

July 8, 1947.

J. W. WEST
ELECTRONIC DISCHARGE DEVICE FOR ULTRA
HIGH FREQUENCY ENERGY GENERATION
Filed Jan. 7, 1944

2,423,444

2 Sheets-Sheet 1

FIG. 1

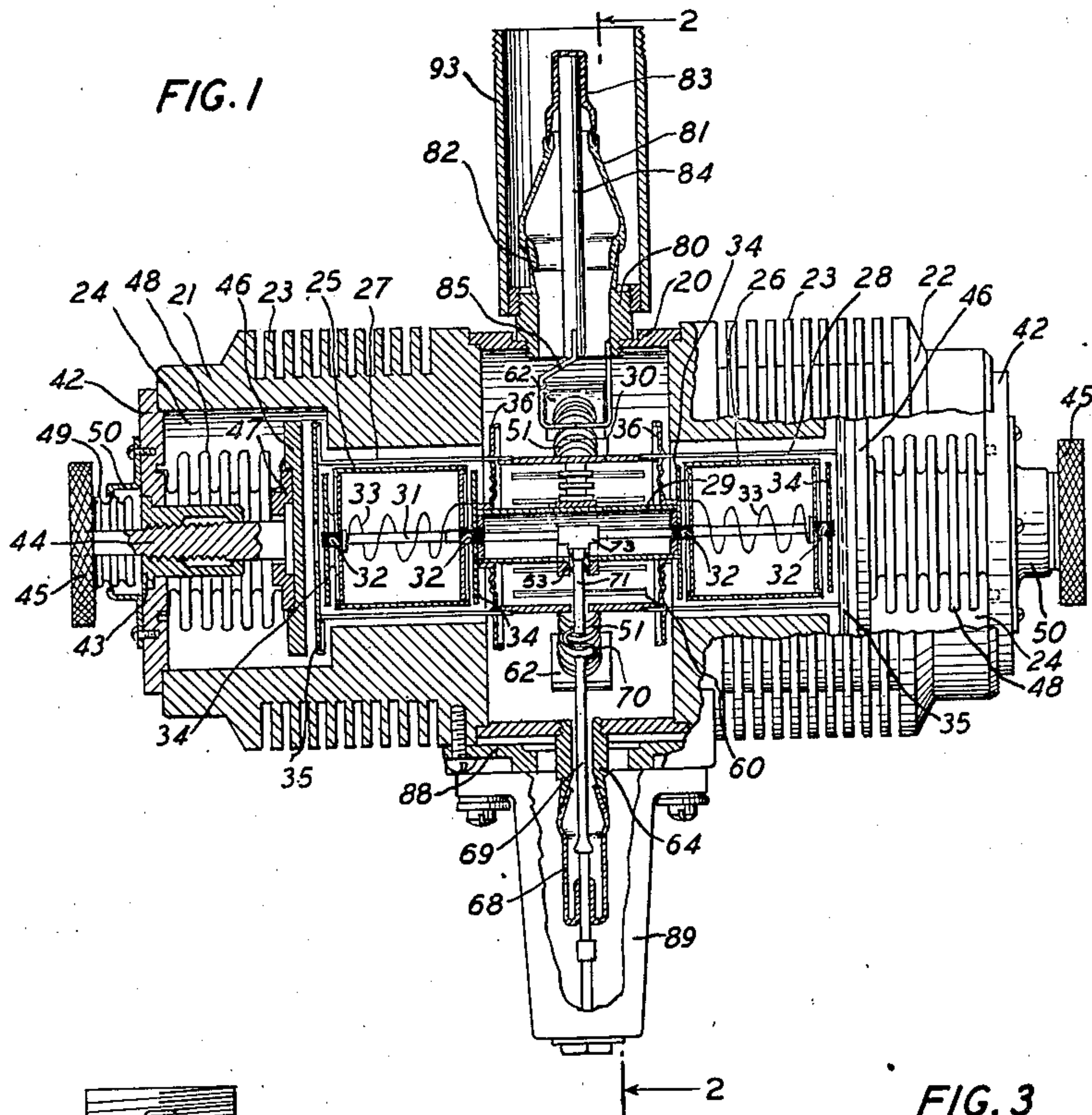


FIG. 2

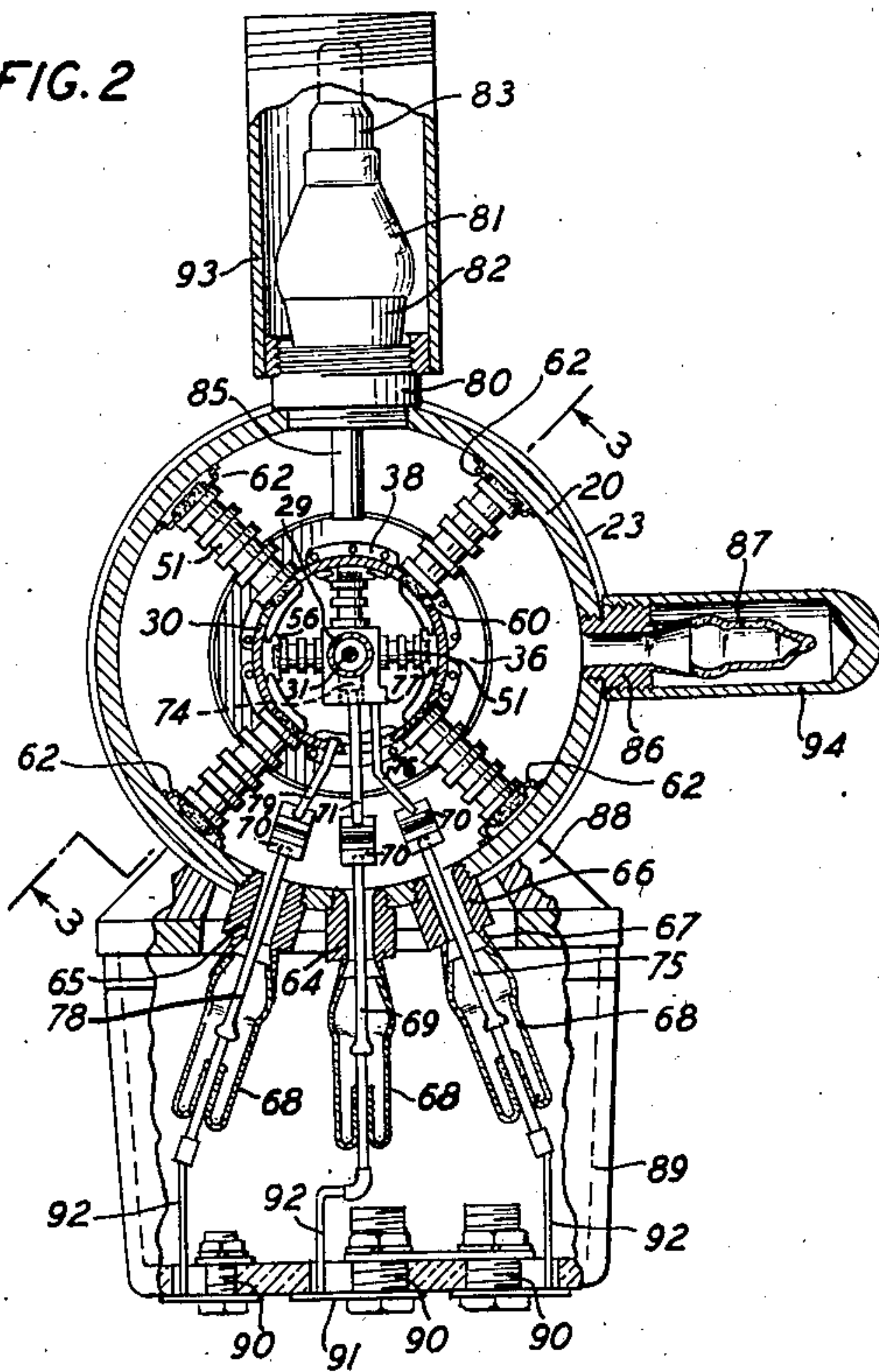
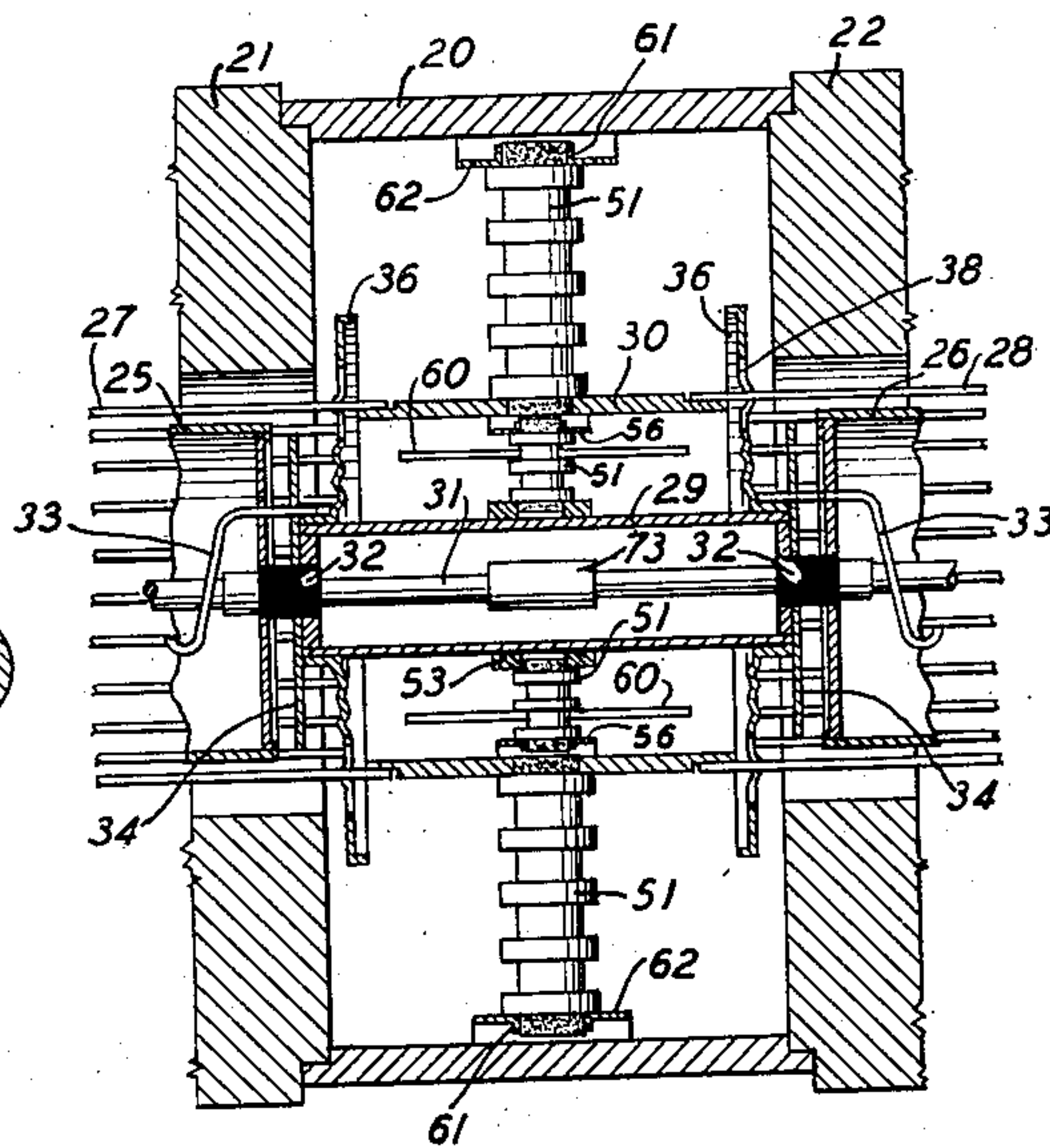


FIG. 3



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2 Sheets-Sheet 2

FIG. 4

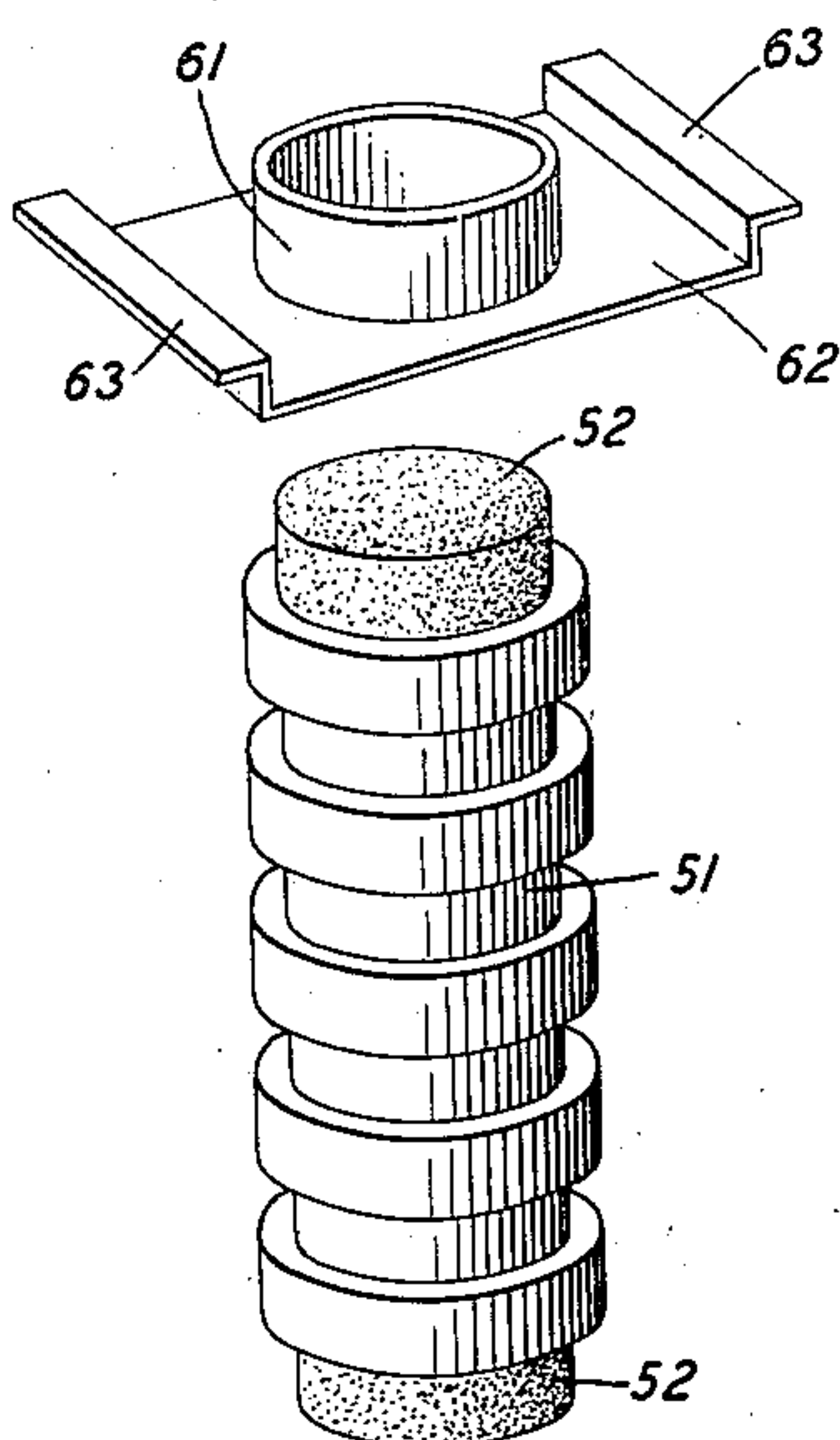


FIG. 5

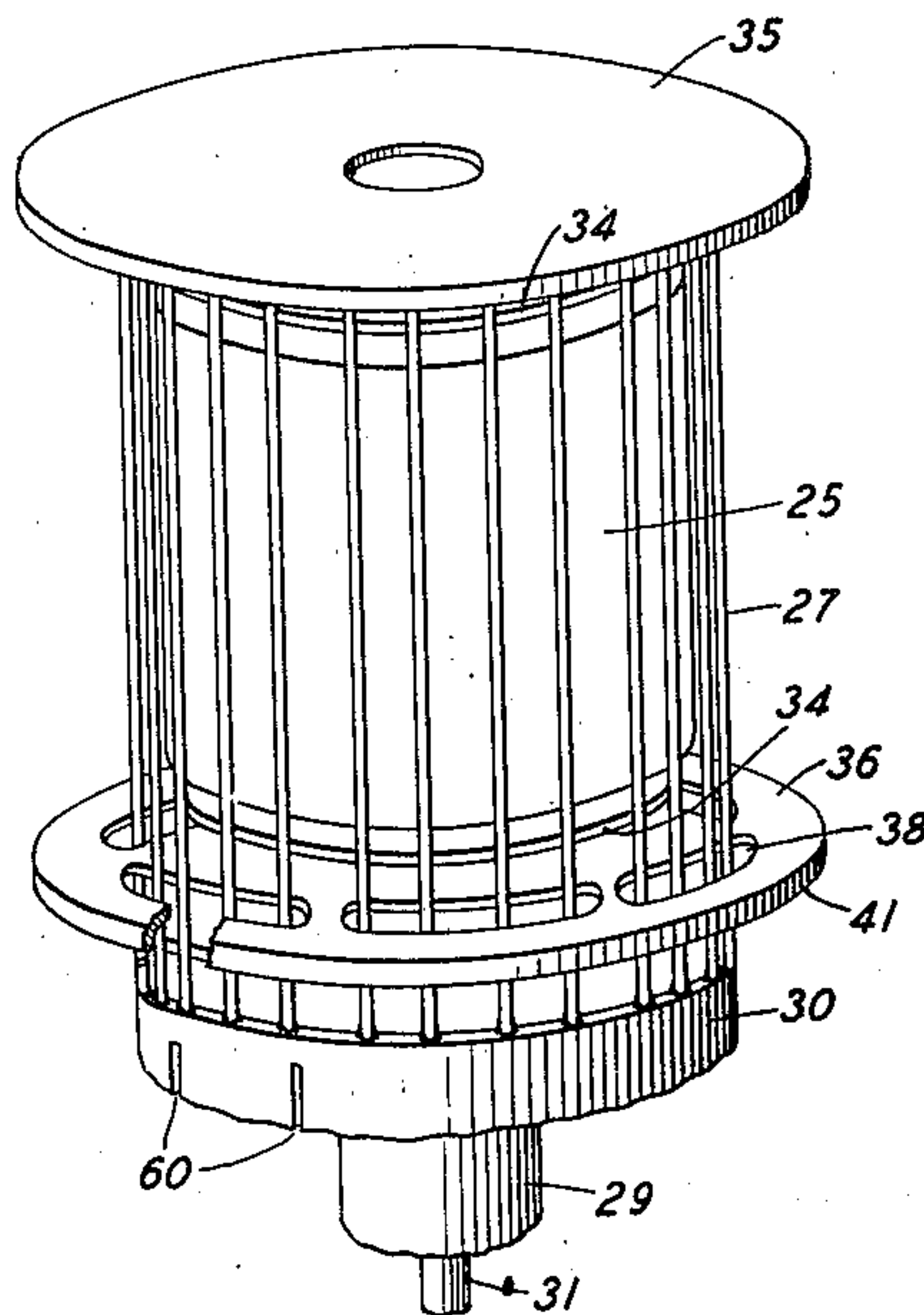


FIG. 6

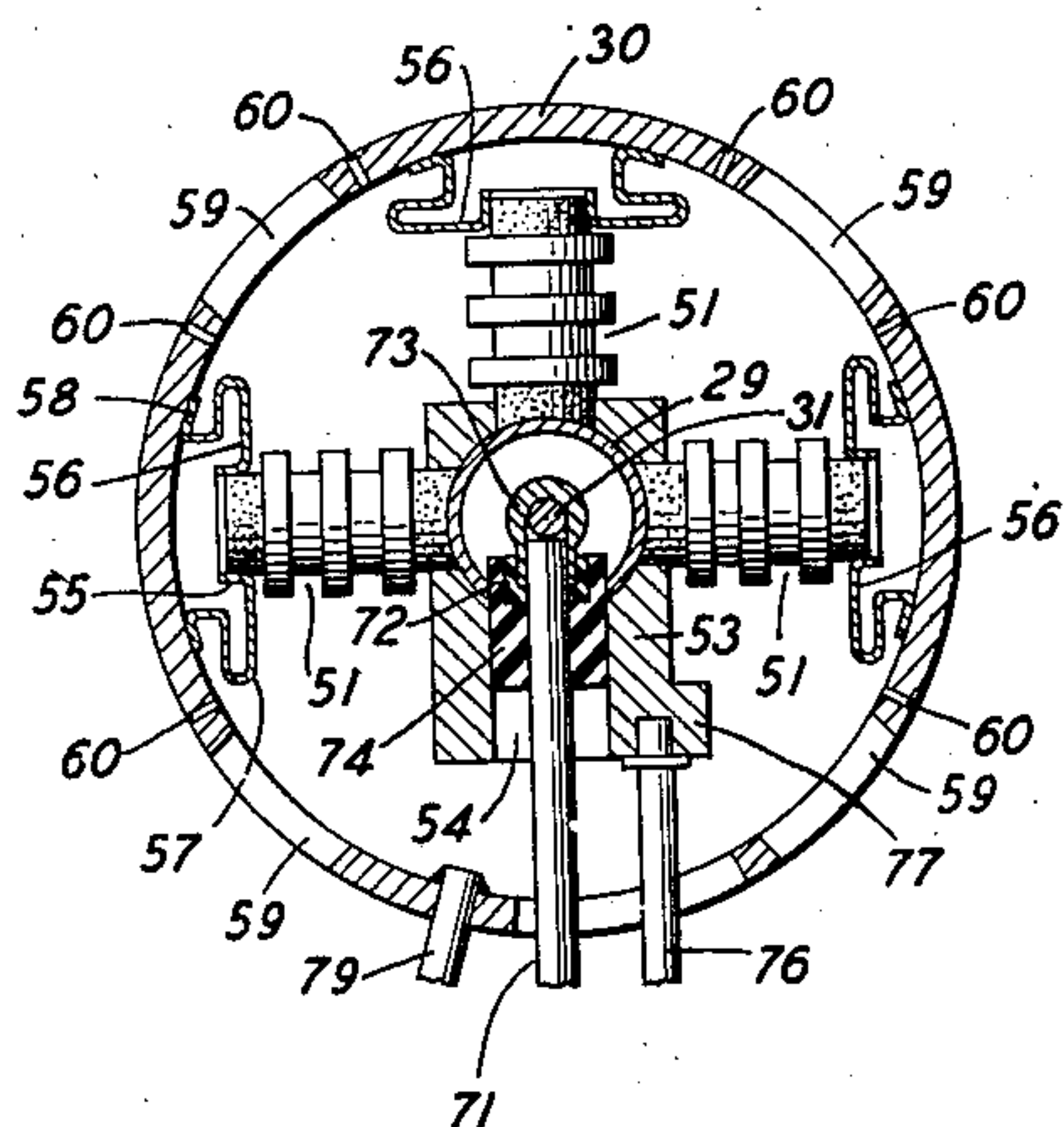


FIG. 7

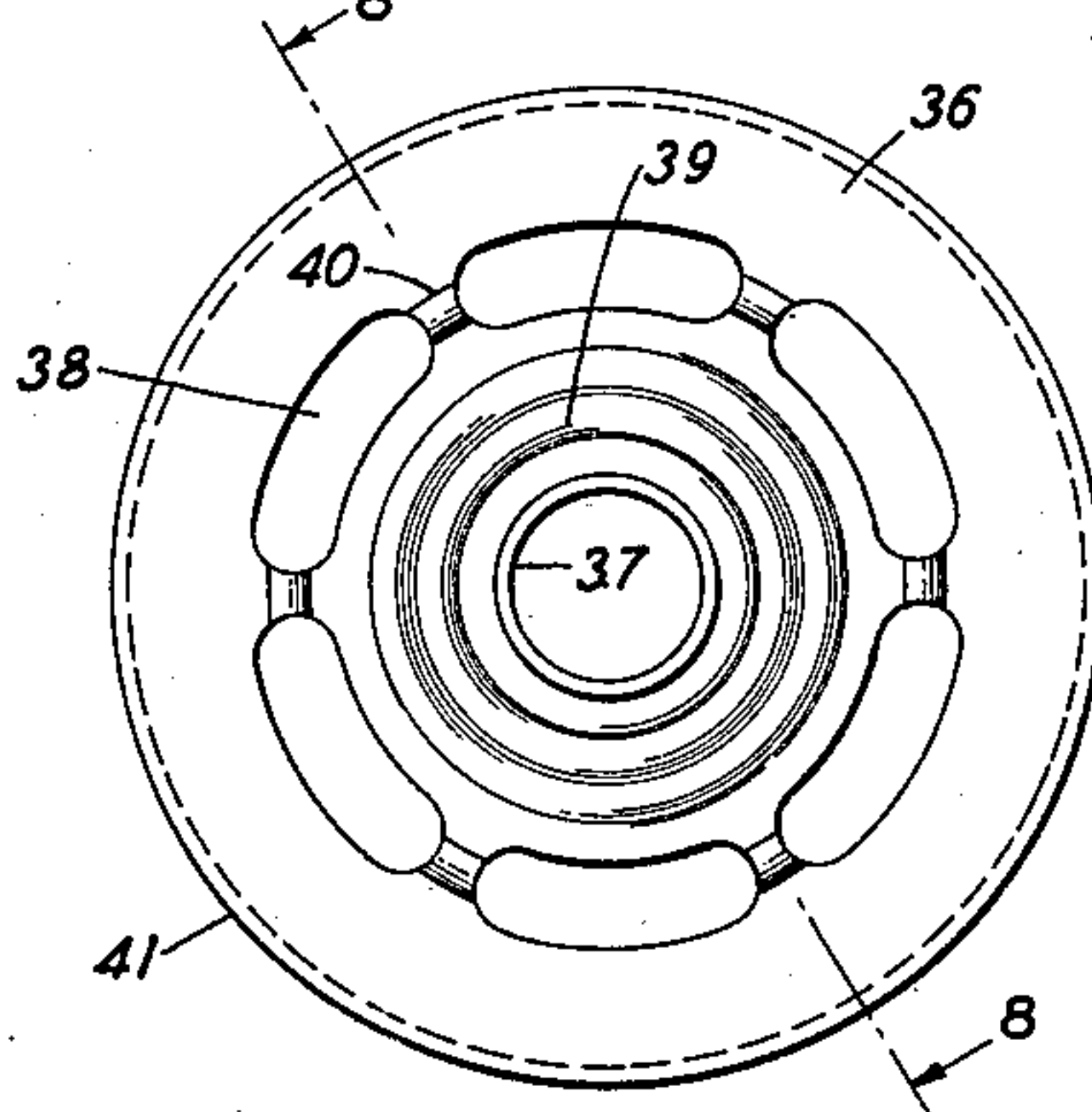
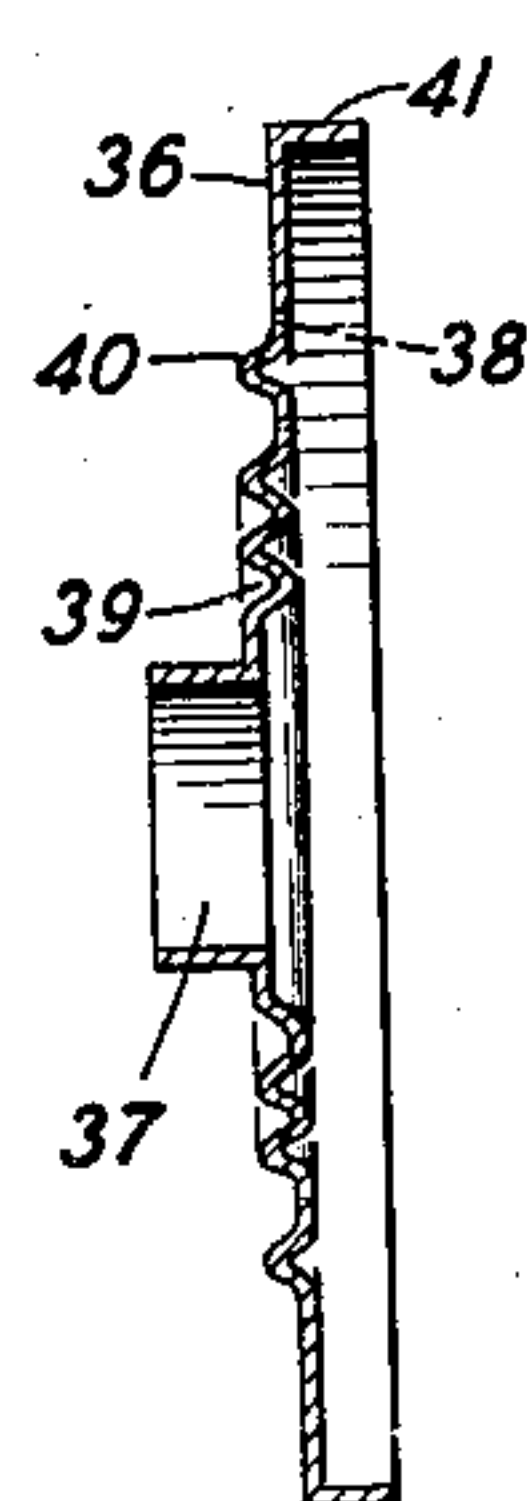


FIG. 8



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Application January 7, 1944, Serial No. 517,382

18 Claims. (Cl. 315—6)

1

This invention relates to high power electronic discharge devices and more particularly to such devices employed in generating ultra-high frequency energy radiations.

The primary object of this invention is to insure stable dynamic and electrostatic characteristics in the operation of the device whereby high output efficiency is maintained constant over long service periods.

Another object of the invention is to facilitate the mechanical assembly of the device to obtain coaxial symmetry of the internal electrodes with the enclosing electrodes.

A further object of the invention is to protect the hermetic seals extending from the exterior of the device so that accidental impact will not injuriously affect the highly evacuated discharge path in the device.

Another object of the invention is to effectively minimize the electrostatic impedance between the high and low potential electrodes in the device.

A further object of the invention is to depreciate the effect of the intense heat energy generated in the device from varying the electrostatic properties of the respective electrodes.

Still another object of the invention is to sufficiently insulate the respective electrodes in the device at the nodal point of high frequency voltages supplied to the device whereby energy strains are least apt to occur during operation.

A further object of the invention is to obtain uniform balance in the disposition of the insulating spacers between the electrodes so that substantially no interference is encountered with the current supply conductors extending to the various cooperating electrodes.

In accordance with this invention these objects and other advantages are attained in a high power duplex or push-pull electronic oscillation generating device having a metallic casing, each end of which forms an external anode element which may be cooled to dissipate heat energy generated during operation and the casing forming a completely evacuated and sealed receptacle enclosing and shielding the cooperating electrodes for generating the power utilized in the operation of the device. A dual control electrode assembly is mounted within the casing in symmetrical relation to the anode elements of the device and cooperates therewith to form capacitive and inductive resonance chambers or cavities for coupling these electrodes in an oscillatory circuit. A dual cathode assembly is mounted within the control electrodes or grid assembly and is coax-

2

ially related thereto along the whole length of the device to produce the high electron source for each unit and introduce distributed capacity and inductance components in the communicating paths to the control electrodes. This construction facilitates the introduction of the supply conductors to the cathode and control electrode assemblies at a medial plane of the device where the high frequency voltages are negligible so that energy strains do not occur in the seals of the conductors.

A feature of this construction relates to the symmetrical interspatial relation of the internal electrode assemblies with respect to the duplex anode elements of the device to insure uniform electrical characteristics during operation for a relatively long service life. This is accomplished by mounting the electrodes in coaxial relation and maintaining them in constant symmetry by a plurality of radial spacer members of high dielectric strength and sufficient surface resistance to withstand the potential gradients between the electrodes. These spacer members are mounted in a medial plane of the device between the casing and dual grid assembly and between the dual grid assembly and the dual cathode assembly, the spacers between the outer adjacent electrodes being uniformly distributed in transverse relation and the spacers between the inner adjacent electrodes being distributed in similar fashion but oriented uniformly in relation thereto. This arrangement facilitates the coupling of the various groups of electrodes to their respective lead-in conductors to provide symmetrical grouping of the conductors to appropriate sealed terminals mounted on the casing and also contributes to the rigid mounting of the coaxial electrodes without danger of torsional stress therein.

Another feature of this construction relates to the fabrication of the spacer members to the walls of the cylindrical electrodes in the device. This is accomplished by providing a coherent metallic coating on each end of the insulating spacers and seating the metal coated ends in sockets on the surfaces of the electrode supports.

A further feature of the invention relates to the mounting of the insulating spacers in relation to the coaxial electrode units whereby expansion forces are compensated to prevent change in symmetrical relation between the respective electrodes in each unit. This is accomplished by mounting one end of each insulating spacer rigidly in a common support element for each group of spacers and affixing the other end of the spacer in a yieldable socket or spring mount-

ing attached to the respective support column of the groups so that circumferential expansion of the coaxial support columns does not materially affect the normal space relation between the electrodes. This construction, furthermore, facilitates the assembly of the dual grids and cathodes within the casing since the spacers are rigidly affixed at one point to the columns and each column with the radial spacers may be inserted in position and when properly aligned the yieldable sockets may be affixed to the adjacent walls of the grid column and casing, respectively.

Another feature of the invention is concerned with the distribution of the spacer members between the electrode assemblies and the current conductors extending through the wall of the receptacle to the various electrodes whereby both the spacers and the conductors are situated in the nodal plane of the device to reduce high frequency current strains in the insulators and hermetic seals of the conductors. This is accomplished by mounting the cathode assembly from the inner surface of the grid assembly by oppositely disposed spacer members and in the transverse direction in the same plane supporting the cathode assembly by a radial conductor sealed through the wall of the casing and another insulating spacer in directly opposed relation to the conductor connecting the cathode and grid assemblies together. A pair of radial conductors are also disposed on opposite sides of the first conductor and are connected to the cathodes and grids, respectively, to group these low potential conductors together. The grid assembly, together with the enclosed cathode assembly, is mounted coaxially within the anode casing by equally spaced insulating members in transverse relation with two of the members disposed radially adjacent the low potential conductors and the others in opposed relation so that the outer spacers are oriented 45 degrees with respect to the inner spacers and the central radial conductor. The high potential conductor for the anode is sealed in the anode wall intermediate the last-mentioned outer spacer members and directly opposite the position of the low potential conductors so that high leakage resistance is attained between these conductors. An auxiliary advantage of this arrangement is the provision of adequate protective housings for the insulated conductor seals extending from the device. The group of low potential conductor seals is enclosed in an insulating receptacle rigidly secured to the anode casing and suitable terminals carried thereby are provided to accommodate the current supply lines to the conductors of the device. The anode conductor seal is protected by a cylindrical sleeve which, together with the insulated conductor, forms a concentric line for deriving power from the dual output electrodes or anodes of the device.

A further feature of the invention relates to the inter-electrode shielding to increase capacitive coupling between the high potential anode and the cathode assembly and sustain oscillating current fields in the device more readily. This is accomplished by mounting annular electrostatic shields on the cathode assembly, the shields extending outwardly beyond the inner wall surfaces at the ends of the anode portions and being provided with a series of openings to permit the passage therethrough of the lateral wires of the grids. These shields are rein-

forced by suitable surface configurations to eliminate warping so that the intense heat energy generated during manufacture of the device will not affect their spacial relation with respect to the cooperating electrodes in the device.

These and other features and advantages of the invention will be more clearly understood from the following detailed description when considered with the accompanying drawings:

Fig. 1 is a view in elevation of a high power, high frequency push-pull electronic oscillator device with portions of the container and internal electrodes broken away to show the detailed construction;

Fig. 2 illustrates the device in cross-section on the line 2—2 of Fig. 1;

Fig. 3 is a partial view in cross-section on an enlarged scale taken on the line 3—3 of Fig. 2 to illustrate the detailed assembly of the radial spacer members between the electrodes;

Fig. 4 is an enlarged perspective view of the components of the insulating spacer members in exploded fashion to illustrate one of the features of this invention;

Fig. 5 is a partial perspective view of the grid and cathode assemblies in one end of the device with the electrostatic shield of this invention mounted in relation to these electrodes;

Fig. 6 is an enlarged cross-sectional view of the mounting assembly of the grids and cathodes within the device as shown in Fig. 2 illustrating in more detail the spacing of the supporting columns of these electrodes;

Fig. 7 is a plan view of the inter-electrode shield of this invention; and

Fig. 8 is a cross-sectional view of the shield taken on the line 8—8 of Fig. 7.

Referring to the drawings and particularly to Figs. 1, 2 and 3, the embodiment of the oscillation generator of this invention, as shown therein, comprises a completely enclosed metallic casing which forms a highly evacuated container or vessel for the dual or duplex units which constitute the reciprocal oscillation generator elements for producing ultra-high frequency energy in microwave band transmission systems. The casing is formed of an intermediate cylindrical shell or column 20 of copper, which is hermetically joined or soldered to a pair of terminating solid metallic masses 21 and 22, preferably of copper, having a central passageway therethrough of substantial area but of less diameter than the diameter of the intermediate shell 20. The masses 21 and 22 constitute external anode portions of the device and may be provided with circumferential radial fins 23 for readily dissipating the heat energy generated in the copper masses of the anodes during operation of the device. The cooling fins may be replaced by any other type of cooling instrumentality, such as a water circulating jacket or a coil of pipe surrounding the anode mass, the fins being shown as one example of cooling means. The shell and anode portions enclose dual or duplex electrode assemblies mounted in cooperating relation to the shell and anode portions so that the device functions as a push-pull triode oscillation generator in which the current flows reciprocally in opposite phases between the two triodes to generate high power at ultra-high frequencies in the range from 0 to 1500 megacycles, with a power output of 1 kilowatt to 1 megawatt depending on the dimensions and constants of the electrodes and resonant cavities of the device. In order to proportion the ca-

5

capacities between the electrodes in each triode and also to reduce the transit time of the electron flow to a minimum, the cooperating electrodes within each anode portion are mounted coaxially and relatively close to the internal surface of the mass defined by the central opening therein. Each anode portion is also provided with a large diameter opening 24 on the outer end thereof which communicates with the central cavity in which the electrodes are located.

The cooperating electrode assemblies are oppositely disposed box-like cylindrical cathodes 25 and 26 and oppositely disposed cylindrical open-work control electrodes or grids 27 and 28 coaxially positioned in the openings of the anode portions 21 and 22, respectively. The cathodes have a large cylindrical surface uniformly spaced in close relation to the internal surfaces of the anode portions and this surface is coated with an electron emissive material, such as barium and strontium oxide, to supply a copious emission of electrons across the short gap to the anode in order to convey a large current necessary to generate the high power to be delivered by the device. The duplex cathodes are electrically connected together in opposed relation by an inner conductor column or tubular member 29 of small diameter and the duplex grids are electrically connected together by an intermediate column or tubular member 30 of larger diameter, both columns being in concentric relation to the outer column 20 of the device. A central metallic standard or support rod 31 extends through both cathodes and the column 29, the rod being insulated from the cathode enclosures by insulating bushings 32 at each end of the enclosures. Each cathode is heated to emission temperature by an internal heater element 33, of tungsten, which may be in the form of a large diameter helix surrounding the rod 31 and attached at one end to the rod and at the other end to the terminating end of the cathode supporting column 29. The cathode is also provided with disc shields 34 at opposite ends of the enclosures to serve as heat deflectors for confining the heat energy of the cathode to the cylindrical surface opposed to the anode surface. Each control grid is formed of an end disc 35 having a flanged periphery which extends across the large diameter opening 24 in the anode casing and forms a partial electrostatic shield between the cathode and the anode. A plurality of parallel wires extend between the grid disc 35 and the intermediate column 30 and are interposed between the active cathode surface and the internal surface of the anode portion.

The opposite end of the cathode enclosure, that is, the end directed towards the center of the casing is also electrostatically shielded with respect to the anode, to increase the capacitive coupling between these electrodes of large difference of potential. In accordance with this invention this shielding effect is accomplished by a metallic disc member 36, shown more clearly in Figs. 5, 7 and 8. This disc shield is provided with a central flange ring 37 which is affixed to the end of the inner column 29 adjacent to the cathode heat shield 34 and is also provided with a plurality of arcuate slots 38, to permit groups of upright wires of the grids to pass freely there-through. The disc is provided with a plurality of continuous corrugations 39 intermediate the ring 37 and the slots 38, the ribs between adjacent slots are reenforced by a discontinuous corrugation 40 and the peripheral edge of the disc is provided with a flange 41, the corrugations

6

and flanges contributing to the strength of the thin disc to prevent distortion thereof due to the high temperatures encountered during manufacture and operation of the device.

As shown in Fig. 1, the device may be provided at either end with a frequency adjusting terminating element, to regulate the capacitive coupling within the active electrode areas between the control electrodes and the anodes. The adjustable element comprises a metallic cap 42 brazed to the end of the anode to form a closure for the large diameter cavity 24 in the outer end thereof, the cap being provided with a central bushing 43 which extends into the cavity. The bushing is internally threaded to receive a screw member 44 having an external knurled knob 45 extending beyond the cap 42 and affixed at the other end to a metallic condenser plate or disc 46 which is secured to the screw member by a retainer ring 47. A metallic Sylphon bellows member 48 surrounds the bushing and screw member and is attached at opposite ends to the retainer ring 47 and the inner surface of the cap 42 to prevent leakage of air into the casing through the threaded connection. External to the bushing the screw member 44 is enclosed by a short bellows sleeve 49 carried by the knob and joined to the cap by a tight-fitting flanged ring 50. The condenser disc 46 is variably movable in reciprocable relation by the screw and knob member to change the capacitive coupling between the anode and the grid in the large area cavity of the anode and thereby accurately tunes the anode-grid circuit to the desired frequency.

Because of the mass of the cooperating electrode assemblies, i. e., the dual cathodes and grids together with the coupling support columns 26 and 30, respectively, disposed within the dual anode casing and the requirement of limiting the insulation supports of these assemblies to the nodal point where the high frequency potential difference is substantially zero so that energy stresses are substantially eliminated on the insulating supports and the fragile seals of the current conductors entering the device, there arises considerable difficulty, from a mechanical and electrical point of view, concerning adequate facilities for maintaining constant spacial relation between the respective electrodes in the dual units since it is essential that the uniformity in spacing between the cathode grid and anode in one unit must be the same in the other unit to insure balanced reciprocal output power to obtain high efficiency operation in ultra-high frequency transmission systems. Furthermore, the limitation of the location of the insulating supports requires that these supports must provide high dielectric impedance to insure positive resistance to high frequency energy fields between the electrodes of large potential difference and the supports must be relatively strong to rigidly hold the individual dual electrodes in uniform coaxial relation with respect to the anodes of the device. In mounting stand-off insulators or spacer rods between the concentric columns at the nodal point of the device it is desirable to avoid connections which project through the columns since such projections alter the inductive characteristics of the respective cavities and may form localized points which develop arcing paths in the discharge space. Furthermore, it is difficult to fasten the insulators within the columns by metallic attachments without considerably reducing the limited insulation path across the gap between adjacent columns.

However, in accordance with this invention, these difficulties are overcome and a substantially rigid supporting structure is provided to secure constant coaxial relation between the electrodes in the units and constant maintenance of the appropriate values of capacity and inductance of the cavities coupling the triode units in the oscillator circuit. This is accomplished by mounting a plurality of cylindrical stand-off insulators or insulating spacer rods 51 in spaced relation in a radial direction between the inner and intermediate columns 29 and 30 and also between the intermediate column 30 and the outer column or intermediate casing portion 20, the spacer rods in the outer cavity being staggered with respect to the spacer rods extending across the inner conductors between the cathodes and grids. These rods are located in a single plane at the nodal or medial point of the device, as shown in Figs. 1 and 3, and constitute a reinforced support assembly for mounting the cathode and grid assemblies in positive coaxial relation within the anode cavities so that electrical stresses are held to a minimum in the discharge path of the device. The detail construction and the fabrication of the spacer rods with respect to the coaxial columns is shown clearly in Figs. 2 to 4, inclusive, and Fig. 6 and reference to these figures will show the various advantages attained by the constructional assembly involved in this invention.

As shown in Fig. 4, the stand-off insulator or spacer rod comprises a highly refractory material such as "Lavite" or "Steatite" which has its cylindrical surface undercut at uniformly spaced intervals to provide alternate diameters of two dimensions and thereby materially increase the over-all length of the insulation resistance between the ends of the rod. The small diameter ends of the rod are coated with a stable metallic covering, such as steel, by the spray method using a Schoops' pistol, in order to retain a film of soldering metal thereon and prevent the separation of the solder film from the ends of the insulator during the fabrication process of the spacer members in the device. The inner column 29 which supports the dual cathodes is mounted coaxially within the intermediate column 30 by providing a metallic block 53, shown in Fig. 6, which is sweated to the column at a central point, the block being provided with spaced apertures on three sides to form sockets for the insulating spacers and an elongated opening 54 extending opposite to one of the socket openings. A pair of diametrically opposite spacer rods 51 are positioned in the sockets in the block and a similar spacer rod is mounted in the remaining socket at right angles to the pair of rods aligned across one diameter of the space between concentric columns 29 and 30. The metallic coated ends of the spacer rods 51 extending into the block are provided with a film of high melting-point solder, such as 80 per cent copper and 20 per cent silver, and the insulator rods are rigidly sweated into the sockets to form a tight joint therein. The undercoat of steel on the ends of the insulator 51 is securely bonded to the refractory material of the spacer rod and is not affected by the heat treatment required to form the brazed or sweated joint in the sockets of the block 53. Therefore, no difficulty is experienced in forming a substantially rigid joint in the block due to the special pretreatment of the ends of the insulators prior to the soldering operation. The outer metal-

coated ends of the spacer rods adjacent the inner surface of the grid support column 30 are sweated, by high melting-point solder, to a short cylindrical sleeve 55 in a resilient saddle plate or socket member 56, formed of spring steel, shown in Fig. 4, the saddle or socket having return bend portions 57 which terminate to the rear of the sleeve 55 as outwardly bent feet 58, which are securely soldered to the inner wall of the grid column 30, to anchor the saddle in directly opposed relation to the socket openings in the block 53. These saddles or sockets are sufficiently rigid to maintain the cathode column 29 in coaxial relation to the grid column 30 and the respective cathodes 25 in relation to the respective grids 23 in the oppositely disposed units. However, due to expansion and contraction of the cathode column 29 and block 53, under operating temperature conditions, the saddles are slightly yieldable to compensate for the expansion of the column and block so that distortion and stresses do not occur in the assembly.

The grid supporting column 30 is provided with a plurality of circular openings 59 at equally spaced points in line with the resilient saddles 56 on the inner surface thereof, two of the openings being intermediate the three inner spacing insulator rods and the other two openings being diametrically opposite the above-mentioned openings and are equally distributed around the periphery of the column, a line passing through each pair of opposed apertures, being at 45 degrees, with respect to the diametrical line running through the inner stand-off insulators. In addition, the grid column 30 is provided with elongated narrow slots 60 on opposite sides of each circular opening 59, to permit slight yielding or breathing of the column under high temperature conditions so that permanent distortion of the column or fracture of the joint between the column and the outer stand-off insulators does not occur during operating. The inner ends of the larger size stand-off insulators 51 between the grid column 30 and the anode column 29 are soldered into the circular opening 59 to rigidly support the stand-off insulators with respect to the grid column 30, whereby the larger size spacer rods are staggered in relation to the smaller size rods within the grid column. The free ends of the outer rods 51 are seated and soldered into sleeves 61 of sockets or saddle members 62 of resilient or pliable metal, such as steel, and these saddles are provided with angle end portions 63 which are sweated to the inner surface of the anode column 29 by high melting-point solder, to rigidly support the combined electrode supporting columns within the device longitudinally yet permit expansion of the columns without causing deformation of the columns or breakage of the insulators due to the resiliency of the saddles attaching the stand-off insulators to the inner surface of the anode column 29. The staggered arrangement of the radial stand-off insulators between the coaxial columns of the dual electrode units materially enhances the supporting assembly of the internal electrode structures with respect to the anode casing of the device and facilitates the assembly of the structures since the dual cathode structure may be mounted within the grid supporting column 30 prior to the mounting of the grids on the column and the coaxial cathode and grid columns may be mounted within the outer anode column 20 prior to affixing the anodes to the ends of the outer col-

umn. Furthermore, the uniformly distributed cross-bracing of the stand-off insulators and their location at the medial point of the structure strengthens the support of the dual electrode assemblies and minimizes high frequency voltage stresses on the insulator supports. Another advantage of this construction is the fabrication of the distributed stand-off insulators to their respective supporting columns prior to insertion in the surrounding column so that the peripheral soldering operation is all that is necessary after insertion of the unit in the surrounding column. This insures axial symmetry between the coaxial columns and uniform space relation between the cathodes and grids with respect to the anodes which surround them.

The uniform relation of the stand-off insulators and the staggered disposition of the outer radial rods with respect to the inner rod facilitates the grouping of the low potential leading-in conductors to the internal electrodes at one point on the circumference of the device intermediate two of the outer stand-off insulator rods and the disposition of the high potential leading-in conductor for the anode at a diametrically opposite point of the device intermediate the remaining outer spacer rods. Therefore, the group conductors and the solitary high potential conductor together with their fragile hermetic seals may be adequately protected against shock or damage from external sources. As shown in Fig. 2, the intermediate casing column 20 is provided with three drilled and threaded openings at a medial point intermediate the two lower outer stand-off insulators and threaded metallic nipples 64, 65 and 66 are rigidly fastened to the column in circumferential series relation with the nipple 64 in diametrical relation to the perpendicularly mounted stand-off insulator 51 between columns 29 and 30 and centrally disposed with respect to the companion nipples 65 and 66, respectively. Each nipple is provided with a tapered knife edge sleeve 67 at the outer end and a vitreous tubulation 68 is hermetically sealed to the knife edge extension to form a tight joint with the nipple. A central conductor 69 extends through the central tubulation and nipple 64 and is connected within the column 20 to a flexible metallic strap 70 which in turn is connected to a rigid extension 71 which passes through an opening in the column 30 and an insulating bushing 72 located in an opening of the column 29. The extension 71 is securely attached to a socket sleeve 73 fastened to the central standard 31 within the column 29 and a larger bushing 74 in the opening 54 of the block 53 holds the bushing 72 in position. A conductor 75 is sealed in the other tubulation and extends through nipple 65 and is connected to a similar flexible strap 70, which is coupled to an extension 76 also extending through the grid column 30 and is affixed to an abutment 77 on the lower end of block 53. The conductors 69 and 75 supply current to the standard and cathodes whereby the helical heater elements 33 within the cathodes 25 are heated to the proper temperature for heating the cathodes by radiation. A remaining conductor 78 extends through nipple 65 and the corresponding tubulation attached thereto and is attached within the casing to a flexible strap 70 which is joined to a short stub wire 79 directly attached to the intermediate column 30 for applying a suitable controlling potential to the dual grids supported by this column. A larger diameter nipple 80 is threaded

into an opening at the top of the casing, as shown in Fig. 2, and carries a bell-shaped vitreous tube 81, sealed to the tapered knife edge extension 82 of the nipple. A hollow copper cup terminal 83 is sealed to the outer end of the tube 81 and a conductor 84 projects inwardly through the seal from the cup and is coupled to a loop 85 within the casing, the other end of the loop being joined to the inner surface of the nipple 80, to form an output absorbing element for deriving power from the cavity within the device. The entire casing is evacuated through an exhaust nipple 86 threaded into the side of the casing, the nipple being sealed to a glass termination 87 which is sealed off after a high degree of vacuum is attained in the casing. The various nipples threaded into the periphery of the outer column 20 in the medial plane thereof are hermetically sealed to the column by a solder having a lower melting-point than the solder employed in joining the stand-off insulators to the columns and the saddles, the solder having a composition of lead 50 per cent and silver 50 per cent. This lower melting-point solder is employed so that the soldered joints within the casing between the saddle supports and the columns will not be affected by the subsequent soldering operation performed on the sealing nipples.

The group of low potential conductors at the lower end of the casing, as shown in Fig. 2, are protected from injury by providing a metallic frame boss 88 which is shaped to conform to the configuration of the outer column 20 and is attached to the anode portions of the casing by screws. An insulating housing 89, such as ceramic or plastic, surrounds the group of conductor seals and abuts against the boss 88 and is attached thereto by screws. The bottom of the housing is provided with apertures to receive metallic ferrules or jack terminals 90 which carry attaching lugs 91 to which extensions 92 are attached within the housing, the extensions, being coupled to the respective conductors extending from the seals. This structure forms an adequate protective housing for the group of sealed conductors extending from the vessel and provides means for coupling suitable plug conductors in the ferrules for applying external voltages to the various electrodes. A cylindrical metallic sleeve 93 is threaded to the large diameter nipple 80 and forms a protective housing for the anode lead-in conductor to protect the hermetic vitreous seal thereof. This metallic covering also facilitates the coupling of a coaxial line to the output of the device. The vacuum sealing tip 87 is also protected by a metallic cap 94 which encloses the tip and is threaded to the nipple 86 joined to the vessel.

While the invention has been disclosed with respect to a particular embodiment of the invention, it is, of course, understood that various modifications may be made therein without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. An electronic discharge device comprising a pair of oppositely disposed metallic anode portions having central cavities, a pair of oppositely disposed cathodes mounted within said anode portions, coaxial metallic hollow columns intermediate and joining said anode portions and cathodes respectively, radial insulating spacer members disposed between said columns in a medial plane thereof, and means on at least one of said columns forming interlocking seats sup-

porting said spacer members with respect to said columns and being adapted to compensate for expansion and contraction forces imposed on said spacer members.

2. An electronic discharge device comprising a pair of oppositely disposed metallic anode portions having central cavities, a pair of oppositely disposed cathodes mounted within said anode portions, coaxial metallic hollow columns intermediate and joining said anode portions and cathodes respectively, radial insulating spacer members disposed between said columns in a medial plane, and yieldable metallic members on at least one of said columns forming interlocking seats supporting said spacer members with respect to said columns and being adapted to compensate for expansion and contraction forces imposed on said spacer members.

3. An electronic discharge device comprising a pair of oppositely disposed metallic anode portions having central cavities, a pair of oppositely disposed cathodes mounted within said anode portions, coaxial metallic hollow columns intermediate and joining said anode portions and cathodes respectively, radial insulating spacer members having metallic terminations disposed between said columns in a medial plane, and metallic sockets on at least one of said columns engaging said metallic terminations and forming interlocking seats supporting said spacer members with respect to said columns.

4. An electronic discharge device comprising a pair of oppositely disposed metallic anode portions, a pair of oppositely disposed cylindrical control electrodes mounted within said anode portions, a pair of oppositely disposed cylindrical cathodes mounted within said control electrodes, coaxial metallic columns interconnecting electrodes of each pair, a plurality of radial insulating spacer members extending between said columns in a medial plane thereof, and resilient metallic sockets on at least one end of said members and affixed to the adjacent surface of said columns.

5. An electronic discharge device comprising a pair of oppositely disposed metallic anode portions having central cavities, a pair of oppositely disposed cylindrical control electrodes mounted within said cavities, a pair of oppositely disposed cylindrical cathodes mounted within said control electrodes, concentric conducting tubular members joining the respective pairs of electrodes, cylindrical stepped insulator rods mounted in radial relation between said tubular members in a medial plane thereof, said rods having metallic sleeve terminations, and resilient metallic sockets securing said rods to the inner surfaces of the tubular members joining said control electrodes and anode portions, respectively.

6. An electronic push-pull oscillating device comprising dual anode portions coupled in opposed relation by an outer conducting sleeve portion and forming an enclosing casing, dual cylindrical grids disposed within said anode portions and coupled in opposed relation by an intermediate sleeve portion, dual cathodes within said grids and coupled in opposed relation by an inner sleeve portion, said sleeve portions being coextensive and concentric with respect to each other, a plurality of stand-off insulating rods extending radially between said sleeve portions in a medial plane, said inner and intermediate sleeve portions having recesses in spaced relation to accommodate the inner ends of the respective rods extending therefrom, and resilient socket

members on the outer ends of said rods secured to the inner walls of said intermediate and outer sleeve portions, respectively.

7. An electronic push-pull oscillating device comprising dual anode portions coupled in opposed relation by an outer conducting sleeve portion and forming an enclosing casing, dual cylindrical grids disposed within said anode portions and coupled in opposed relation by an intermediate sleeve portion having spaced recesses therein and longitudinal slots between said recesses, dual cathodes within said grids and coupled in opposed relation by an inner sleeve portion, said sleeve portions being concentric with respect to each other, a recessed block mounted on said inner sleeve portion, a set of stand-off insulating rods extending radially from said recessed block, another set of stand-off insulating rods extending radially from the recesses in said intermediate sleeve portion, and resilient socket members mounted on the opposite ends of said rods and engaging the inner surfaces of said intermediate and outer sleeve portions respectively, the socket members on said first set of rods being disposed medially between the recesses in said intermediate sleeve portion.

8. An ultra-high frequency device having concentric electrodes forming oppositely disposed triodes in reciprocal relation, concentric tubular metallic members spacing said triodes in longitudinal relation, means spacing the electrodes and tubular members in coaxial relation with respect to each other including radially disposed stand-off insulating rods, and metallic socket members secured to one end of each of said rods and the surfaces of certain of said tubular members, the radial rods between two of said tubular members being staggered with respect to the rods between the other tubular members.

9. An ultra-high frequency device having concentric electrodes forming oppositely disposed triodes in reciprocal relation, concentric tubular metallic members spacing said triodes in longitudinal relation, means spacing the electrodes and tubular members in coaxial relation with respect to each other including radially disposed stand-off insulating rods, and a pair of metallic disc shields affixed to and extending outwardly from the inner concentric tubular member, said shields having openings for the passage therethrough of portions of the intermediate electrodes of said triodes.

10. An electron discharge device comprising a metallic vessel having opposite ends forming external anode portions, a pair of concentric metallic members within an intermediate portion of said vessel, a cylindrical control electrode supported on each end of one of said members and disposed in spaced relation within the respective anode portions, a cylindrical cathode supported on each end of the other metallic member and concentrically spaced within the respective control electrodes, an electrode terminal conductor hermetically sealed in a wall of said vessel and coupled to said anode portions, a group of electrode terminal conductors sealed in said vessel in oppositely disposed relation to said first conductor, said group of conductors being connected to the cathode and control electrodes through said pair of metallic members, and a protective cap enclosing said group conductors.

11. An electron discharge device comprising a metallic vessel having opposite ends forming external anode portions, a pair of concentric metallic members within an intermediate portion of

said vessel, a cylindrical control electrode supported on each end of one of said members and disposed in spaced relation within the respective anode portions, a cylindrical cathode supported on each end of the other metallic member and concentrically spaced within the respective control electrodes, an electrode terminal conductor hermetically sealed in a wall of said vessel and coupled to said anode portions, a group of electrode terminal conductors sealed in said vessel in oppositely disposed relation to said first conductor, said group of conductors being connected to the cathode and control electrodes through said pair of metallic members, a metallic boss secured to said vessel and surrounding said group conductors, an insulating cover receptacle enclosing said group conductors and attached to said boss, and terminals on said receptacle connected to said conductors.

12. An electron discharge device comprising a metallic vessel having opposite ends forming external anode portions, a pair of concentric metallic members within an intermediate portion of said vessel, a cylindrical control electrode supported on each end of one of said members and disposed in spaced relation within its respective anode portion, a cylindrical cathode supported on each end of the other metallic member and concentrically spaced within its respective control electrode, an electrode terminal conductor hermetically sealed in a wall of said vessel and coupled to said anode portions, a group of electrode terminal conductors sealed in said vessel in oppositely disposed relation to said first conductor, said group of conductors being connected to the cathode and control electrodes through said pair of metallic members, an insulating protective cap enclosing said group conductors, and a metallic coaxial member surrounding the first conductor.

13. An electron discharge device comprising a double-ended metallic vessel having opposite end portions forming external anodes of the device, a pair of concentric metallic members within an intermediate portion of said vessel, a cylindrical open-work electrode supported on each end of one of said members and extending into said anodes, a cylindrical cathode supported on each end of the other member and disposed within its respective open-work electrode, electrode terminal conductors for said members extending through the side wall of said vessel, radial insulating rods extending between said members and the wall of said vessel, said rods having a metallic coating on the ends thereof, and metallic sockets affixed to the coated ends of said rods and carried by said members and vessel wall, respectively.

14. An electronic discharge device comprising a metallic casing including oppositely disposed hollow anode portions and an intermediate cylindrical wall portion, a metallic column extending axially within said casing for a distance coincident with said cylindrical wall portion, a pair of cathodes mounted on opposite ends of said column and disposed concentrically within said anode portions, and metallic shielding members carried by said column and extending across the gaps between said cathodes and anode portions adjacent the juncture of said anode portions and intermediate wall portion.

15. An electronic discharge device comprising a metallic casing including oppositely disposed hollow anode portions and an intermediate cylindrical wall portion, a metallic column extending

axially within said casing for a distance coincident with said cylindrical wall portion, a pair of cathodes mounted on opposite ends of said column and disposed concentrically within said anode portions, another metallic column of a diameter intermediate said first column and said wall portion coaxially mounted therebetween, a pair of grid electrodes mounted on opposite ends of said latter column and having parallel wires connected at one end to said latter column and interposed between the respective cathode and anode surfaces, and metallic disc shields carried by opposite ends of said first column, said shields having openings therein through which extend said parallel wires of said control electrodes.

16. An electronic discharge device comprising a metallic casing including oppositely disposed hollow anode portions and an intermediate cylindrical wall portion, a metallic column extending axially within said casing for a distance coincident with said cylindrical wall portion, a pair of cathodes mounted on opposite ends of said column and disposed concentrically within said anode portions, another metallic column of a diameter intermediate said first column and said wall portion coaxially mounted therebetween, a pair of grid electrodes mounted on opposite ends of said latter column and having parallel wires connected at one end to said latter column and interposed between the respective cathode and anode surfaces, and a pair of metallic disc shields having a ring portion embracing opposite ends of said first column and openings therein through which said parallel wires freely extend, said disc shields also having inner continuous corrugations intermediate the ring portion and said openings, discontinuous corrugations between adjacent openings surrounding said inner corrugations and a reinforced edge, to withstand warping due to thermal energy stresses prevailing in the discharge path in said device.

17. An ultra-high frequency push-pull oscillation generator device comprising a cylindrical metallic enclosing vessel having an external anode portion on each end thereof, a cylindrical grid-like electrode within each anode portion in coaxial relation thereto, a continuous metallic column having a plurality of spaced apertures and slots extending longitudinally therebetween and supporting opposite grid-like electrodes, a set of radial insulating spacer rods having metallic coated end portions and stepped intermediate portions extending in transverse directions between said column and said enclosing vessel intermediate said anode portions, said rods having one end located in said apertures, a cylindrical box-like cathode in coaxial relation within each grid-like electrode, a small diameter metallic coupling cylinder joining opposite cathodes together, a second set of insulating spacer rods similar to said first-mentioned rods extending radially between said column and coupling cylinder but in staggered relation with respect to said first set of rods, a plurality of spring saddle plates secured to the inner surfaces of said enclosing vessel and column and supporting the metallic coated end portions of said rods extending therein, a plurality of conductors sealed in said vessel and extending between a pair of said first set of rods for connection to said coupling cylinder and said column, a single conductor sealed in said vessel between another pair of rods of said first set in opposite relation to said plurality of conductors, and an internal loop connection between said single conductor and said vessel.

18. An ultra-high frequency push-pull oscillation generator device comprising a pair of oppositely disposed relatively thick wall cylindrical metallic anode portions, the ends thereof being open and one of each being of larger diameter than the other end, said metallic portions forming external anode portions of the device, a medial cylindrical metallic portion secured to the periphery of the smaller diameter ends of said thick wall portions, dual cylindrical box-like cathodes mounted within said anode portions, dual grid-like electrodes mounted between said cathodes and anode portions, said electrodes having disc end portions situated in the larger diameter openings in said anode portions, metallic coupling columns extending between and connected to said cathodes and electrodes, respectively, and concentrically mounted within said medial portion, apertured cover members on opposite ends of said anode portions and closing the larger diameter openings therein, a metallic plate within each large diameter opening adjacent the disc end portion of said electrodes, adjustable means extending through said cover members and connected to said plates to vary the capacity relation between said plates and discs, an axial standard extending through said cathodes and inner coupling column, helical heater elements within said box-like cathodes and connected at opposite ends to said standard and inner column, respectively, corrugated metallic diaphragm shields at opposite ends of said inner column and extending beyond the inner periphery of said anode portions but spaced therefrom, said shields having a plurality of elongated openings in a circular boundary forming passageways for portions of said

grid-like electrodes, a plurality of stepped insulating spacer rods having metallic coated ends mounted in transverse radial relation in a medial plane between said columns and medial metallic portion and resiliently supported at one end on the surface of one of said coupling columns and said medial portion respectively, the rods between said coupling columns being oriented 45 degrees with respect to the rods between one of said columns and said medial portion, a group of metallic nipples on the periphery of said medial portion, radial conductors extending through said nipples and connected to said coupling columns and central standard respectively, insulating tubular joints hermetically sealing said conductors to said nipples, an insulated conductor extending through the opposite side of said medial portion, and a loop member coupling said insulated conductor to said medial portion to serve as an output connection for said anode portions.

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