

Sept. 13, 1932.

J. B. WANTZ

1,877,260

X-RAY APPARATUS

Filed June 14, 1928

2 Sheets-Sheet 1

FIG. 1

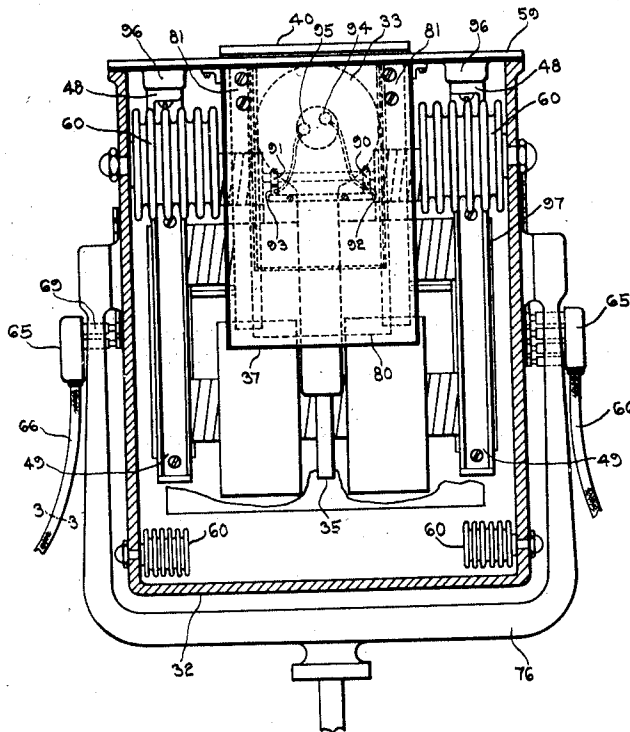


FIG. 2

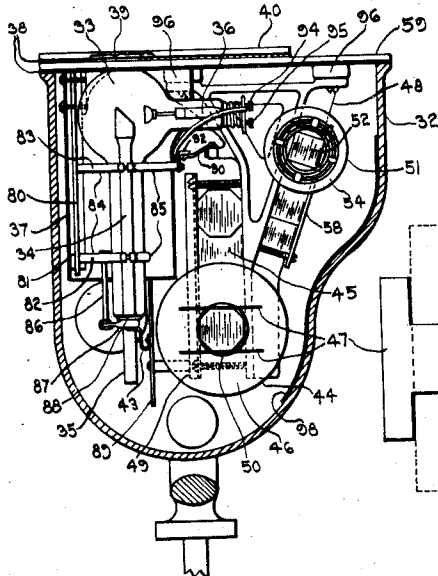


FIG. 3

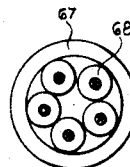


FIG. 5

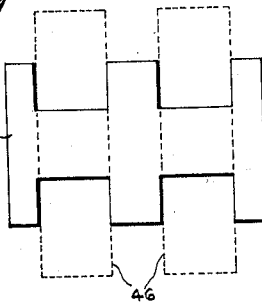


FIG. 4

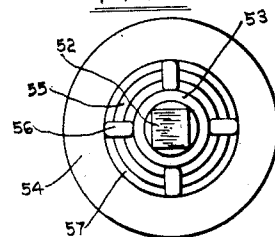
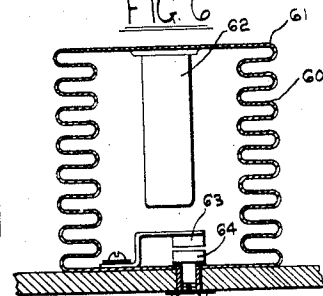


FIG. 6



INVENTOR

JULIUS B. WANTZ

BY *Clayton H. Wood*
ATTORNEY

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2 Sheets-Sheet 2

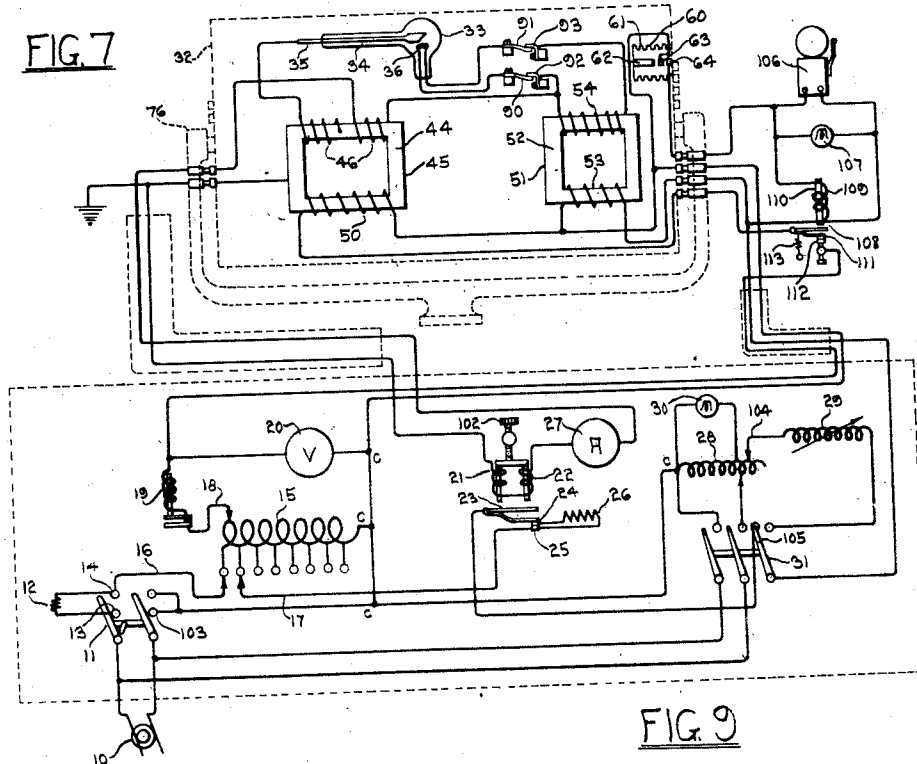


FIG. 9

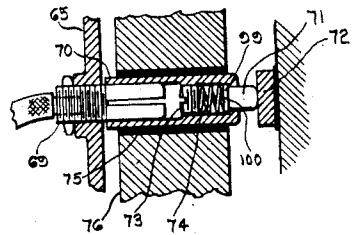
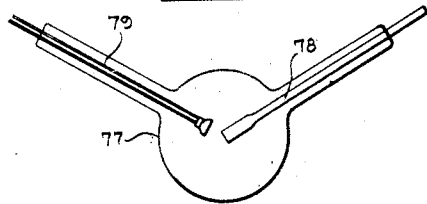


FIG. 8



INVENTOR

JULIUS B. WANTZ

BY *Clayton H. Hargrave*
ATTORNEY

UNITED STATES PATENT OFFICE

JULIUS B. WANTZ, OF OAK PARK, ILLINOIS, ASSIGNOR TO VICTOR X-RAY CORPORATION,
OF CHICAGO, ILLINOIS, A CORPORATION OF NEW YORK

X-RAY APPARATUS

Application filed June 14, 1928. Serial No. 285,390.

The present invention relates to X-ray instrumentalities and has particularly to do with the application of and mounting for an X-ray tube adapted to perform all types of work, the insulation thereof, and a means whereby its effectiveness may be increased. The invention also has to do with the character of tube which is employed.

Heretofore oil-immersion for insulation and safety has been employed in connection with X-ray tubes of relatively limited capacity. The present invention contemplates the employment of a tube adapted for all radiographic and fluoroscopic work of a normal character.

It is, in short, an adaptation of oil-immersion to a tube having a capacity for all types of conventional X-ray work.

Among the objects of the invention, are included, the following:

The provision of an oil-immersed unit comprising an X-ray tube which has such capacity that it will be capable of performing all normal radiographic work; and

The provision of an X-ray tube unit for normal radiography and fluoroscopy in which the dangers from exposed high tension wires is avoided and uncontrolled X-radiation is eliminated;

To supply a unit of the type hereinafter described wherein an X-ray tube of novel construction is employed, and wherein such tube is especially modified to render it highly useful for the purposes in hand;

To provide a device of the character described having means for blocking off secondary radiations from the wall of the tube, the oil, or any object or objects in the path of the X-light;

The employment of safety devices whereby either a visual or audible signal or both will be actuated when the temperature of the tube or its surrounding accessories and elements reaches a dangerous point;

The provision in a device of the character hereinabove referred to of means for stabilizing the passage of current through the X-ray tube in combination with auxiliary means for controlling the electromotive force

in the event such stabilizing means is rendered inoperative;

Novel means for making electrical connections upon such a device and whereby the kinking or twisting of cables, due to movement of the device, is prevented; and

The provision of a novel structure adapted to be employed for the various purposes herein recited.

These objects, and such other objects as may hereinafter appear, are obtained by the novel construction, combination, and arrangement of the several elements which constitute the invention, one embodiment of which is shown in the accompanying drawings, in which:

Figure 1 is a vertical section, parts of the device being shown in full lines;

Figure 2 is a similar section at right angles to Figure 1 and comprises a sectional side elevation of the embodiment;

Figure 3 is a transverse section of the line 3-3 of Figure 1;

Figure 4 is a sectional view of a portion of the filament transformer employed showing the novel means of insulation therein;

Figure 5 is a plan view of a spacer used for supporting and spacing the secondary of the high tension transformer, one from the other;

Figure 6 is a section of one of the expansion and contraction devices showing contact mechanism in association therewith;

Figure 7 is a schematic diagram of the circuits and connections employed in the apparatus;

Figure 8 is an elevation of an X-ray tube which may be employed in the apparatus;

Figure 9 is an enlarged section of one of the contact mechanisms employed for making connections between the cable and the transformers and other apparatus within the insulating tank.

Like reference characters are used to designate similar parts in the drawings, and in the description thereof hereinafter given.

Reference should be had first to Figure 1. The numeral 76 is used to designate a bifurcated member adapted to support the entire apparatus, such bifurcated member com-

prising a part of any desired X-ray tube mounting apparatus.

The X-ray tube employed and its energizing instrumentalities hereinafter to be described, are disposed within a tank 32 of suitable material and having at opposite sides thereof reinforced portions, ears or lugs which are adapted to support pivots seated within the ends of the bifurcated member 76.

10 The tank 32 comprises a unitary receptacle open at its top, which top is closed by a cover 59. Supported upon such cover 59 is an auxiliary cover 40 upon which the X-ray tube 33 and its shielding is mounted, the sub-cover 40
15 being composed of a material a portion of which at least is transparent to X-light.

As is indicated in Figure 2, a window 39 may be employed in the sub-cover 40 to facilitate the passage of the X-radiation there-
20 through.

The tube 33 comprises an anode 34 at right angles to the cathode 36. Secured to the auxiliary cover 40 is a tube-supporting board 80 which depends into the tank 32, such board
25 being adapted to be slidably mounted upon tracks 81 disposed at opposite sides thereof, and suitably and rigidly secured in the tank 32 so that a tube board 80 when inserted therein maintains the tube 33 mounted there-
30 in in a fixed position for engagement with a plurality of contacts therefor and fixedly disposed within the tank 32.

Near the bottom of said slidable base 80 as shown in Figure 2, is a plurality of brackets 82 and 83 for securing the X-ray tube 33, such
35 brackets comprising a Y-shaped member 84 adapted to engage the stem of the tube 33 at one side and a clamping member of U-shape 85 adapted to be secured to said Y-shaped
40 member 84 whereby the stem of the tube 33 is firmly held between said Y-shaped member and said U-shaped device.

The anode 34 of the tube 33 has an extension portion 35, as previously recited, which
45 projects beyond the envelope of the tube 33 to increase the radiation to the oil surrounding such tube, of the heat generated in the anode of the tube.

Depending from one of said clamping devices 82 is a support 86 for an anode stem carrying an encircling member 87. Such
50 ring is adapted to impinge the stem 35 of anode 34 of the tube, said stem 35 having a shoulder 88 for limiting the movement of
55 said stem 35 into ring member 87.

When the tube supporting board 80 and the tube 33 thereon are in place, the ring 87 or the anode stem 35, or both, impinge the spring
60 contact 43 projecting outwardly from a bakelite or other shield 89 disposed intermediate the tube 33 and the secondary of the high tension transformer for insulation purposes.
The contact 43 is suitably disposed upon said
65 shield 89 and the area of the latter is sufficient to extend above and below the exterior turns

of the secondaries and well beyond the limits of the exposed stem 35. A suitable connection intermediate the contact 43 and one terminal of the secondaries is provided.

As has been previously indicated, the tube 70 33 is a right-angle tube. Adjacent its shorter stem, which stem provides a housing for the cathode 36, are two contacts, 90 and 91, one of which 90 is electrically connected to the other terminal of said high tension trans- 75 former secondaries and to one side of the filament current transformer secondary. The other of said contacts 91 is electrically connected to the opposite terminal of the secondary of the filament current transformer. 80 The stationary contacts 90 and 91 cooperate with movable contacts 92 and 93 secured to the tube supporting bracket 83. These last named contacts are in electrical connection with the cathode terminals 94 and 95 by means 85 of a suitable connection such as a wire as shown. It is so arranged that when the tube 33 is forced into position within the tank 32, electrical contacts with the anode and with the cathode are automatically made. When 90 electrical energy is supplied to the high tension and filament current transformers within the tank 32 the resultant electromotive force induced in the secondaries of such trans- 95 formers is impressed upon the anode, and filament of the tube 33, through the electrical conduits herein outlined.

It should be manifest at this point that the apparatus could be employed without the sectional cover 40 and in conjunction with an X-ray tube permanently secured within the
100 tank 32.

Upon the underside of the cover 59 are a plurality of bosses, 96, from which depend two brackets 48 of a generally triangular configuration. Intermediate and upon such
105 brackets 48 are disposed the high tension transformer and the filament current transformer. Said high tension transformer comprises a single primary and two secondaries. 110 The filament current transformer is of the usual step-down type whereby a low voltage, say 10-15 volts, is adapted to be impressed upon the filament forming a part of the cath- 115 ode of the tube.

The high tension transformer 44 comprises a core 45 and has two secondaries 46. Spacer strips 47 are arranged within said secondaries for supporting and spacing said high tension secondaries, one from the other, and from 120 the core 45. These parts are all supported, as previously indicated, by the main transformer supporting castings 48, and a clamping iron 49 is employed for holding the core 44 of the high tension transformer in a position against said casting 48. 125

The primary of said high tension transformer is designated 50, and it is adapted to be surrounded by said two secondaries 46. The filament transformer is designated by the 130

numeral 51 and comprises a core 52, a primary 53, and a secondary 54. Within the filament transformer is employed an insulating tube 55, and also insulating spacers 56. Clear oil insulation 57 is thus provided between the primary 53 of the filament transformer and the secondary thereof 54. Said core 52 is secured upon bracket 48 by the employment of a clamping iron 58, the manner of securing said core in position being substantially the same as for the core of the high tension transformer.

A shield of X-ray protective material of suitable configuration, designated 37, is arranged about the X-ray tube 33. A second protective sheet 38 is disposed on the under side of the covers 40 and 59, and is provided with a window 39 therein through which the X-light generated in said tube 33 may pass, the adjacent or contiguous portion of the cover 40 being transparent to X-light. A suitable slot is arranged in the shielding 37 to receive the cathode stem of the tube 33, auxiliary shields made of material opaque to X-rays being provided as indicated at 97 on the outside surfaces of the brackets 48 and as shown at 98 on the inside surface of the tank 32. On each side of the tank 32 is a plurality of expansion and contraction devices 60. Each of these devices comprises a tube 61 adapted to be expanded or contracted with the expansion and contraction of the oil within the tank 32, the increased or decreased temperature of such oil causing appreciable volume variation therein. The arrangement illustrated in Figure 6 is the usual arrangement therefor, such expansion and contraction devices comprising a sealed vessel having flat ends and an expansible and compressible cylindrically corrugated side wall.

One of these devices 60 is arranged as illustrated in Figure 6, and carries a pusher rod 62 which is soldered to the tube 61 or otherwise secured therein. Said rod 62, when the upper wall of said cylinder 61 is pressed downwardly as an incident to the expansion of the oil within the tank 32 coincident with the heating thereof, is adapted to impinge the movable contact 63, movement of such contact 63 being in the direction of and against a stationary contact 64. Contacts 63 and 64 when closed are adapted to close a circuit either to an audible or a visible signal as is hereinafter described, and may also be arranged to actuate a circuit breaking relay as illustrated. Necessarily one of said contacts, 63 or 64, is electrically connected to one side of a suitable circuit, and the other contact to the other side of such circuit, the two contacts being insulated one from another excepting when in impinging relation. As shown, the electrical connection to the movable contact is through the material of the expansion and contraction device 60, while

fixed contact 64 is electrically connected to the other side of the circuit and is insulated from the expansion and contraction device material and the wall of the tank 32. If so desired a plurality of these contacting devices could be provided if for any reason such structure would be thought advantageous for the actuation of a plurality of signal or safety devices.

A connection plug, novel to the present device, is indicated generally by the numeral 65. Such plug is the terminal for a cable 66 comprising a flexible insulating tube of rubber or similar substance 67 and surrounding a plurality of conduits or wires 68. Such wires unlike ordinary cables are not fixed but are relatively movable with respect to each other and to the sheath 67 whereby the resistance to bending incident to ordinary cable construction is overcome and an extremely flexible cable secured. The contact members of said connection plug 65 are designated 69 and are each insulated from the other by the material of the casing. Such connections 69 are adapted to protrude into a socket or sleeve 70 disposed in but insulated from the material of fork 76. Said sleeve 70 terminates in a brush member 71 which is adapted to impinge a slip ring 72 upon the tank 32 and insulated therefrom. The sleeve 70 terminates in a constricted neck which is adapted to hold the brush member 71 seated because of the collar 99 thereon. A tensioning screw 73 is provided in said sleeve 70 and this is adapted to regulate the pressure upon a coil spring 74 which presses brush 71 outwardly. A pig tail 100 is provided for proper electrical conductivity. Insulation 75 is provided about said socket 70 so that there will be no electrical connection with the material of tank 32, and this insulation is adapted to provide a seat for said socket firmly in the arm 76.

Reference should now be had to Figure 7. This is a schematic layout of the circuit employed in conjunction with the present invention.

The circuits comprise a source of power 10, with conduits leading to a main switch 11. Other conduits from the source of power and not controlled by said main switch 11 extend to a selector switch 31 for cutting into and out of circuit the stabilizer and filament regulator there shown.

In the main switch 11, a lead resistance 12 is bridged across contacts 13 and 14 thereof. There are corresponding contacts upon the opposite side of said switch. In one position, the current must pass through the lead resistance 12, but by further movement, the contacts bridged by the blades of the switch are changed and the lead resistance 12 is cut from the circuit.

From the switch 11, conduits are arranged to an auto-transformer 15 which is adapted

to compensate for line variation and to provide for controlling the electromotive force impressed across the primary of the high tension transformer forming a part of the circuit.

5 A variable primary tap for taking care of line variations and designated 16 is employed. A variable secondary tap 17 for varying the voltage across the filament circuit may also be employed.

10 The numeral 18 designates a variable tap for varying the voltage across the high tension transformer primary, and a series overload breaker 19 is provided.

A voltmeter 20 is employed for indicating the voltage across the primary of the high tension transformer 44.

The primary of said transformer 44 is designated 50. The secondary of said high tension transformer is divided and is designated 46. The core of said transformer is marked 45 and one of the secondaries 46 at its center is grounded to said core.

To the secondaries and at their center, a stabilizer 21 comprising coils 22, and an armature 23, the latter being spring actuated, is always employed with an apparatus of this character. In connection with the stabilizer 21 is a movable contact 24, and a stationary contact 25. A resistance for the stabilizer is designated 26. Such stabilizer is adapted to operate in the usual manner of stabilizers, the setting thereof depending upon the distance between the armature and the core, which is subject to variations and regulation by the handle 102.

The circuit through the stabilizer to the primary 53 of the stepdown (filament) transformer 52 is from one terminal of the high tension transformer primary 50 to one terminal of the step down transformer primary 53 across said primary, to selector switch 31 to armature 23, to contact 24, to contact 25 direct or through resistance 26 according as whether contacts 24 and 25 are open or closed, to the other side of the line through autotransformer 15.

An ammeter 27 is provided in the circuit from the center of the secondaries 46 for measuring the amperage of currents passing through the tube 33.

The filament transformer 51 comprises a core 52, a primary 53, and a secondary 54. The stabilizer 21 in circuit with the primary of said transformer 51, is adapted to regulate the current passing through the tube 33 comprising the anode 34 having an extension stem 35, and a cathode 36. As is usual one leg of the high tension and of the filament transformers are common. By the voltmeter 20 the electromotive force impressed across the tube 33 may be determined by calibration with ammeter 27. The circuits to the tube 33 from the transformers is conventional.

When it is desired to use the apparatus without the stabilizer 21, switch 31 is closed.

Such a switch 31 called a selector switch is arranged to cut in and cut out of the circuit the said stabilizer.

An auxiliary auto-transformer 28 provided for adjusting the voltage to a correct value for use with a separate filament current regulator, such separate filament regulator being designated 29, is thus brought into circuit, the circuit then being from post 103 of switch 11, auto-transformer 28, autocontact of switch 31 to the other side of switch 11. The auto-transformer 28 being thus energized, it delivers energy to the filament regulator 29 across blade 105 through wire to primary 53 of filament transformer, and then returns to the line side of the auto-transformer 28.

A signal light 30 is provided to indicate when the auto-transformer 28 is in and out of circuit, such light burning only when the auto-transformer 28 is in circuit.

The contacts or plugs 76 at opposite sides of the tank 32 provide the necessary electrical connection from the interior of the tank externally thereto for the impression of electromotive force upon the high tension transformer, the filament current transformer, for the conduits necessary to operate the stabilizer 31, and the electrical connection necessary to operate the audible signal 106 and the visible signal 107 indicative of excessive heat within the tank 32.

These latter signals have in association therewith a circuit including a relay 108 having a coil 109, an armature 110, a movable contact 111 in association with said armature, a fixed contact 112 which fixed contact is adapted to be moved toward or away from said movable contact by an adjusting screw, a spring 113 for holding said contacts 111 and 112 normally in engagement with each other, the energizing circuit for said device and said relay being from one side of the primary of filament transformer 52 to the movable contact 63, the fixed contact 64 when the contact 63 impinges said fixed contact, to a bus to which an electric bell 106, a light 107, and the coil 109 of relay 108 are connected. The other side of these devices being connected together and to the other energizing line of the filament transformer 52.

The circuit to be controlled by the relay 108 is that energizing the primary of high tension transformer 44. One line wire of this circuit is opened and connected across contacts 111 and 112 so that when the circuit is closed through the relay, the movement of the armature 110, and the subsequent movement of the contacts 111 and 112, will open the circuit to the primary of the high tension transformer.

One of the circuits, namely, that to the coil 22 of the stabilizer 21, is grounded externally to the apparatus.

The operation of the device is relatively simple. It would be impossible to build a tank having as a part thereof a single expansion and contraction device which would compensate for all of the expansion incident to the heating of the transformer oil while the device is in operation. In order to save space and procure accuracy of operation, a plurality of such chambers is required, certain thereof being placed in one side of the tank and the remainder in the opposite side thereof. In this way an equalized expansion is obtainable.

One or more of these devices may be provided with contacts 63 and 64 and a pusher rod 62. Thus one of such devices could be employed to operate one type of signal, and a second one thereof to operate a second type. For example, the first could be made to operate a light which would become visible when a certain degree of temperature was reached by the oil within the tank 32. This would be a warning to the operator that the oil is approaching a dangerous point, and would warn him that an extended further use of the tube might possibly be attended with danger although no immediate danger existed.

A second signal could be actuated by a second device provided with the contact and pusher rod referred to, such signalling system to actuate an audible signal such as a bell, the bell to comprise a warning that an excessive temperature has been reached and that the electromotive force energizing the tube is to be cut off immediately, otherwise disaster might follow.

It is conceivable that other arrangement of signals could be employed, the invention comprising means for compensating for the expansion of the oil within the tank, and communicating to the operator thereof information regarding the condition of the tube, that is, whether it is overheated, acting normally, or is approaching a danger point.

I claim:

1. The combination with an X-ray apparatus comprising a tank and a tube, tube energizing instrumentalities mounted in said tank and having oil insulation thereabout, of a bracket to support said tank, a cable comprising a plurality of conduits and detachably connected to said bracket and insulated therefrom, and contacts upon said tank and insulated therefrom whereby to establish electrical connections with the instrumentalities within such tank irrespective of the position of said tank relative to said bracket and without movement of said cable relative to said bracket.

2. The combination with an X-ray apparatus comprising a tank, and a tube and tube energizing instrumentalities in said tank, of a support for said tank, a cable comprising a plurality of conduits, and contacts between

said tank and said cable whereby said cable may be rigidly secured to said support and insulated therefrom, and said tank may be moved relatively to said support without disturbing the electrical connections between the instrumentalities within said tank and said cable irrespective of the position of said tank on said support and without movement of said cable relative to said support.

JULIUS B. WANTZ.

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