This actuating shaft is made of metal, and extends through a hole in the cover 8, which serves as a bearing. The actuating shaft 43 is adapted to be rocked. The switch base 39 also carries a metallic post 44 which is stationary and which extends upwardly from it like the post 42.

The two shafts 41 and 43 and the two posts 42 and 44 are provided with tubular insulating members 45.

Mounted rigidly upon the actuating shaft 43 is a crank 46, and a similar crank 47 is mounted upon the upper end of the rocking shaft 41. A pitman 48 extends from the crank 46 to the crank 47, in order to enable these two cranks to be actuated in unison, by rocking movements of the actuating shaft 43.

A contact arm 49 is mounted rigidly upon the rocking shaft 41, and another contact arm 50 is mounted rigidly upon the actuating shaft 43. A metallic post 61 is located midway between the rocking shaft 41 and the actuating shaft 43.

The parts just described are so formed and arranged that when the actuating shaft 43 is turned in a clockwise direction according to Figure 1 the two contact arms 49 and 50 are brought into engagement with the metallic post 61 and thus into metallic communication with each other, and when the actuating shaft 43 is turned in a counterclockwise direction according to this figure, the contact arms 49 and 50 are disengaged

from each other, the contact arm 49 being brought into contact with the contact button 51, carried by the metallic post 42 and virtually forming a part thereof, the contact arm 50 being brought into engagement with the contact button 52, carried by the post 44 and constituting practically an enlarged portion thereof.

Mounted rigidly upon the upper end of the actuating shaft 43 is a rocking arm 53, of the form shown more particularly in Figure 4. Associated with the rocking arm 53 is an indicator 54, shown more particularly in Figure 4, and provided with legends High and Low, these legends referring respectively to the voltage to be controlled by aid of the actuating shaft 43, or rather by the switch of which this shaft is a part.

A cord 55 is connected with one end of the rocking arm 53, and connected with the opposite end of this rocking arm is another cord 56. The cords 55 and 56 are threaded through eyes 57, and are pulled by hand as occasion requires, in order to shift the rocking arm 53 back and forth, thus operating the switch.

Mounted upon the cover 8 are a pair of binding posts 58, 59, through which current is supplied to the primary circuit of the transformer, and a binding post 60 which is used as a ground connection.

Mounted upon the cover 8 and extending upwardly therefrom are four high tension insulators 62, 63, 64 and 65, which are of tubular form, and are made of insulating material, such as bakelite, electrose, mica, porcelain or glass. They are respectively provided with neck portions 62^a, 63^a, 64^a and 65^a integral with them and also of tubular form, as may be understood from Figure 1, and which extend downwardly through holes in the cover.

These neck portions are encircled by cylindrical sleeves 66, 67, 68 and 69 of insulating material, such as formica, hard rubber composition, electrose or the like, and are accurately formed and fitted.

Each sleeve 66, 67, 68 and 69 is by measurement a little shorter than the neck portion upon which it is mounted, but is of such length as to extend a little below the bottom thereof when the parts are in position and supported by the cover 8, as may be understood from Figure 5. Each sleeve is held in place by a closure plate 70, having the form of a disk and pressing tightly against its lower end, these parts being thus rendered oil-tight.

Encircling the sleeve 68 and thus carried by the insulator 64 is a winding 72, serving as the primary winding of a little step-down transformer for generating small currents of low potential used for heating the cathode filament of an X-ray tube, as hereinafter described. Similarly, two other primary

windings 71 and 73 of the same kind encircle the sleeves 67 and 69, carried by the insulators 63 and 65.

The insulator 62 does not contain any transformer mechanism, but the insulators 63, 64 and 65, carrying the respective primary windings 71, 72 and 73, as above described, contain certain parts coacting with the primary windings, and together therewith constituting three small transformers, one for each of the three insulators.

As the parts carried by the insulators 63, 64 and 65 are alike for each of the three insulators, I will describe these parts with reference to the insulator 65 alone, as shown more particularly in Figure 5.

The insulator 65 is provided internally with an annular shoulder 65^b, and resting upon this shoulder is an anchor disk 65^b, made of metal and provided with a socket 65^c, integral therewith and extending upwardly therefrom.

A metal bolt 65^d extends downwardly through a hole in the disk, and is fitted in place by means of a bushing 65^e.

Below the anchor disk 65^b is a laminated core 65^f of soft iron, fitted into a tube 65^g of insulating material, such as formica, bakelite, electrose or the like, and encircling this tube is a winding 65^h comprising a few turns of coarse wire. This winding is a secondary winding mating the primary winding 73 above described; these windings and the parts immediately associated therewith constituting a step-down transformer.

A supporting strip 65^k, made of metal, preferably iron or steel, extends centrally through the core 65^f, and for most practical purposes may be considered as a part thereof. The supporting strip is at its upper end secured to the bolt 65^d, its lower end being fastened to a screw 65^l. This screw extends through a hole in the closure plate 70, and is engaged by a nut 65^m and washer 65ⁿ. By tightening the nut 65^m the supporting strip 65^k is placed under tensile strain, and the parts carried by it are thus held firmly in position. In order to remove the core and secondary winding, the nut 65^m is loosened, and with the washer 65ⁿ removed.

The anchor disk 65^b can then be lifted out, carrying with it the core and secondary winding, and this group of parts may now be handled practically as a single unit.

The removal of the nut 65^m disengages the closure disk 70, and thereby releases the sleeve 69 and primary winding 73.

The oil level of the oil tank 7 is indicated in Figure 3 by a line, and the legend "Oil level".

With the high tension insulators mounted in position upon the casing and the casing filled to the level indicated with the oil, the three primary windings 71, 72 and 73 are completely immersed in oil, and thereby

thoroughly insulated. Even the laminated cores and primary windings have additional insulation because of the body of oil encircling them at their lower ends. Not only that, but it is merely a matter of engineering to build the cores and secondary windings of such size, and so locate them, that they will be wholly below the level of the oil in the tank, and by so doing to still further improve their insulation.

Whenever the cover 8 is removed or replaced, it carries with it the three step-down transformers, just described, so that the cover with its high tension insulators and the low tension transformers may in practice be handled as a single unit.

The low tension transformers are connected with the cathode filaments, as indicated in Figure 6.

A pair of valve tubes are shown at 74, 75, and are used as rectifiers for the high tension currents.

The valve tube 75 is mounted upon the insulator 62 and extends upwardly therefrom, with its cathode end upward. A metallic sphere 76 is connected with the upper end of this valve tube, and is provided with a high tension tap 77, rounded to prevent corona. This tap serves practically as a high tension binding post. A clip, not shown, is detachably gripped upon it at any time, in order to connect it up with inside mechanism of any kind to which high tension currents are to be supplied.

A metallic tube 78 is connected with the sphere 76, and serves partially as a support therefor. This metallic tube is at its lower end fitted into the socket 65^a, located within the upper end of the high tension insulator 65, above described and shown in Figure 5, and extends therefrom obliquely upward to the left according to Figure 3.

In a similar manner the valve tube 74 is supported upon the insulator 64, the cathode end of the tube extending upward. Above the valve tube 74 is a metallic sphere 79, carrying two taps 80 and 81, like the tap 77. The sphere 79 is connected with a metallic tube 82, the latter being mounted upon the insulator 63 and extending therefrom obliquely upward to the right according to Figure 3.

The various parts above described are connected up as indicated in the diagram shown in Figure 6. The mechanism can be used in two ways, according to the condition of the switch mechanism, as indicated by full and broken lines in Figure 6.

An X-ray tube is shown at 83, its anode and cathode ends being indicated by plus and minus signs. The X-ray tube is not housed within or supported by the casing, and may be located at any point outside thereof, as may be convenient for the purpose.

The various electrical connections are shown diagrammatically in Figure 6.

From the cathode end of the X-ray tube 83 a conductor 84 leads to a junction 85; and a shorter conductor 84^a which includes a secondary winding 65^b of the kind shown in Figure 5 and above described, is tapped on to the conductor 84. From the junction 85 a conductor 86 leads to the condenser 27, another conductor 87 leads to the stationary contact post 42, and another one 88^a to the secondary winding 24^a.

From the anode end of the X-ray tube 83 a conductor 88 leads to a junction 89, and from thence three conductors 90, 91 and 92 lead respectively to the condenser 28, the stationary contact post 52 and the secondary winding 25.

Connected with the secondary winding 25^a are a pair of conductors 93, 93^a, leading to the cathode end of the valve tube 74, the conductor 93^a including a secondary winding 65^b of the kind shown in Figure 5, this secondary winding mating the primary winding 72 above described. From the anode end of this tube 74 a conductor 94 leads to a junction 95, and thence two conductors 96 and 97 lead respectively to the condenser 27 and the rocking post 41.

A conductor 98 leads from the actuating shaft 43 to a junction 99, and thence a conductor 100 leads to the condenser 28, and a pair of conductors 101, 101^a lead to the cathode end of the valve tube 75, the conductor 101^a including a secondary winding 65^b above described, this secondary winding mating the adjacent primary winding 73. The anode end of the valve tube 75 is connected by a conductor 102 with the main secondary winding 24.

Two conductors 103 and 104 are connected with the respective binding posts 58 and 59. The conductor 103 is also connected with two conductors 105 and 106, the conductor 105 including the main primary winding 22, the conductor 106 similarly including the main primary winding 21.

Thus the two main primary windings 21 and 22 are in parallel with each other with respect to the binding posts 58 and 59, through which they are energized, from any suitable source of alternating current.

The primary windings 71, 72 and 73, in parallel with each other, are bridged across the conductors 103 and 104 in any suitable manner, as for instance, by the conductors shown at 107, 108, 109, 110, 111, 112, 113, 114, 115 and 116, arranged as indicated in the diagram, Figure 6.

The main primary circuit may be traced as follows: source of alternating current (not shown), binding post 58, conductor 103 whence the circuit divides, one branch being through conductor 105 and thus through the

primary winding 22, the other branch being through the conductor 106 and thus through the primary winding 21, the two branches merging together in conductor 104, thence to binding post 59 to source of supply. This circuit energizes the main transformer.

The main secondary circuit is different at different times, depending upon the condition of the electric switch as controlled from time to time by the operator; by aid of the two cords 55 and 56, and as indicated by the diagram shown in Figure 6.

If the operator wants the machine to generate uniform currents of relatively high voltage, he pulls the cord 55, and thereby brings the electric switch into the condition shown in Figures 1 and 2 and indicated by full lines in the diagram shown in Figure 6.

The secondary circuit through the X-ray tube 83 may now be traced as follows:

X-ray tube 83, conductor 88, junction 89, conductor 92, main secondary windings 25 and 25^a, conductors 93 and 93^a, valve tube 74, conductor 94, junction 95, conductor 97, rocking shaft 41, contact arms 49 and 50 (now in contact) actuating shaft 43, conductor 98, junction 99, conductors 101 and 101^a, valve tube 75, conductor 102, secondary windings 24 and 24^a, conductor 88^a, junction 85 and conductor 84 back to X-ray tube 83.

The circuit just traced remains unaltered so long as the switch mechanism remains undisturbed, and the discharge through the X-ray tube is always in the same direction. The continuity of the discharge is due to action of the condensers.

It will be noted that the two condensers 27 and 28, while not included in the circuit just traced, are nevertheless each bridged across a part of the circuit, in such manner as to store up considerable quantities of electric energy. This arrangement of the condensers enables the machine to maintain the voltage almost continuous, which is an object of great value for therapeutic purposes.

It may also be noted that in the circuit just traced each secondary winding produces one half of the terminal voltage and each valve tube rectifies one half of the total current. It will also be observed that while the electric stresses due to the high voltage are very great, they are as far as practicable distributed uniformly throughout the system.

When the operator wants to produce pulsating relatively heavy currents of lower voltage and to cut out the condensers, he simply pulls the cord 56. This places the machine in the condition indicated by broken lines in the diagram in Figure 6.

The main secondary circuit now has two branches in parallel with each other, and may be separately traced with reference to its two branches, as follows: first, X-ray tube 83, conductor 88, junction 89, conductor 92, main

secondary windings 25 and 25^a, conductors 93, 93^a, valve tube 74, conductor 94, junction 95, conductor 97, rocking shaft 41, contact arm 49 (broken lines), contact button 51 of stationary post 42, conductor 87, junction 85 and conductor 84, 84^a, back to X-ray tube 83. Second, X-ray tube 83, conductor 88, junction 89, conductor 91, contact button 52 of stationary post 44, contact arm 50 (broken lines), actuating shaft 43, conductor 98, junction 99, conductors 101 and 101^a, valve tube 75, conductor 102, main secondary windings 24 and 24^a, conductor 88^a, junction 85, and conductors 84 and 84^a, back to X-ray tube 83.

It may be noted that with the machine in the condition indicated by broken lines in Figure 6, the X-ray tube is energized, first by a current generated in the main secondary windings 25 and 25^a and passing freely through the valve tube 74, and then by a current generated in the main secondary windings 24 and 24^a and passing freely through the valve tube 75. If now the primaries of the two high tension transformers are connected as shown in Figure 6, then current will flow through one valve tube during one-half cycle and through the other valve tube for the following one-half cycle; if however, the polarity of one of the primaries of the high tension transformers is reversed, then both valve tubes will pass one of the two impulses at the same time, but the voltage and the load upon the valve tubes will thereby not be noticeably affected. The X-ray tube, however, in the former case receives during one cycle two small impulses, and in the latter one impulse of double magnitude.

The arrangement contemplated by Figure 6, with the switch in the condition indicated for it by full lines in that figure, is of peculiar value for therapy, and especially for penetrating the heaviest portion of the body, for which I found the uniform voltage current to be particularly efficient. As an independent consideration, the current loads as well as the voltages are here well distributed and with reasonable care no trouble need occur.

By short-circuiting the condensers and throwing them out of action as indicated by broken lines in Figures 6, all time lag due to capacity is done away with, and then short time exposures can be readily made.

I do not limit myself to the precise mechanism shown, as variations may be made therein without departing from my invention, the scope of which is commensurate with my claims.

I claim:

1. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer located within said oil tank, a cover mounted upon the top of said oil tank and normally closing the same, a high tension in-

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- insulator carried by said cover and extending downwardly therethrough to a point below the upper level for oil therein, a conductor connected with said transformer and extending through said insulator, and a valve tube mounted upon said high tension insulator and supported thereby, said valve tube having a pair of electrodes, one of which is connected with said conductor.
2. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer located within said oil tank, a flat cover mounted upon the top of said oil tank and normally closing the tank, a high tension insulator carried by said cover and extending upwardly therefrom, a valve tube supported by said insulator and extending vertically upward from the same, said valve tube being provided with an anode and a cathode, said cathode being connected with said high tension transformer, and low tension transformer mechanism carried by said insulator and connected with said cathode, for supplying to said cathode currents for heating the same.
3. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer located within said oil tank, a cover mounted upon said oil tank and normally closing the same, a high tension insulator mounted upon said cover and extending therethrough, a conductor extending through said insulator and connected with said high tension transformer, a valve tube mounted upon said insulator and provided with an anode and a cathode, said cathode being connected with said conductor, and a low tension transformer connected with said conductor for the purpose of supplying heating currents to said cathode, said low tension transformer being carried bodily by said insulator.
4. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer mounted within said oil tank, a cover carried by said oil tank and closing the same, a high tension insulator supported by said cover and extending therethrough into said tank, a low tension transformer carried by said insulator and housed therein, a valve tube connected with said insulator and provided with an anode and a cathode, and conductors connected with said cathode, from the secondary of said low tension transformer.
5. The combination of an oil tank, a cover mounted upon said oil tank and normally closing the same, an insulator carried by said cover and extending therethrough into said oil tank, a valve tube connected with said insulator and provided with an anode and a cathode, a low tension transformer carried by said insulator and housed within said tank whenever said tank is closed by said cover, and conductors connected with said low tension transformer and extending to said cathode, for supplying heating current to said cathode.
6. A housing mechanism for X-ray systems comprising an oil tank serving as a transformer casing, a high tension transformer housed within said oil tank, a cover mounted upon said oil tank, a high tension insulator carried by said cover and extending therethrough to a point below the upper level for a body of oil therein, low tension transformer mechanism carried by said insulator and extending downwardly into said tank and thus insulated by said body of oil therein, a valve tube connected with said insulator and extending therefrom, said valve tube being provided with an anode and a cathode, and conductors connected with said cathode and with said low tension transformer, for enabling said low tension transformer to supply heating current to said cathode, said conductors being also in electrical communication with said high tension transformer.
7. A housing mechanism for X-ray systems, comprising an oil tank serving as a casing, a high tension transformer mounted within said casing, a high tension condenser mounted within said casing and connected with said high tension transformer, a cover mounted upon said oil tank, an insulator carried by said cover and extending upwardly therefrom, a valve tube connected with said insulator and extending therefrom, said valve tube being provided with an anode and a cathode, connections from said cathode and said anode to said high tension transformer and said high tension condenser, the connection from said cathode extending through said insulator, and a low tension transformer carried bodily by said insulator and in electrical communication with said connections from said cathode to said high tension transformer.
8. The combination of an oil tank, a high tension transformer and a high tension condenser located within said oil tank so as to be insulated and cooled by a body of oil therein, a cover closing said tank, a valve tube located above said cover and provided with an anode and a cathode, connections from said anode to said high tension transformer and said condenser, a low tension transformer supported by said cover for the purpose of supplying heating currents to said cathode, and electrical connections from cathode to said high tension transformer and said condenser.
9. An X-ray apparatus, comprising an oil tank and a transformer contained within said oil tank and located below the oil level thereof, a flat cover to close said tank, and a high
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tension insulator extending through said cover and terminating in said tank below said oil level, a valve tube carried by said insulator and located outside of said tank, and connections between the high tension transformer and the valve tube.

10. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer located within said oil tank, a flat cover mounted upon the top of said tank and normally closing the same, a high tension insulator carried by said cover and extending upwardly therefrom, and a valve tube supported by said high tension insulator and extending vertically upward from the same, said valve tube being provided with a cathode, said cathode being connected with said high tension transformer.

11. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer located within said oil tank, a cover mounted upon said oil tank and normally closing the same, a high tension insulator carried by said cover and extending therethrough into said oil tank, a conductor extending through said high tension insulator and connected with said high tension transformer, a valve tube mounted upon said high tension insulator and provided with an anode, and a cathode, said cathode being connected with said conductor and a low tension transformer disposed adjacent said cover and connected with said conductor, for the purpose of supplying heating currents to said cathode.

12. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer housed within said oil tank, a cover

mounted upon said oil tank, a high tension insulator carried by said cover and extending through said cover to a point below the upper level for a body of oil therein, a valve tube carried by said high tension insulator and extending therefrom, said valve tube being provided with an anode and a cathode, and a conductor connected with said cathode and extending therefrom to said high tension transformer.

13. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer located within said oil tank, a flat cover mounted upon the top of said tank and normally closing the same, a high tension insulator carried by said cover and extending upwardly therefrom, and a valve tube supported by said high tension insulator and extending vertically upward from the same, said valve tube being provided with an anode, and a connection from said high tension transformer to said anode.

14. A housing mechanism for X-ray systems, comprising an oil tank serving as a transformer casing, a high tension transformer housed within said oil tank, a cover mounted upon said oil tank, a high tension insulator carried by said cover and extending through said cover to a point below the upper level for a body of oil therein, a valve tube carried by said high tension insulator and extending therefrom, and connections from said valve tube to said high tension transformer for enabling said transformer to energize said valve tube.

Signed at New York city, in the county of New York and State of New York, this 23 day of April, 1927.

ARTHUR MUTSCHELLER.