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A. BELL

3,354,339

ELECTRODES STACKED IN SLOTTED TUBULAR SUPPORT

Filed May 9, 1966

3 Sheets-Sheet 1

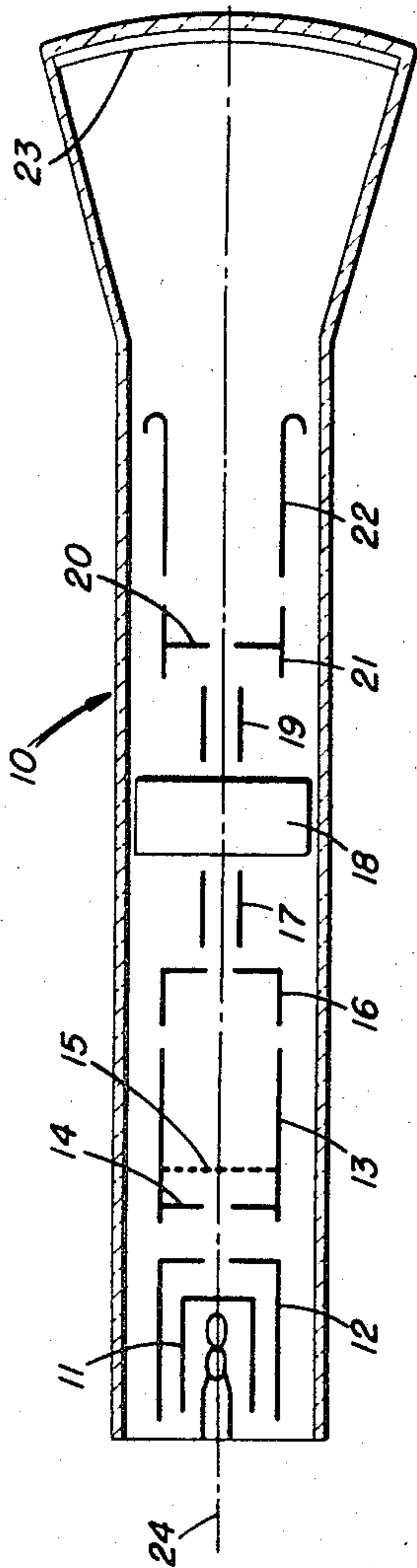


FIG. 1.

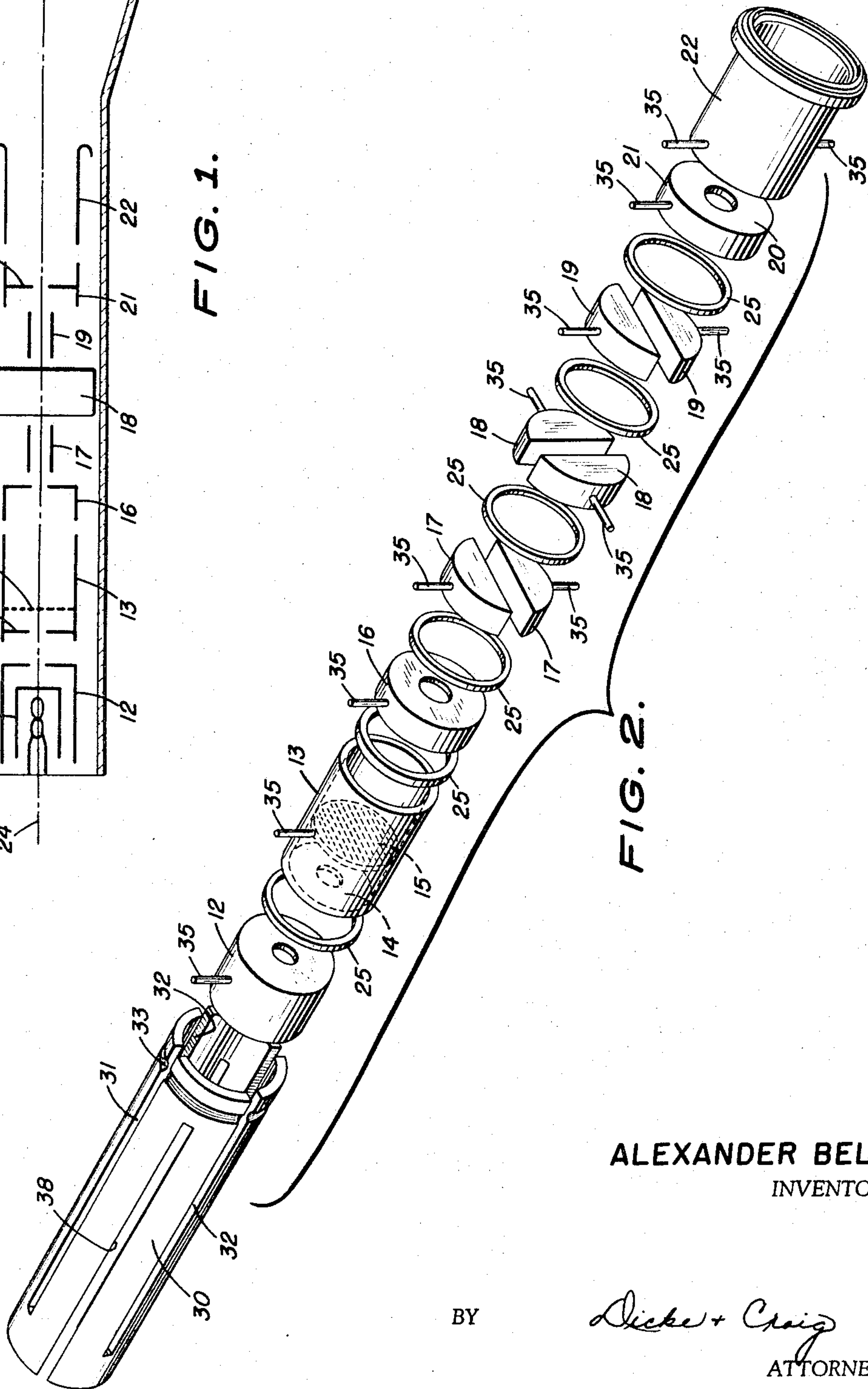


FIG. 2.

ALEXANDER BELL
INVENTOR

BY

Dicke + Craig
ATTORNEYS

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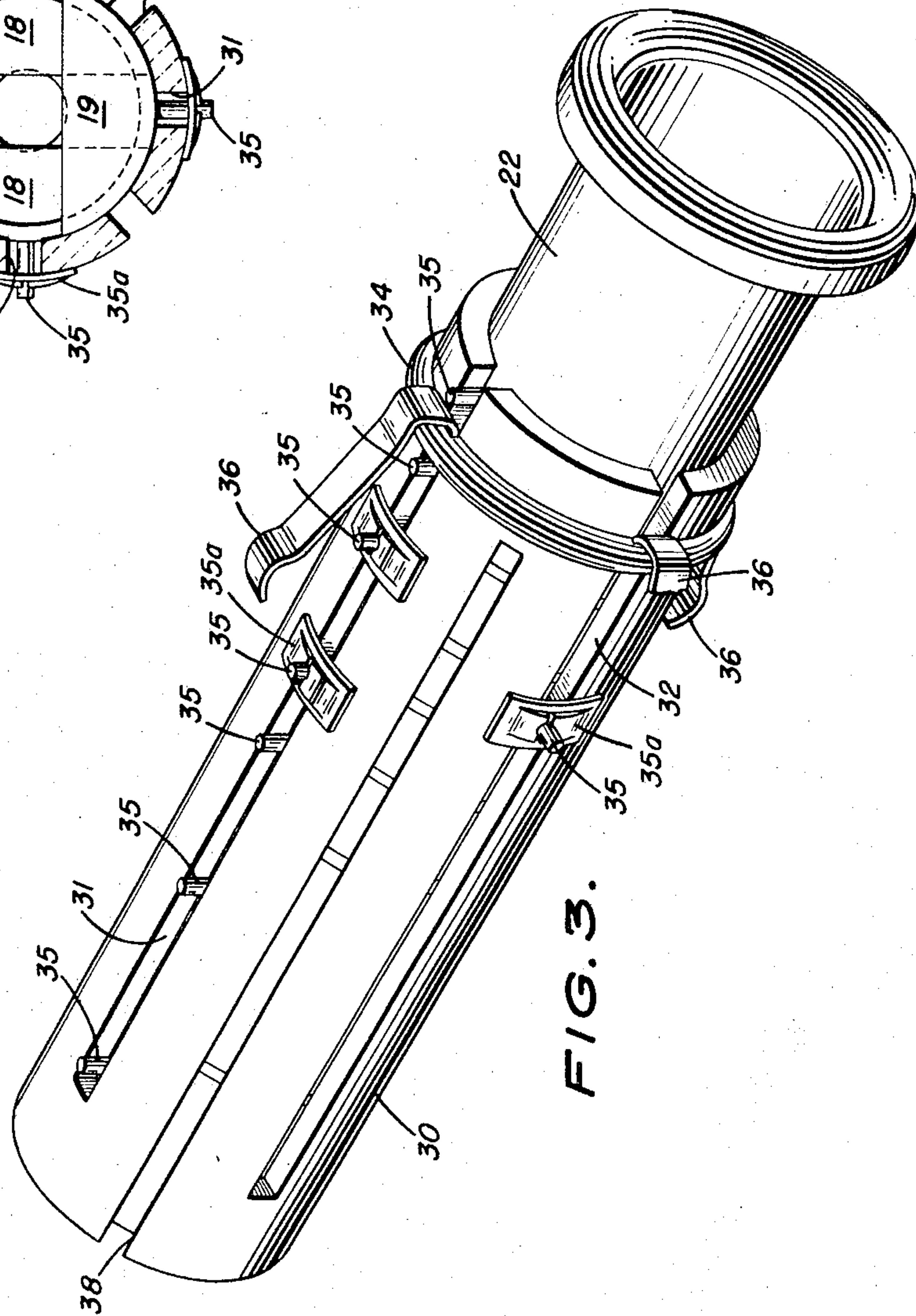
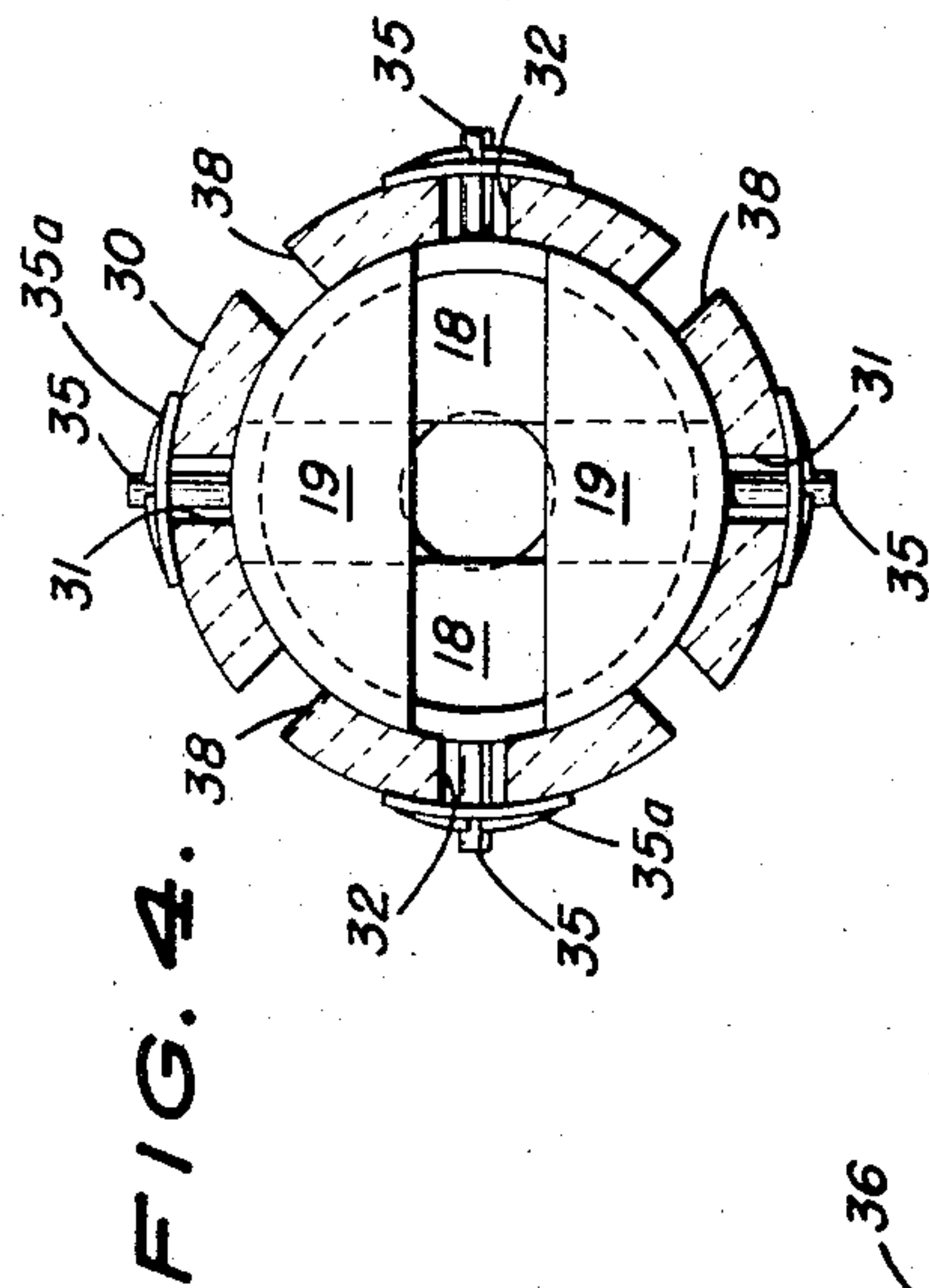
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INVENTOR

BY

Licke & Craig

ATTORNEYS

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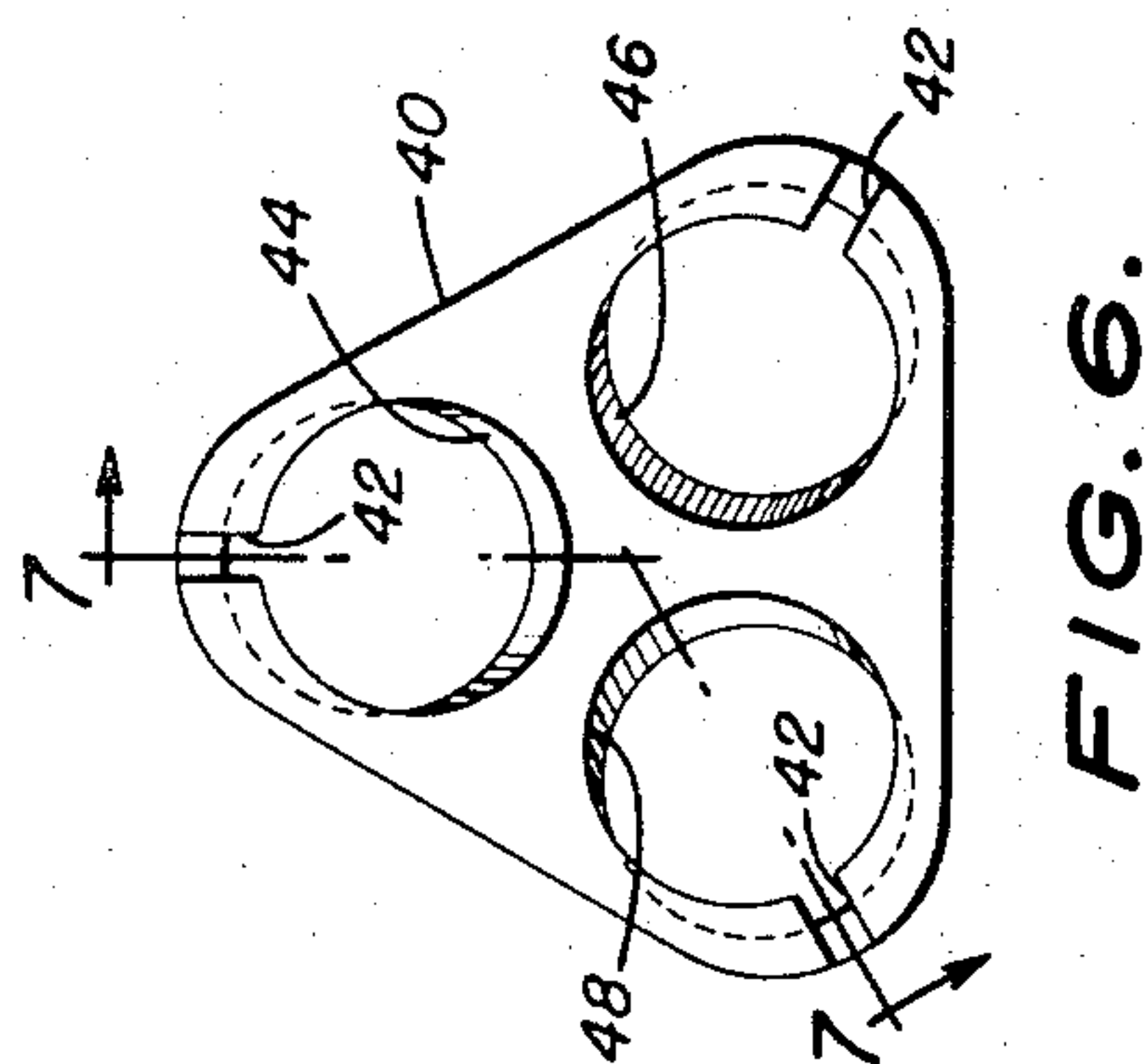
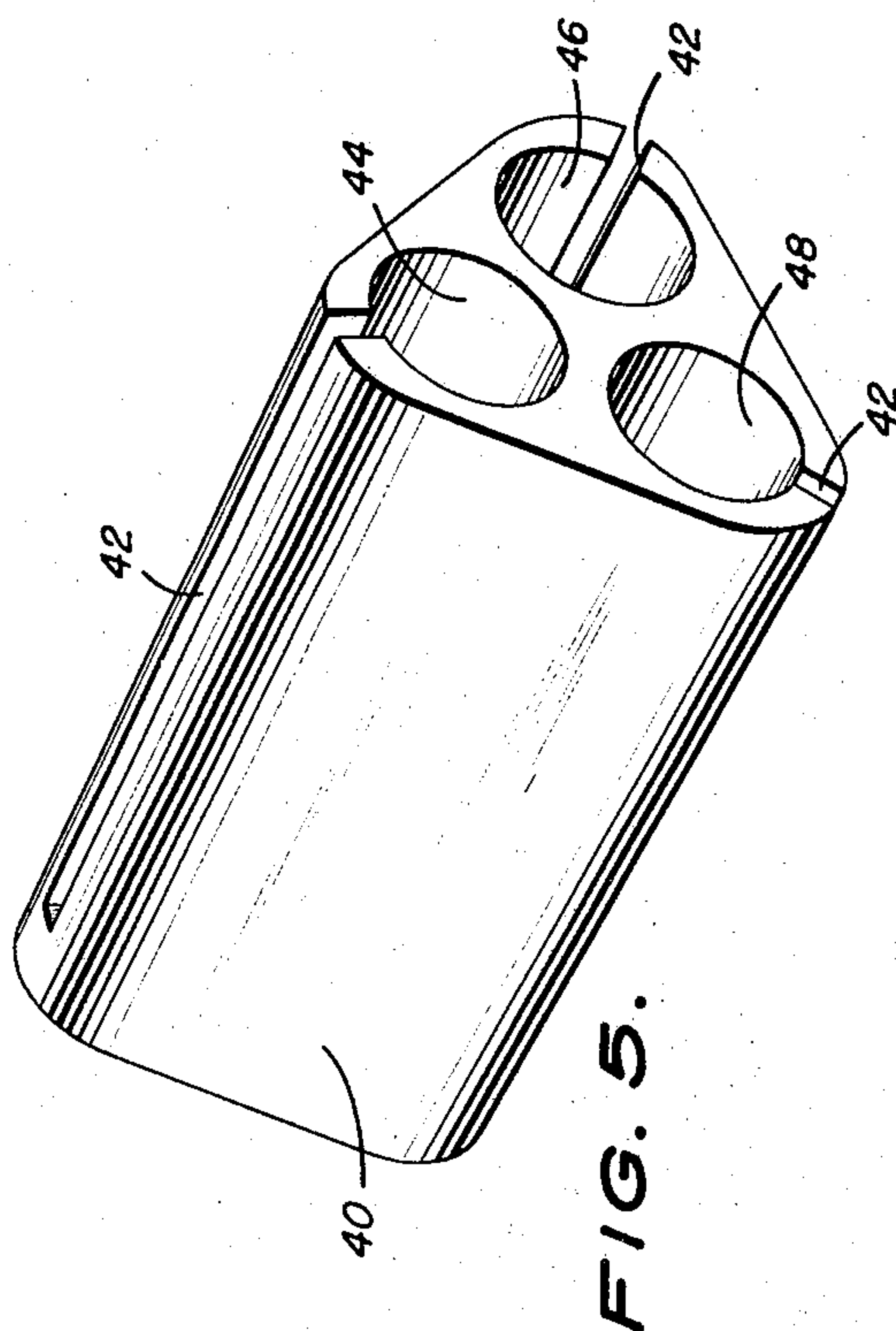
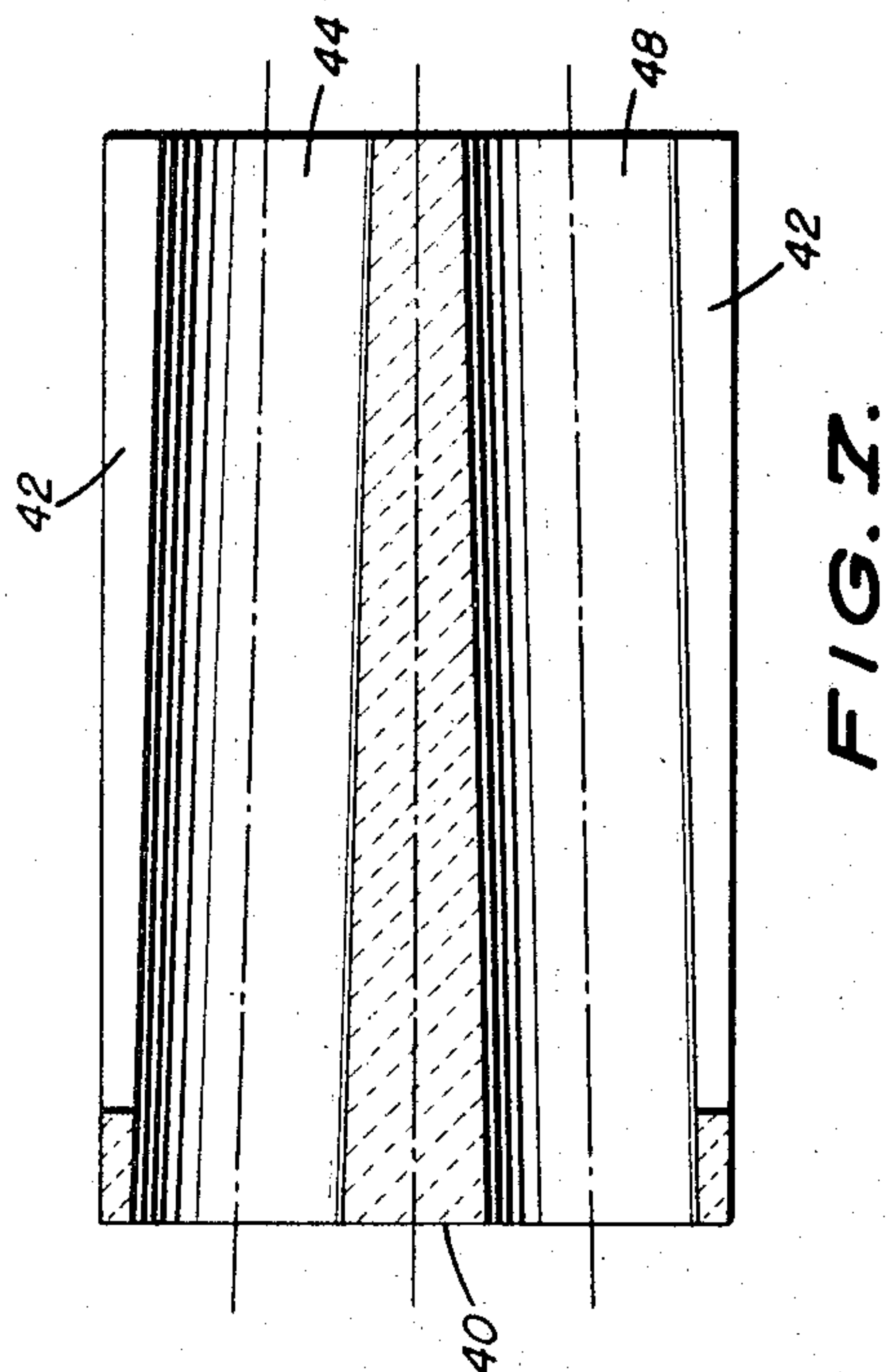
A. BELL

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3 Sheets-Sheet 3



ALEXANDER BELL
INVENTOR

BY

Dicke + Craig
ATTORNEYS

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ELECTRODES STACKED IN SLOTTED TUBULAR SUPPORT

Alexander Bell, Carlsbad, Calif., assignor to Stromberg-Carlson Corporation, Rochester, N.Y., a corporation of Delaware

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9 Claims. (Cl. 313-82)

ABSTRACT OF THE DISCLOSURE

An electron gun construction for shaped beam tubes which is self aligning under influence of a tubular support member in which the electron gun electrodes are mounted in stacked relation, said support member having one or more longitudinal holes accommodating said electrodes in a plurality of longitudinal slots extending to one end thereof for accommodating electrical leads to said electrodes.

The present invention relates in general to electron discharge devices and more particularly to cathode ray tube electron gun constructions and assembly techniques.

The invention has general utility in cathode ray devices, but has been specifically designed for and is of particular advantage for improvement of the internal construction of cathode ray tubes, known as shaped beam tubes.

The shaped beam tube is a character image generating device comprising an evacuated envelope having at one end thereof a beam generating means and at the other end a screen coated with an electron sensitive phosphor capable of generating a light image in response to electron bombardment; intermediate the two ends of the tube a character forming matrix is provided which subdivides the electron beam into a plurality of character shaped streams. Positioned between the character forming matrix and the screen of the tube is a means responsive to a control voltage for selecting one of the group of character shaped streams to be projected onto the screen of the tube, the selection means itself comprising, in the known construction, one or more electrostatic lenses and a series of magnetic deflection coils or electrostatic deflection plates capable of positioning the entire group of character shaped streams with respect to the single aperture disc so as to permit only a single selected stream to pass through to the screen of the tube. Such a shaped beam tube is described more fully in U.S. Patent 2,761,988 issued to Joseph T. McNaney and assigned to the assignee hereof.

Due to the fundamental operation of these shaped beam tubes and the necessarily small size and close spacing of the electron optical lens elements and of the character shaped streams formed by the character forming matrix upon interception of the electron beam, the alignment accuracy and tolerances of the electron gun structure must be very precise to insure continued accurate operation under different conditions of use. In addition, this extreme accuracy of construction has resulted in the need for complicated manufacturing techniques including intricate jiggging and alignment procedures requiring special techniques and skilled assembly.

In order to eliminate these disadvantages in the assembly and provide continued efficient operation of such shaped beam tubes, it has been proposed to provide a so-called "self-aligning gun" construction wherein the various elements and electrodes of the gun construction are supported in rigid accurate alignment in module form using the internal surface of the cathode ray tube, or internal surfaces of auxiliary means supported within the cathode ray tube, as the confining or encompassing

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dimension, thereby providing the various electrodes of the assembly in proper position with respect to this surface. In this way, the envelope, or the auxiliary means supported within the tube envelope, provides for the necessary constraining of the modular construction and gives it alignment and structural rigidity necessary to the simplified initial assembly and continued accurate positioning of these elements during use of the tube.

One such self-aligning construction is proposed in U.S. Patent No. 3,047,759 issued to Joseph T. McNaney and assigned to the assignee hereof in the form of an electron gun structure wherein the series of electron optical elements are supported within a longitudinal tubular member in rigid precise alignment, which tubular member is formed of two semi-tubular shells constructed so as to provide accurately machined grooves and keyed interconnections to effect the necessary support and alignment for each of the elements in the electron gun structure.

The present invention provides a cathode ray tube structure of the shaped beam type in which each of a series of electron optical elements within the cathode ray tube is supported within a longitudinal tubular member of the type set forth in the above-mentioned McNaney patent but of unitary construction and wherein novel means are provided in conjunction with said tubular member in place of the previously used grooves or projections for supporting the various electron or optical elements of the gun construction for proper alignment and continued rigid support within the tubular member.

While the means provided in the modular constructions known heretofore in the form of annular grooves or projections within the tubular member have provided a satisfactory degree of support and alignment within the modular construction, the provision of machined grooves and projections on the tubular member with the tolerances necessary for accurate alignment of the electron optical elements has proven to be very expensive, and in addition, this particular construction has failed to provide the requisite amount of shielding between electron optical elements that is necessary for protecting the electron beam from distortion by dielectric charges found on the ceramic cylinder walls. In addition, due to the need for machining grooves or projections into the inside surface of the tubular member, this member must of necessity be provided in the form of two semi-tubular shells which then must be joined and secured together and maintained in proper position to provide accurate alignment of the modular assembly. The modular support member which is provided in accordance with the instant invention avoids or otherwise completely eliminates these basic drawbacks associated with the prior art constructions.

In brief, the support member of the instant invention is provided as a unitary tubular construction having completely smooth inner and outer walls which are provided with orthogonally positioned slots extending from one end thereof which accommodate the electrical wiring pins for each of the electron optical elements of the electron gun construction and also serve to provide for proper alignment of these elements within the tubular member. The tubular member is provided of a size which corresponds to the size of the electron optical elements so that each of the elements is positively supported within the tubular member. In addition, the proper spacing between electron optical elements is provided by precision insulating spacers which are located between adjacent optical elements and are dimensioned to provide the proper spacing therebetween.

In order to provide for stress relief in the tubular member at the higher operating temperatures, it is also proposed that a second group of orthogonally positioned

slots, extending from the opposite end of the tubular member from the other slots, be provided therein to provide resiliency in the tubular member so that it will neither crack nor become loose when it and the metal parts of the gun assembly, which, for example, may be of stainless steel, expand differentially. Such a construction is especially advantageous for larger gun constructions.

The invention also provides an advantageous construction for electron gun assemblies for color tubes wherein three electron guns are provided. In such case a single support element providing three properly aligned tubular apertures for the three gun constructions along with corresponding slots therein for enabling access to the electrodes thereof result in a self-aligning construction which is easily and inexpensively manufactured.

It is an object of the instant invention to provide within a cathode ray tube of the shaped beam type an improved self-aligning electron gun construction.

It is another object of the instant invention to provide a modular support member for an electron gun construction which makes possible simplified assembly of the electron optical elements within the gun construction and provides self-aligning properties for continued accurate alignment of the various elements thereof during use of the device.

It is another object of the instant invention to provide an electron gun construction for shaped beam tubes which is self-aligning, under the influence of a support member capable of providing modular construction thereof supported within the tube element and insuring permanent alignment of each element of the construction.

It is still another object of the instant invention to provide an electron gun construction of the modular type for shaped beam tubes which is rugged and extremely economical to manufacture.

It is a further object of the instant invention to provide an electron gun construction in modular form for shaped beam tubes which provides a minimum of distortion of the electron beam due to dielectric charges on the cylinder walls of the modular support member thereof.

It is still a further object of the instant invention to provide a modular support member for an electron gun construction which is provided with means for compensating for the differing coefficients of expansion between the support member and the electrodes of the gun.

It is still a further object of the instant invention to provide a modular support member for the electron gun assembly in a color cathode ray tube arranged in the form of a self-aligning modular assembly.

These and other objects, features and advantages of the instant invention will become more apparent from the following detailed description of the invention, when taken in conjunction with the accompanying drawings which disclose one embodiment of the instant invention, and wherein:

FIGURE 1 shows schematically and diagrammatically the construction of a cathode ray tube of the shaped beam type;

FIGURE 2 is an exploded view, showing a typical assemblage of shaped beam tube elements fabricated in accordance with the instant invention;

FIGURE 3 is a perspective view of the construction in accordance with the instant invention in the completely assembled form;

FIGURE 4 is an end section view illustrating the disposition of the electron optical elements within the modular support member in accordance with FIGURE 3;

FIGURE 5 is a perspective view of a second embodiment of the invention adapted for use in three gun color cathode ray tubes;

FIGURE 6 is a front end view of the device of FIGURE 5; and

FIGURE 7 is a sectional view taken along line 7—7 in FIGURE 6.

Referring now more particularly to the drawings for a

detailed explanation thereof, wherein like reference numerals are used throughout the separate views to indicate similar elements wherever possible, and more particularly to FIGURE 1, a cathode ray tube of the shaped beam type basically comprises an evacuated envelope 10 within which is provided in series arrangement electrodes 11 through 22, forming the electron optical lens construction of the cathode ray tube. The envelope 10 encloses an electron beam generating and control means at one end thereof consisting of a cathode 11 and a control grid 12, which will generate and project an electron beam along the axis of the tube envelope 10 toward the target 23 at the opposite end of the tube. The target 23 may be of any well known electron responsive coating such as phosphor or the like. The phosphor may have an aluminum undercoating, as is well known in the art, to enhance the response of the screen to the impingement of the beam, causing a light image thereupon. The light image is then viewed externally of the tube at the face of window of the envelope.

The longitudinal axis 24 of the envelope 10 of the cathode ray tube serves additionally as the optical axis for the beam generation and control system formed by the electron optical elements of the cathode ray tube gun assembly. Therefore, both the beam generating and control means 11 and 12 and the target or screen 23 must be coaxially disposed with respect to the longitudinal axis 24 effecting alignment of the necessary electron optical elements thereabout.

The electrode elements, referred to as electron optical elements, which provide for a control of the beam positioning and cross section thereof between the cathode 11 and the screen or target 23 consists of a first anode in the form of a cylindrical electrode 13 for accelerating the beam, including an aperture disc 14 positioned therein for effecting a first cross-over of the beam, a character matrix 15 containing a plurality of character-shaped openings for forming the electron beam into a plurality of character-shaped streams. Positioned beyond the first anode 13 is a second anode 16 and a beam positioning unit consisting of pairs of deflection plates 17, 18 and 19 which through generation of an electrostatic field in response to application of selective voltages serve to adjust the position of the electron beam formed of the plurality of character-shaped streams with respect to the optical axis 24 of the system so as to align, in the well known manner, one of the character streams with the aperture in aperture disc 20, mounted within the cylindrical anode 21. The single character-shaped stream of electrons passing through the aperture in disc 20 is then further accelerated by the second cylindrical anode 21 and eventually impinges upon target 23 to provide a character representation thereon.

It is quite obvious that completely accurate alignment of each of the elements of the electron gun construction of shaped beam tubes must be effected and maintained for proper operation thereof. Slight misalignments of any one or more of the electrodes of the optical system can result in improper or incomplete character representation on the screen of the cathode ray tube, and due to the close tolerances of the optical system and the close spacing between the character shaped streams of the electron beam only slight inaccuracies in alignment are necessary to result in substantially complete inoperability of the system.

The modulator support member for the electron gun construction in accordance with the instant invention, as seen in FIGURE 2, consists of a tubular insulating member 30 provided with two pairs of orthogonally positioned slots 31 and 32 which accommodate the various wiring pins 35 connected to each of the electron optical elements shown in exploded view in FIGURE 2. The slots 32 may be made of much shorter length than the slots 31 since they are provided to accommodate only the wiring pins 35 for the horizontal deflection plates 18. Thus, the slots

32 may equal the length of slots 31, as seen in FIGURE 2, or be shortened to accommodate other electrodes without departing from the objects of the invention.

A second set of orthogonally positioned slots 38 are also provided in the tubular member 30 extending from the end thereof opposite from the end to which slots 31 and 32 extend, and interdigitated with the last-mentioned slots so as to modify the expansion characteristics of the tubular member, which may, for example, be made of precision ground Mullite. By providing the slots 38, the coefficient of expansion of the tubular member 30 may be more closely matched to that of the electrodes in the gun construction which are preferably made of cast stainless steel. With this arrangement in accordance with the invention the precision alignment and self-alignment properties during use at high temperatures can be maintained.

While four slots 38 are provided in the illustrated example in the drawings, it should be understood that the number and length of these slots may be varied as desired without departing from the spirit and scope of the instant invention. In addition, the number of slots 31 and 32 may also be varied, if desired, with suitable changes in gun construction and disposition.

The inside surface of the support member 30 is provided as a smooth surface free of grooves, projections or other irregularities other than the slots 31 and 32. As is apparent in FIGURE 2, the electron optical elements are provided of a size which conforms to the inner diameter of the tubular member 30 so that the elements 12 through 22 may slide freely into position inside of the support member 30 without difficulty and yet be immovably supported within the support member.

Proper spacing between the various electron optical elements is provided by the spacers 25, which may be in the form of precision stamped mica rings whose individual thicknesses are designed to provide the proper spacing between individual electrodes, while also providing effective shielding between electron elements. Due to this unique spacing feature of the instant invention, the entire assembly of electron optical elements and spacers, as seen in FIGURE 2, may be arranged in modular form with facility by merely slipping the individual elements in order into the tubular support member 30. This stacked arrangement of elements within the tubular support member 30 will produce a rigid supporting of each element by the elements on either side thereof with proper spacing being insured by the spacers 25. A rigid modular construction such as illustrated in FIGURE 3 results.

To secure the assembly after all of the elements have been inserted into the tubular support member 30, a stainless steel split ring 34 is placed in groove 33 positioned adjacent the slotted end of the support member and the two pins 35 of the final anode 22 are welded to the ring to provide a rigid and secure assembly. Snubbers 35 are provided on the ring 34 to properly position the assembly within the neck of the cathode ray tube envelope and to provide for absorption of shocks and vibrations in the well-known manner.

As indicated above, the wiring leads 35 extending from each of the electron optical elements of the electron gun construction serve not only as means for applying proper voltages to these electrodes, but also in conjunction with the slots 31 and 32 provide for a proper alignment of the elements and a means for insuring correct support of such elements as the deflection plates 17, 18 and 19. For example, in connection with the deflection plates, after insertion of the deflection plate pairs into the cylindrical support member 30, the wiring leads 35 associated with each of the deflection plates is pulled outwardly by the wiring lead 35 until the outer surface of each deflection plate, which is a non magnetic stainless steel casting having an arcuate configuration corresponding to the shape of the inner surface of the support member, is firmly positioned against this inner face. Push-on fasteners 35a

associated with each deflection plate are then used to secure the deflection plates to the cylinder 30 by way of the wiring leads 35. Such an arrangement provides for simple construction, eliminating the need for spot welding.

FIGURE 4 illustrates a cross section through the electron gun construction in the vicinity of the deflection plates so as to illustrate the disposition of these plates in the various electrodes of the system and the manner in which the slots in the wall of the tubular support member cooperate with the wiring leads to provide for correct alignment of these elements.

As is quite apparent from the foregoing description of the instant invention, the modular construction utilizing the tubular support member 30 makes possible an extremely simplified assembly of the elements of the electron gun construction into a module which provides for accurate positioning and alignment of these elements. No special measuring or jiggling of the elements during assembly thereof is required, as was necessary in prior art arrangements, to accomplish this precise alignment, and upon completion of the assembly, a sufficient rigidity and self-alignment of the elements is obtained to insure proper stability thereof during use.

Referring now to FIGURES 5, 6 and 7, there is provided in accordance with the invention a support member 40 of substantially triangular cross section which may be used to provide a self-aligning electron gun assembly for a three gun color cathode ray tube.

The support member 40 is provided with three tubular through apertures 44, 46 and 48, each of which correspond to and perform the function of the tubular support member 30 for the single gun construction. A slot 42 is provided in communication with each of the apertures 44, 46 and 48, which slots extend to only one end of the support member 40 and accommodate the wiring leads for each of the respective gun assemblies (not shown) in the manner of slots 31 in the single gun construction.

As is also apparent from FIGURES 6 and 7 the through apertures 44, 46 and 48 are oriented within the support member 40 so as to provide proper convergence of the three beams of the electron gun assembly in the manner well known in the art so that proper alignment of each of the electron guns is assured at all times.

The support member 40 makes possible a modular self-aligning construction for the electron gun assembly of a color cathode ray tube and provides for precision assembly combined with ruggedness to maintain the accurate alignment required. Also, the disclosed construction is well suited to assembly line production, similar to the single gun assembly, since it is necessary only to drop the individual gun elements in place in the support member with ceramic spacers introduced to accomplish the insulation, spacing and shielding between gun elements. With this arrangement the assembly time is greatly reduced, since a minimum of spot welding is required.

Like the single gun construction, the support member 40 is preferably made of Mullite ceramic, which makes possible the precision alignment and maintenance of this alignment through handling and diverse temperature cycles.

Although the invention has been described with a degree of particularity, it should be understood that the present disclosure has been made only by way of example, and that numerous changes may be made in the configuration and arrangement of the structural components without departing from the spirit and scope of the instant invention.

I claim:

1. An electron gun construction for cathode ray tubes comprising:

an electron beam generating means for generating an electron beam,

a plurality of electron optical elements for controlling the position and cross-section of said electron beam,

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- each including at least one transversely disposed wiring lead connected thereto,
 a tubular support member having said electron beam generating means and said electron optical elements mounted therein in coaxial relationship, and
 a plurality of individual annular insulating spacers, each interposed between respective adjacent electron optical elements and having a thickness equal to the required spacing between said elements,
 said tubular support member including a plurality circumferentially spaced longitudinal slots extending to one end thereof, said wiring leads connected to each electron optical element extending through said longitudinal slots.
2. An electron gun construction as defined in claim 1, wherein:
 said tubular support member is a one piece member made of electrical insulating material.
3. An electron gun construction as defined in claim 1 wherein:
 said tubular support member is provided with means for compensating for the difference in coefficient of expansion between said support member and said electron optical elements.
4. An electron gun construction as defined in claim 2 wherein:
 said tubular support member is provided with an annular groove in the outer surface thereof adjacent the end to which said longitudinal slots extend, and clamping means seated in said annular groove for securing said optical elements and said spacers within said support member.
5. An electron gun construction as defined in claim 2 wherein:

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- the inner diameter of said tubular member is substantially equal to the outer diameter of said electron optical elements and the inner surface thereof is uninterrupted except for said longitudinal slots.
6. An electron gun construction as defined in claim 4 wherein:
 the length of said tubular member is substantially equal to the length of the electron optical elements in stacked relationship.
7. An electron gun construction as defined in claim 1 wherein:
 said annular insulating spacers are in the form of stamped mica rings.
8. An electron gun construction as defined in claim 2 wherein:
 said tubular support member includes at least an additional longitudinal slot extending to the end thereof opposite said one end.
9. An electron gun construction as defined in claim 2 wherein:
 said tubular support member includes a plurality of additional longitudinal slots extending to the end thereof opposite said one end and being interdigitated with said orthogonally disposed longitudinal slots.

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ROBERT SEGAL, *Primary Examiner.*