

April 8, 1947.

P. T. SPROUL

2,418,487

CATHODE RAY MAGNETIC FOCUSING DEVICE

Filed March 31, 1944

7 Sheets-Sheet 1

FIG. 1

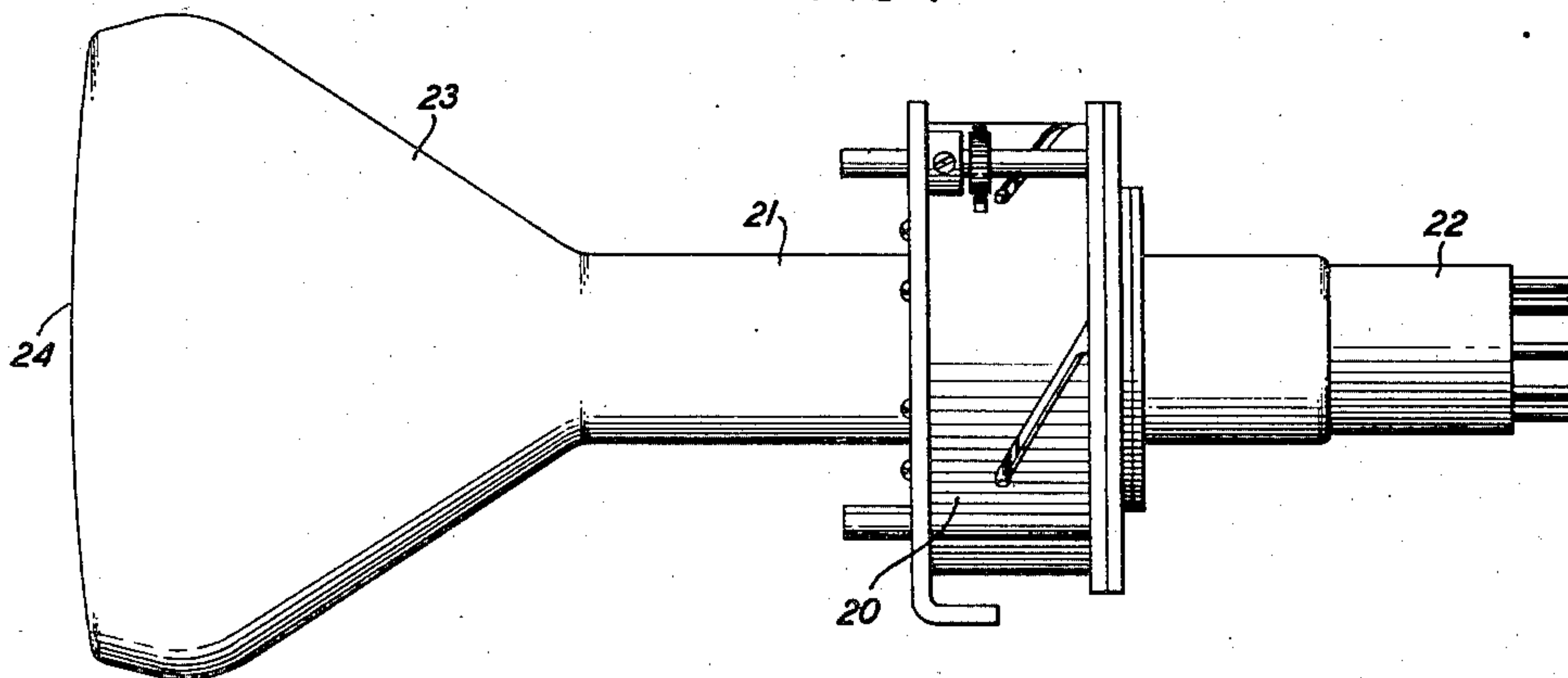
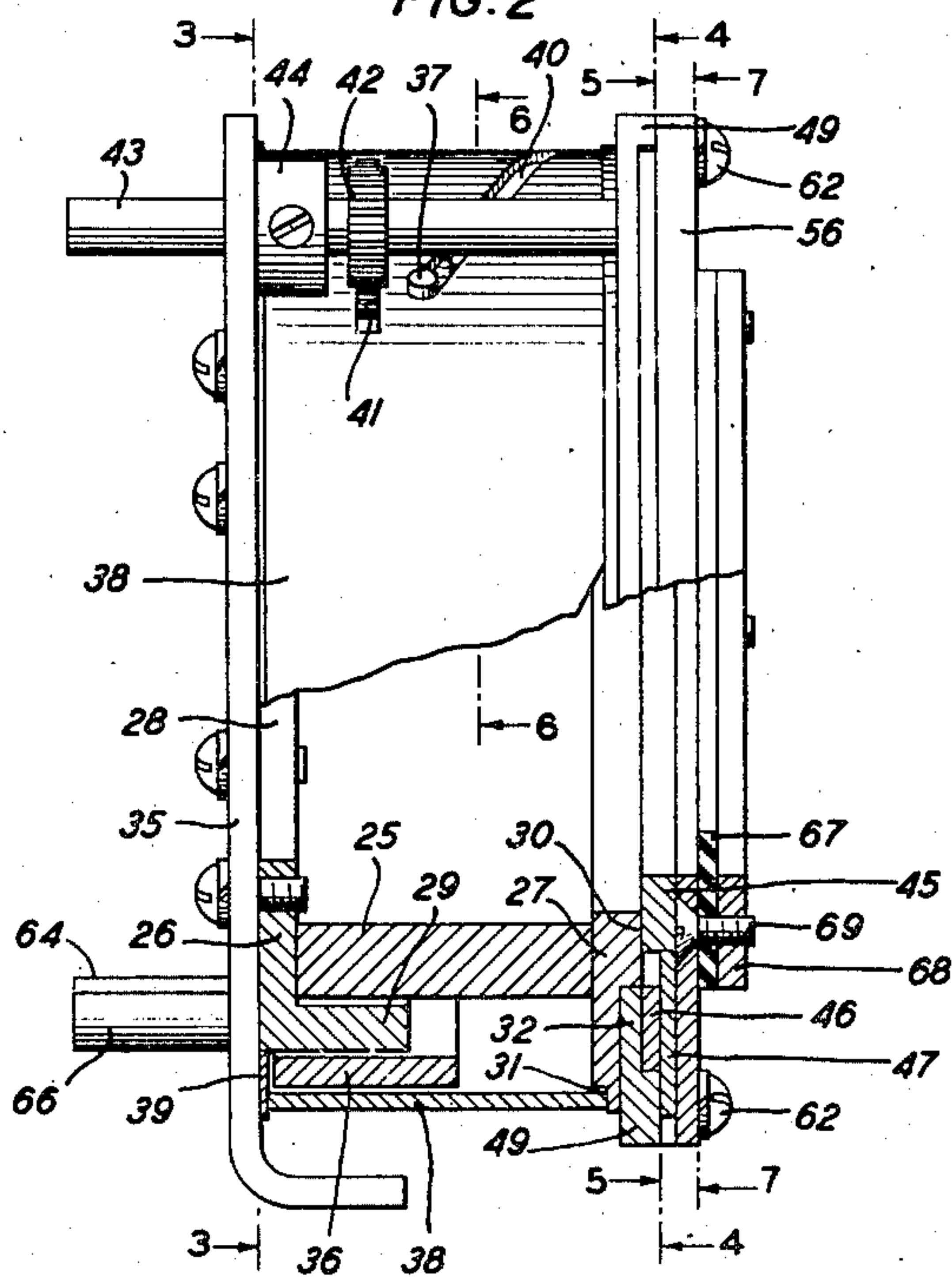


FIG. 2



INVENTOR
P. T. SPROUL
BY
Walter C. Kiesel
ATTORNEY

April 8, 1947.

P. T. SPROUL

2,418,487

CATHODE RAY MAGNETIC FOCUSING DEVICE

Filed March 31, 1944

7 Sheets-Sheet 2

FIG. 3

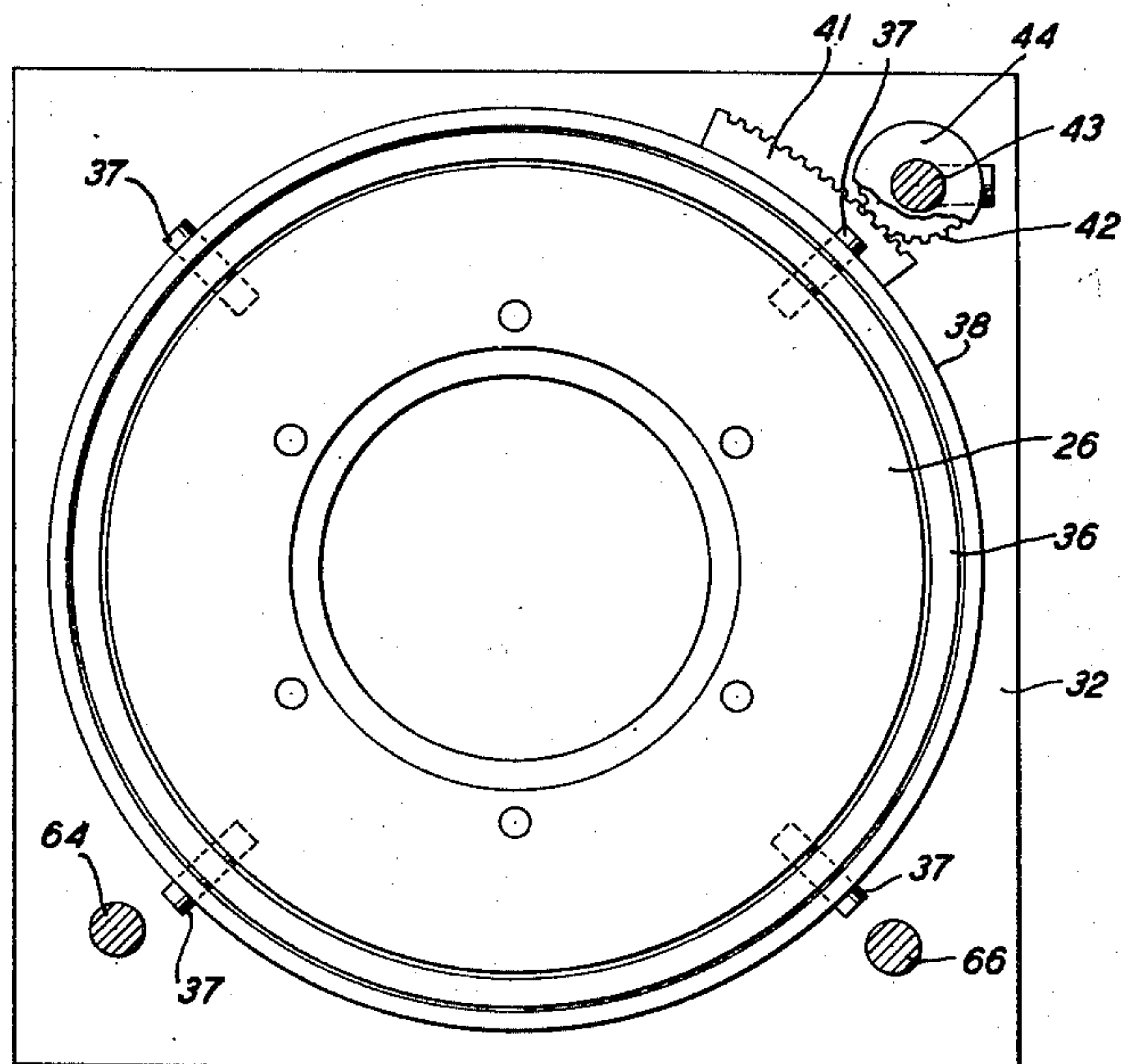
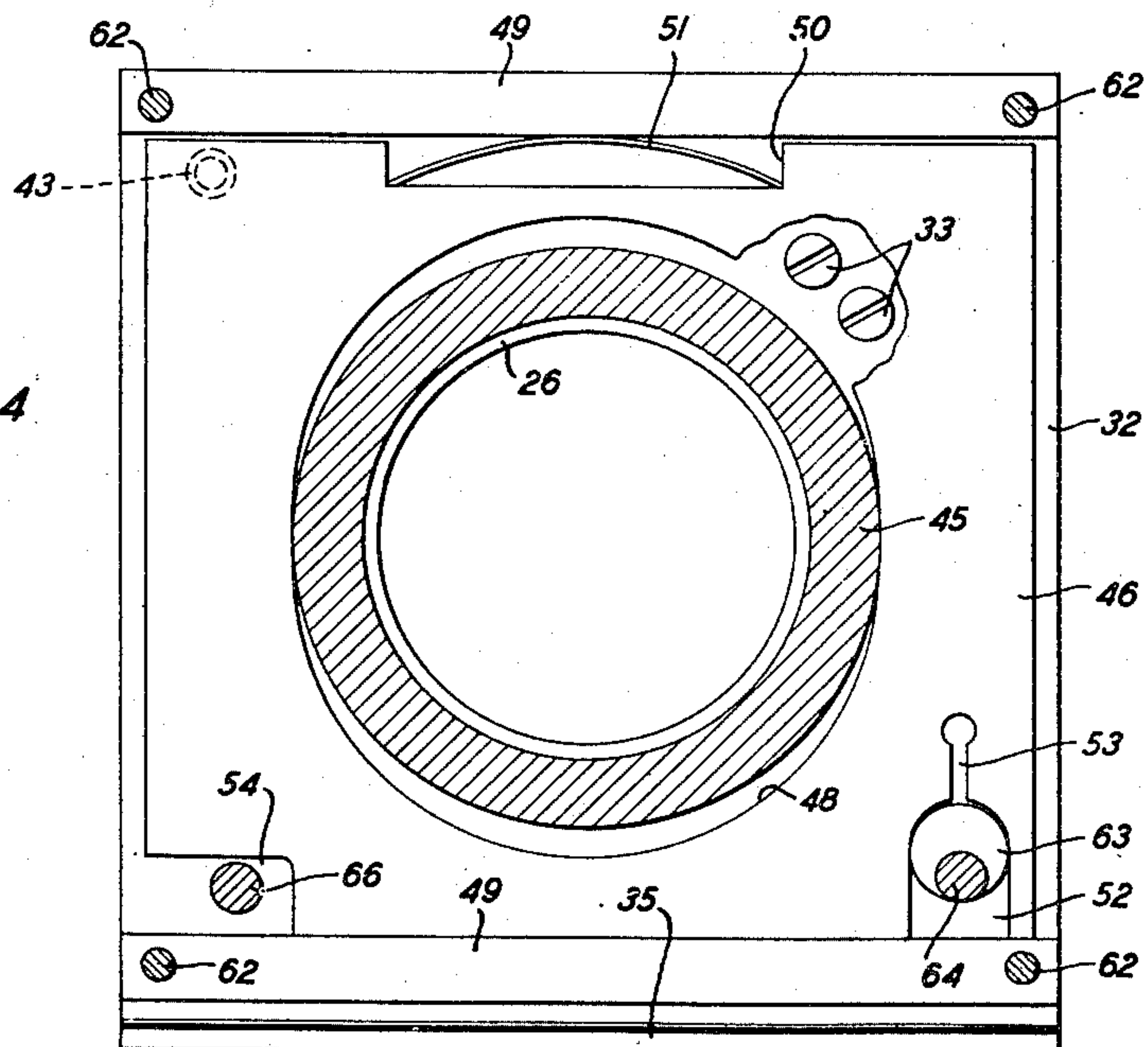


FIG. 4



INVENTOR
P. T. SPROUL
BY
Halter C. Kiesel
ATTORNEY

April 8, 1947.

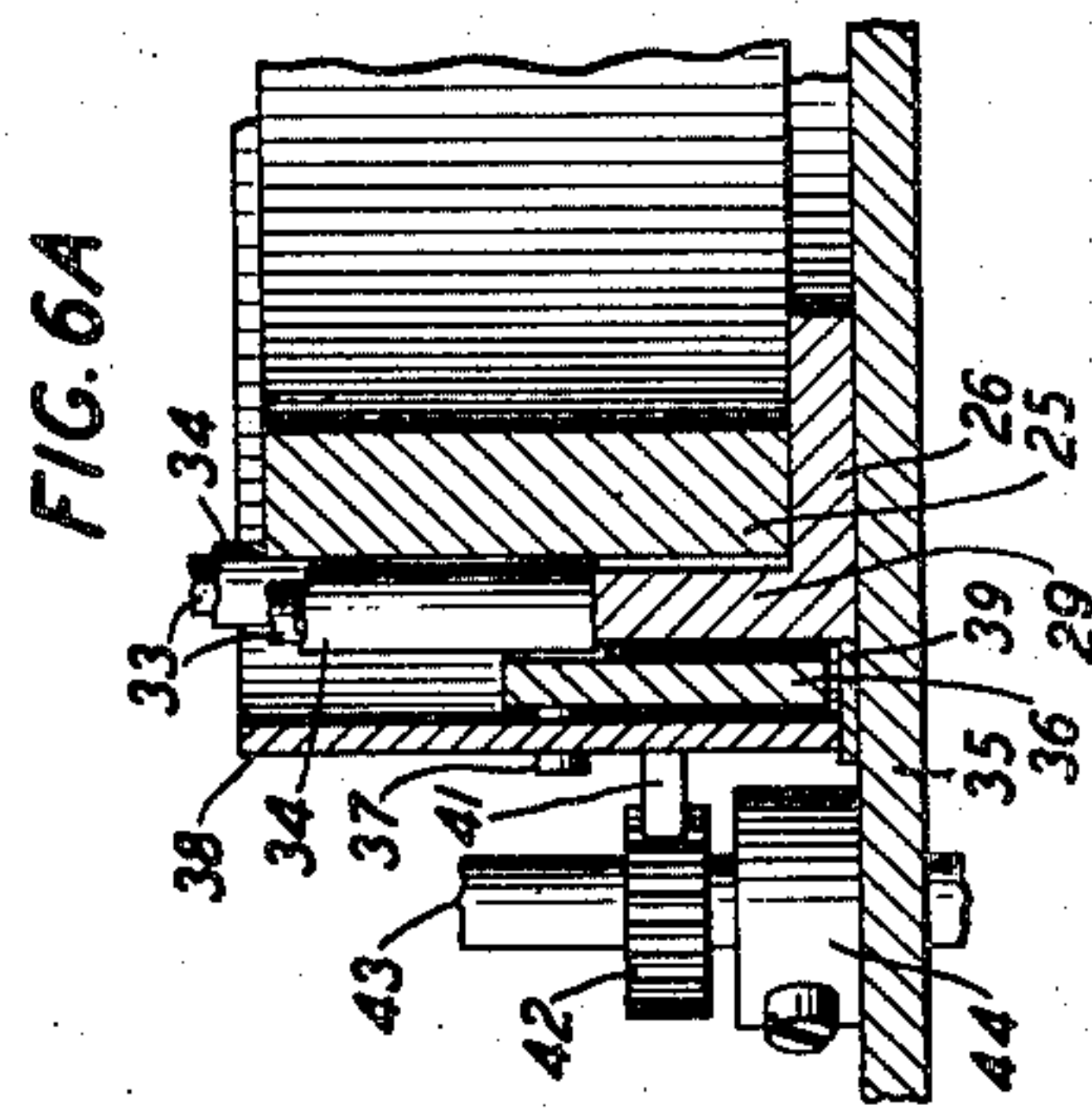
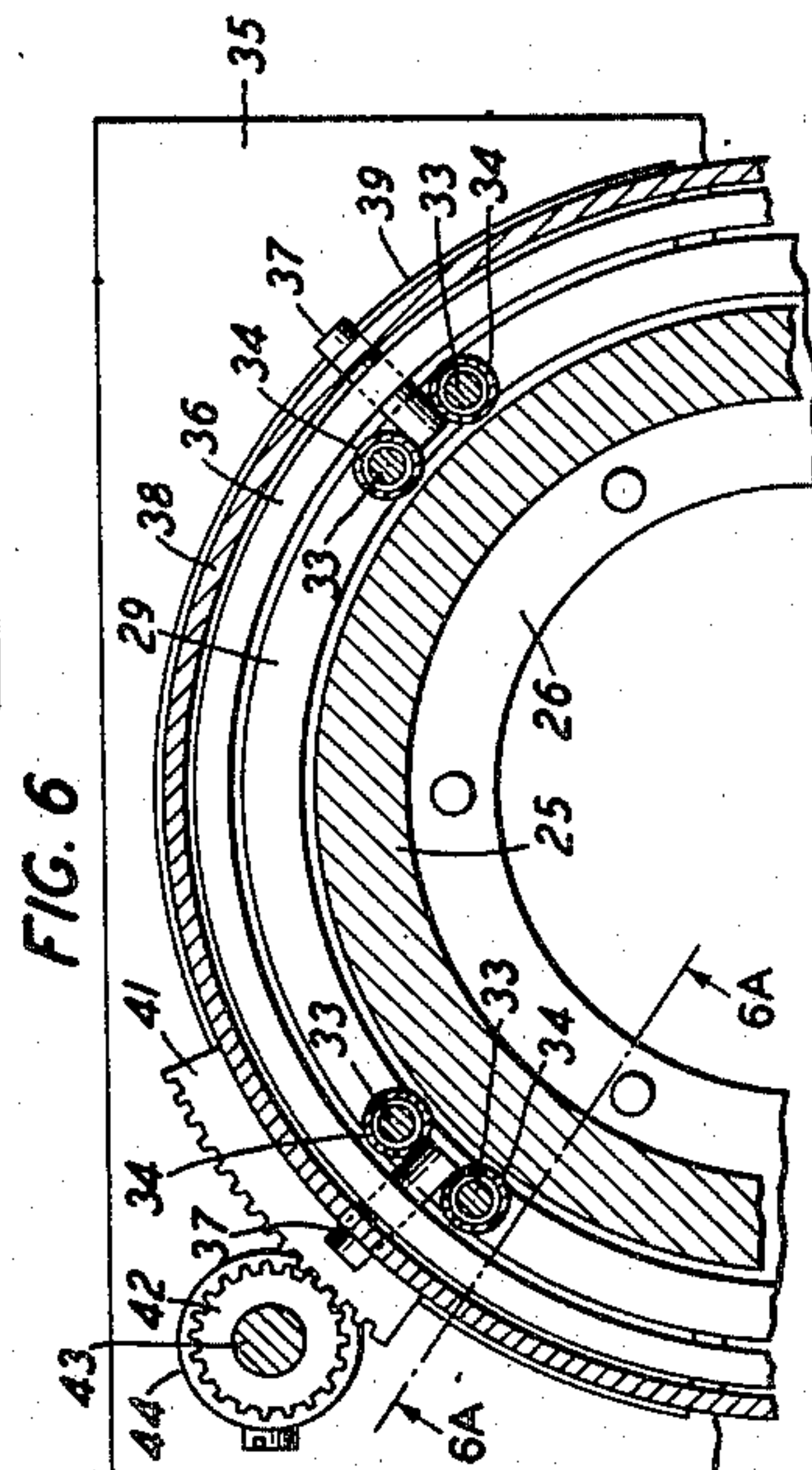
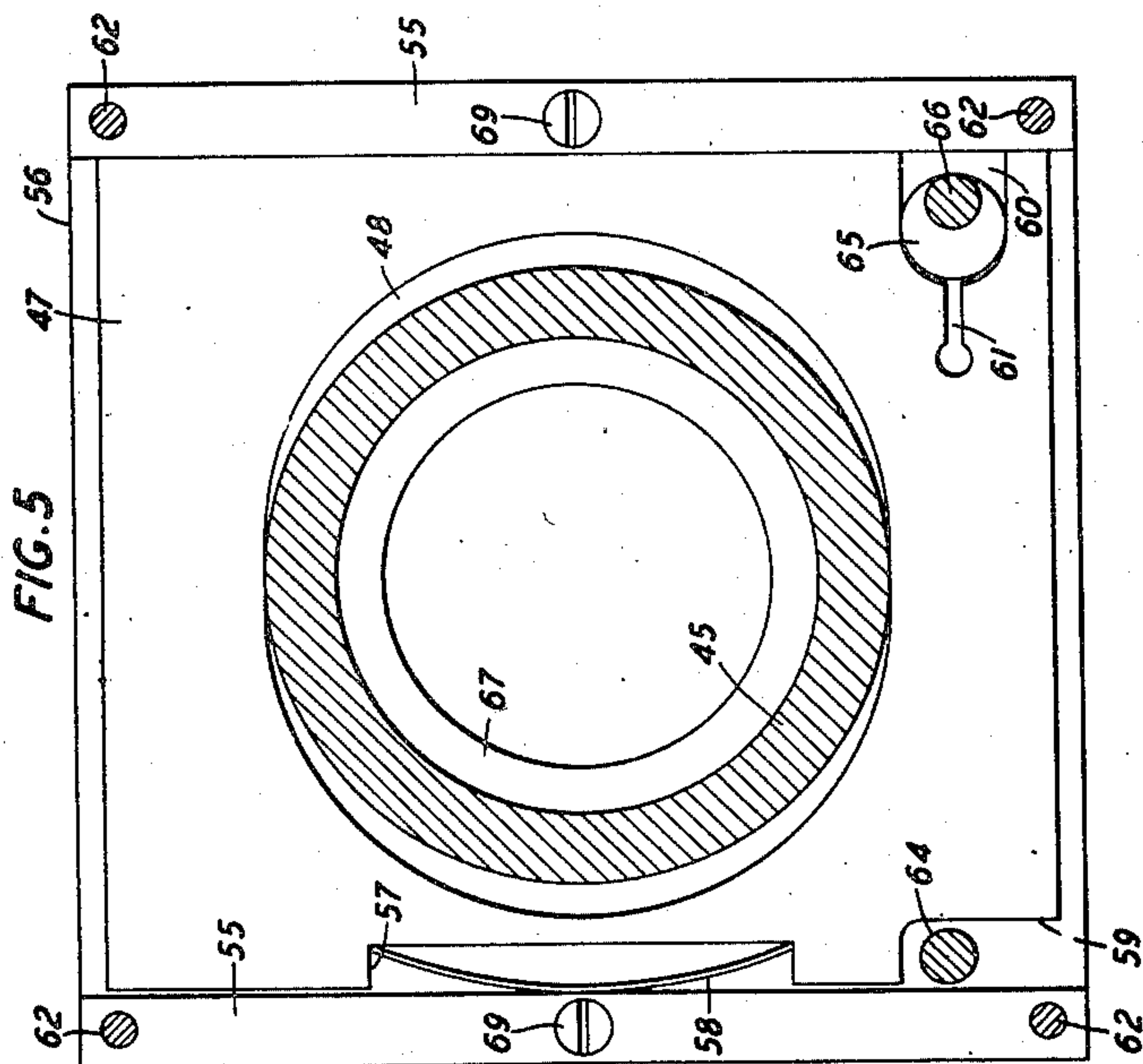
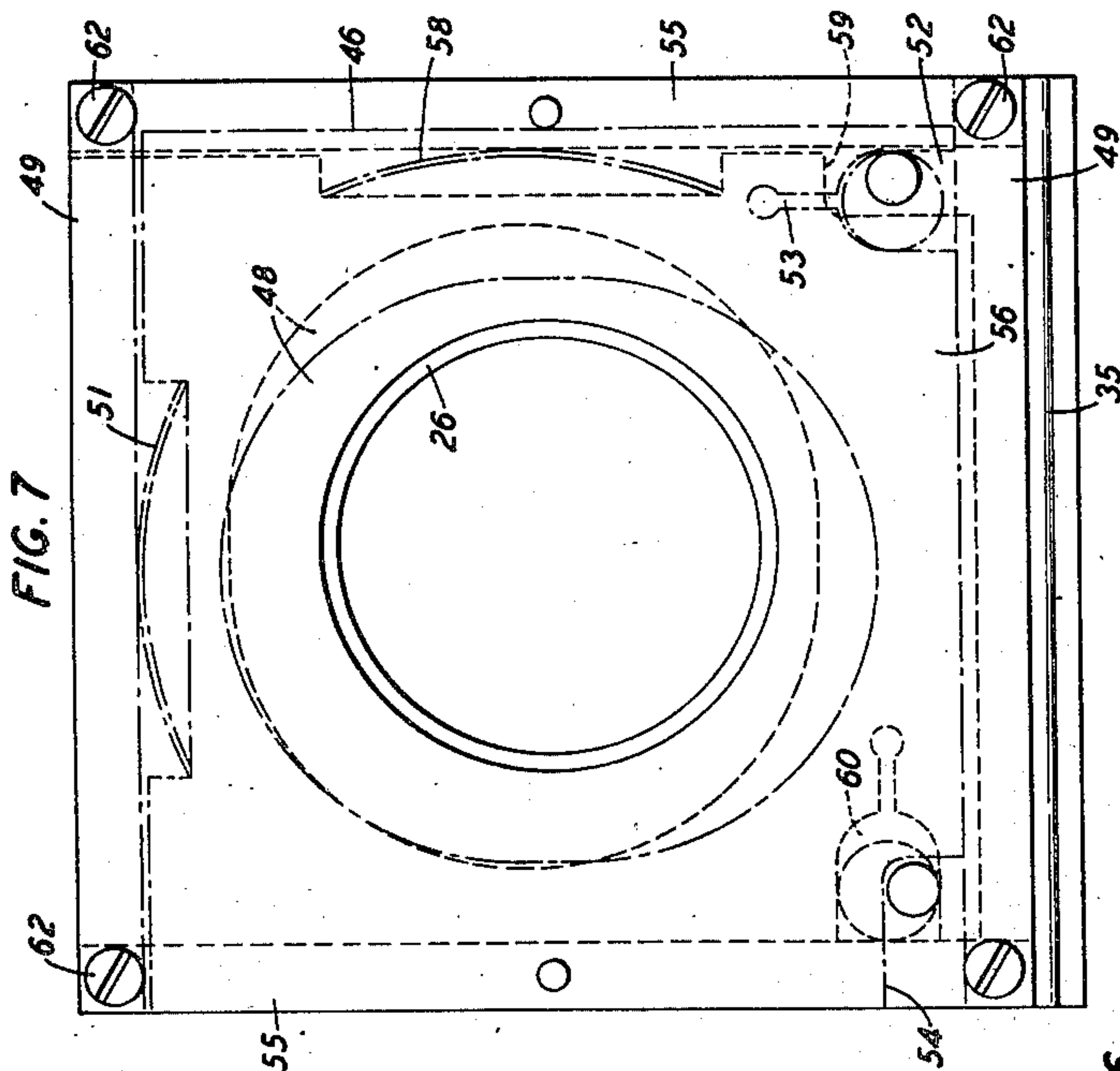
P. T. SPROUL

2,418,487

CATHODE RAY MAGNETIC FOCUSING DEVICE

Filed March 31, 1944

7 Sheets-Sheet 3



INVENTOR
P. T. SPROUL
BY

Walter C. Kiesel
ATTORNEY

April 8, 1947.

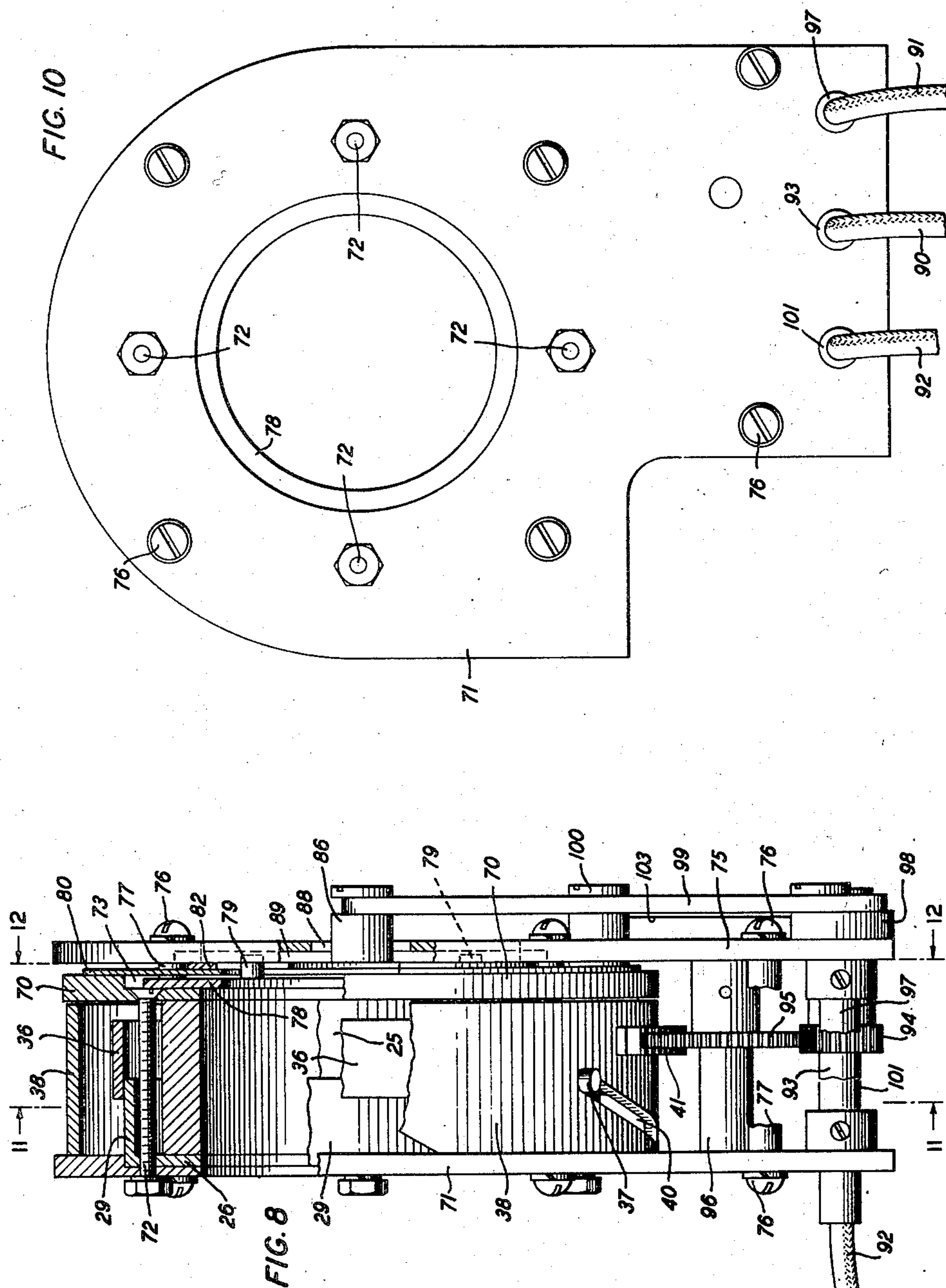
P. T. SPROUL

2,418,487

CATHODE RAY MAGNETIC FOCUSING DEVICE

Filed March 31, 1944

7 Sheets-Sheet 4



April 8, 1947.

P. T. SPROUL

2,418,487

CATHODE RAY MAGNETIC FOCUSING DEVICE

Filed March 31, 1944

7 Sheets-Sheet 5

FIG. 9A

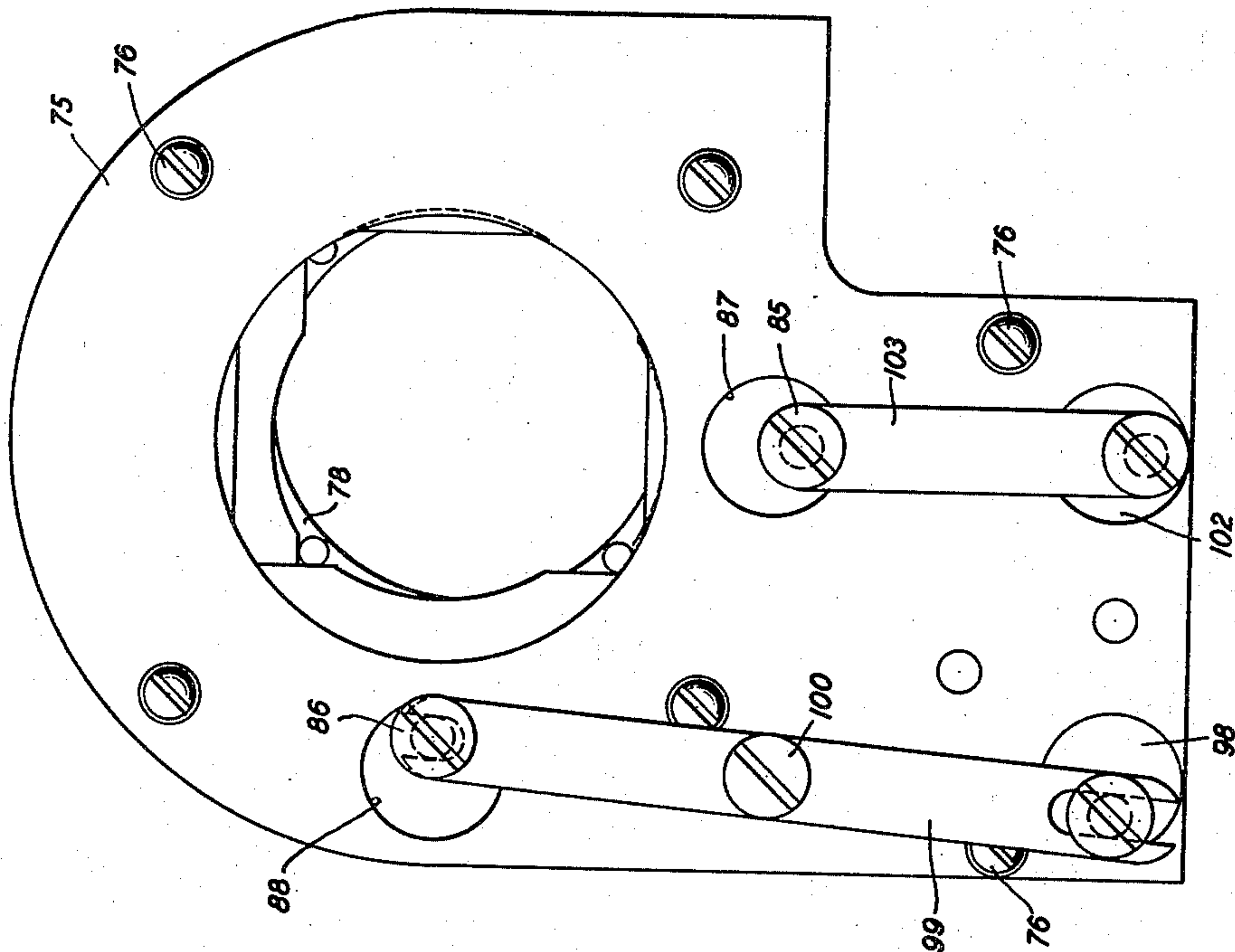
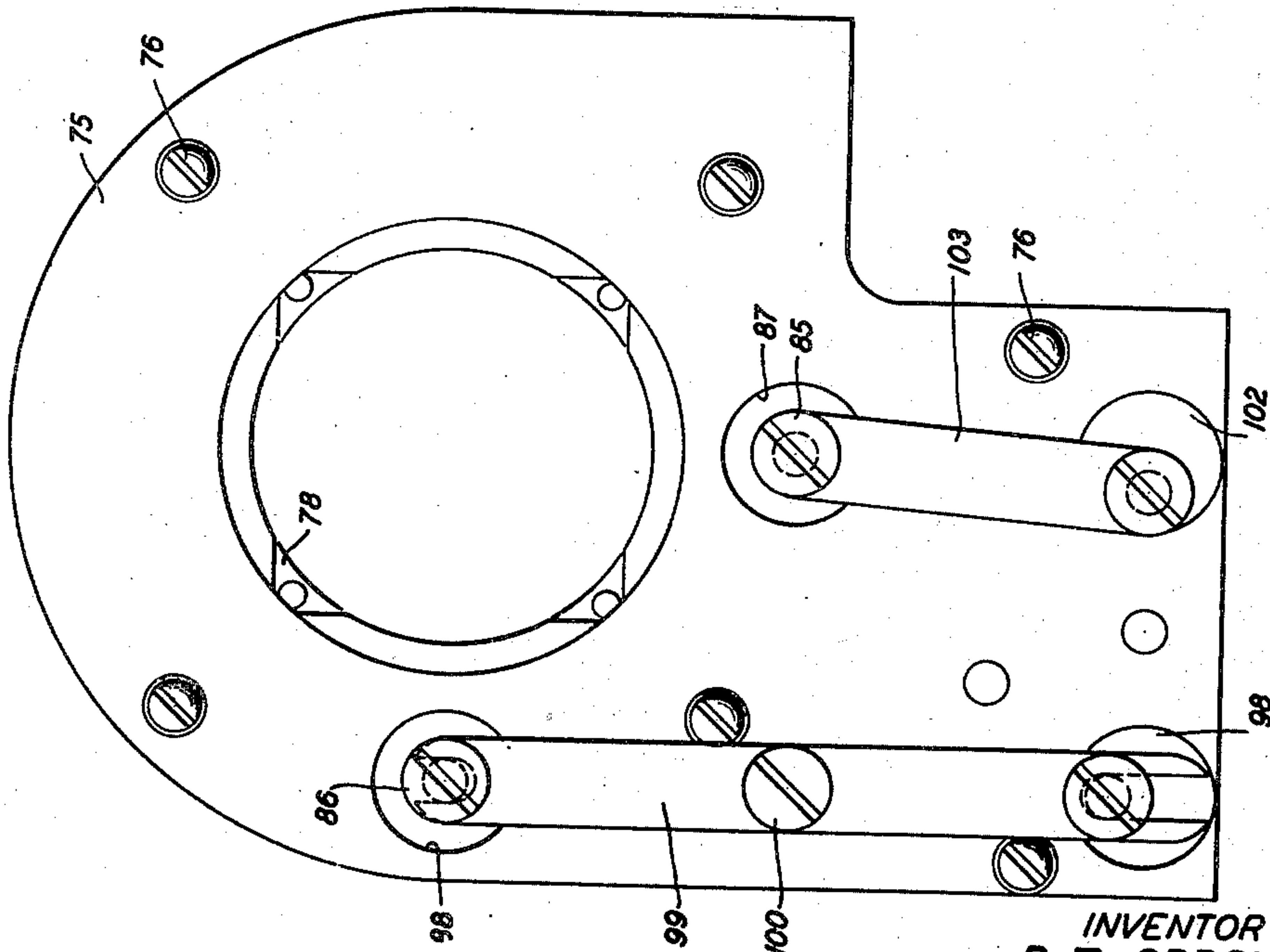


FIG. 9



INVENTOR
P. T. SPROUL
BY
Walter C. Kiesel
ATTORNEY

April 8, 1947.

P. T. SPROUL

2,418,487

CATHODE RAY MAGNETIC FOCUSING DEVICE

Filed March 31, 1944

7 Sheets-Sheet 6

FIG. 12

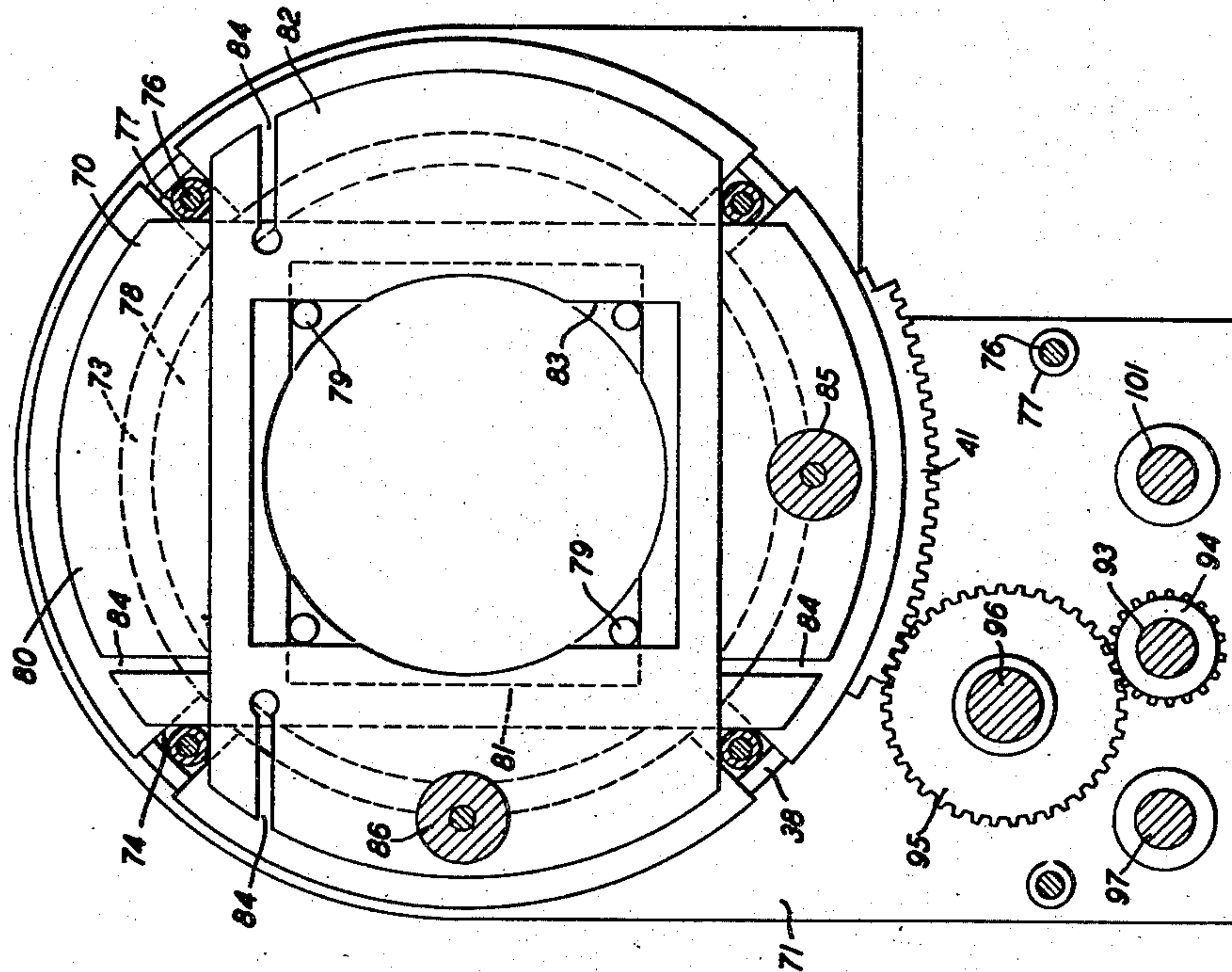
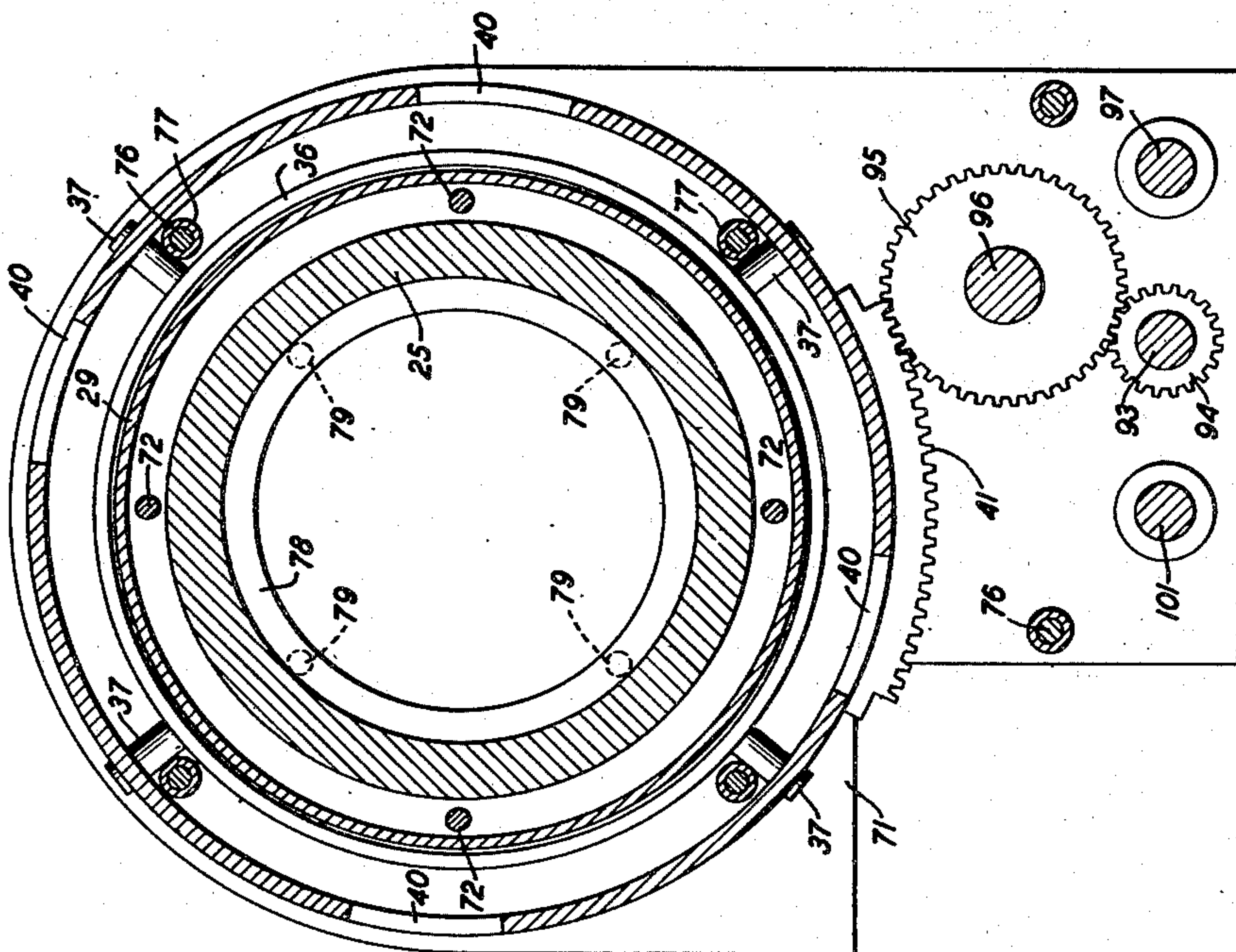


FIG. 11



INVENTOR
P. T. SPROUL
BY
Walter C. Kiesel
ATTORNEY

April 8, 1947.

P. T. SPROUL

2,418,487

CATHODE RAY MAGNETIC FOCUSING DEVICE

Filed March 31, 1944

7 Sheets-Sheet 7

FIG. 13

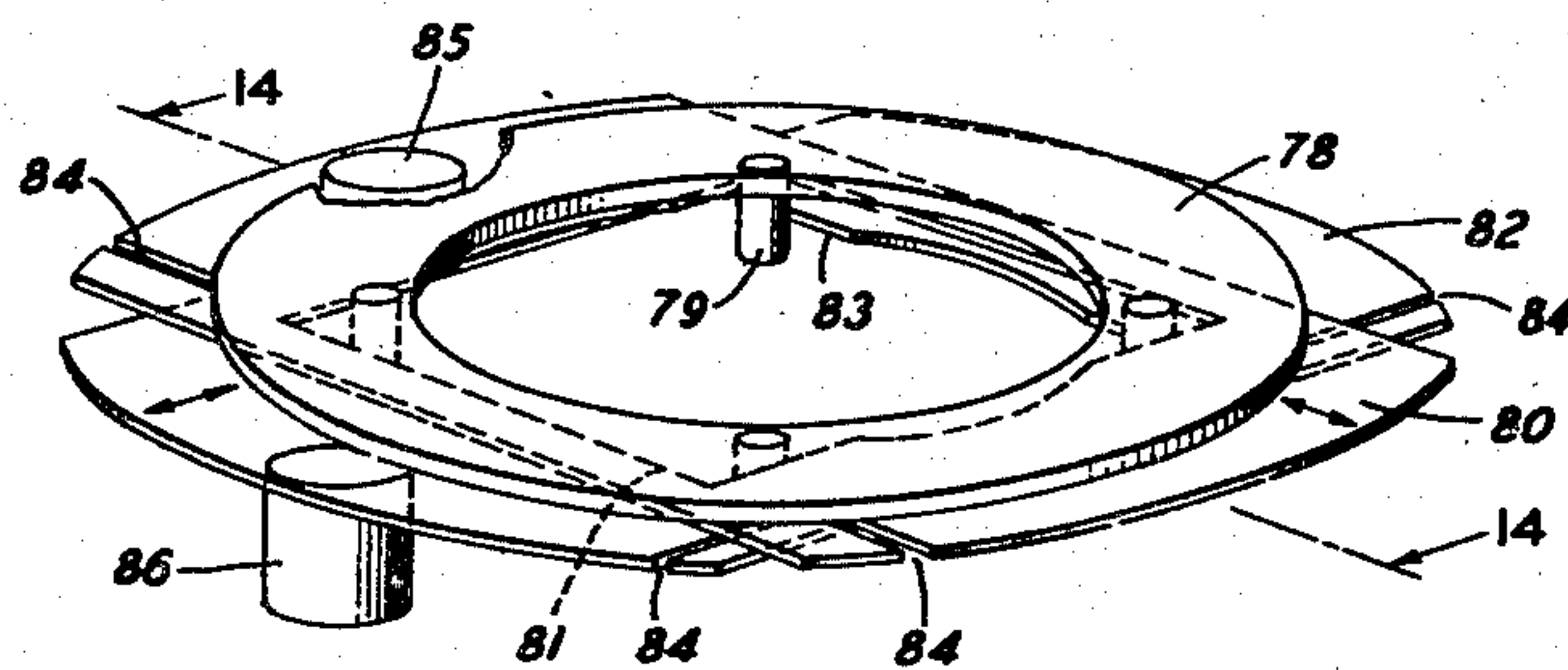


FIG. 14

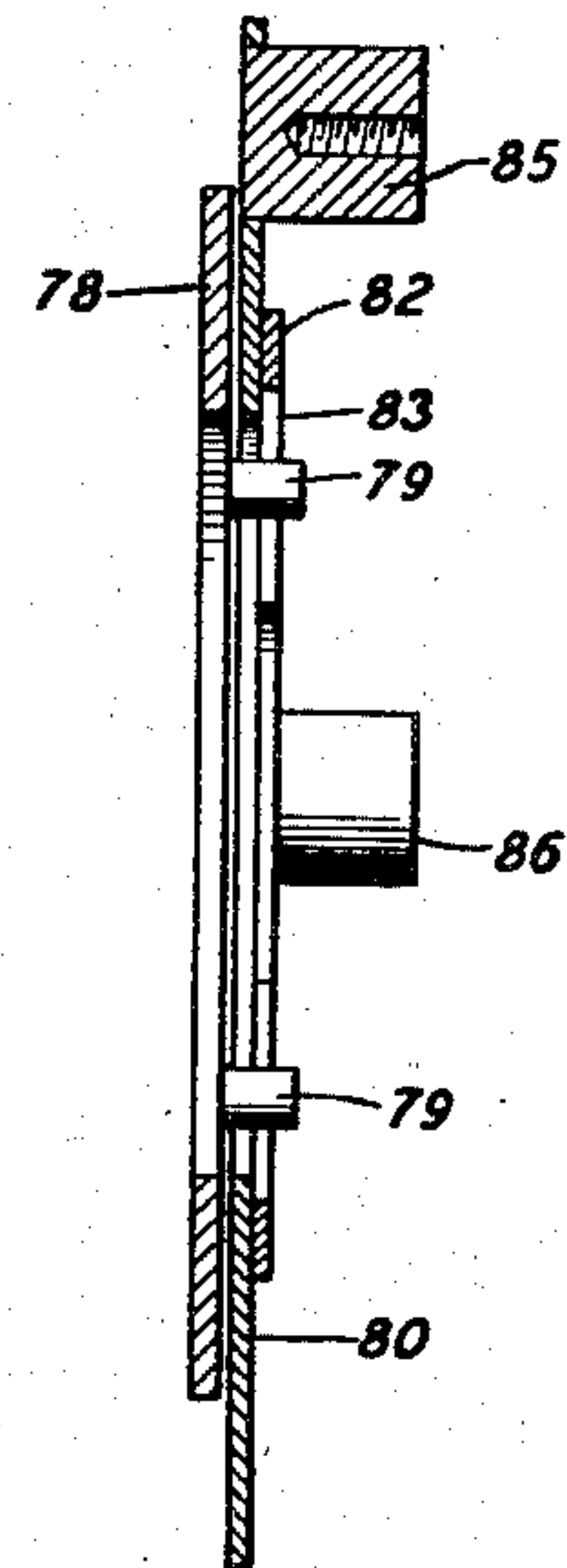
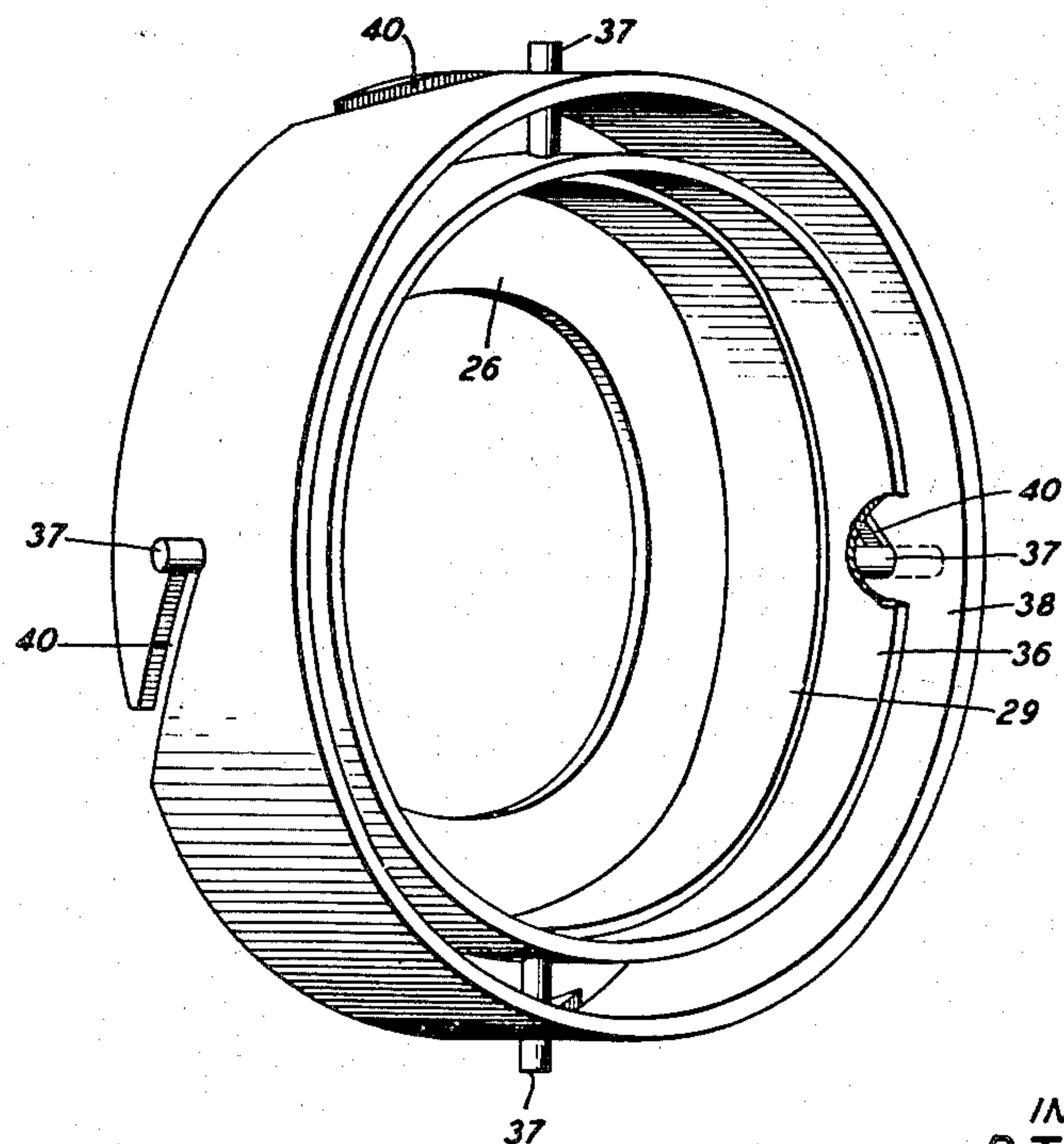


FIG. 15



INVENTOR
P. T. SPROUL
BY
Halter G. Kiesel
ATTORNEY

UNITED STATES PATENT OFFICE

2,418,487

CATHODE RAY MAGNETIC FOCUSING
DEVICE

Philip T. Sproul, Chatham, N. J., assignor to Bell
Telephone Laboratories, Incorporated, New
York, N. Y., a corporation of New York

Application March 31, 1944, Serial No. 528,911

20 Claims. (Cl. 250—161)

1

This invention relates to magnetic devices and more particularly to magnetic focusing devices employed in connection with cathode ray oscillograph devices.

An object of the invention is to improve the efficiency of operation of the manipulative controls for the movable elements of the device.

Another object of the invention is to overcome circular displacement of the beam of the cathode ray device during collimation of the beam along the axis of the device.

Another object of the invention is to facilitate transverse movement of the beam to compensate for manufacturing inaccuracies in the alignment of the beam source with respect to the axis of the screen of the device.

A further object of the invention is to attain uniform movement of the adjustable components of the focusing device to insure positive correctional influence on the beam of the cathode ray device.

Another object of the invention is to fabricate the assembly of the focusing device in such a manner that inertia is avoided and differences in expansion and contraction are compensated so that high operating efficiency is attained.

In accordance with this invention these objects and other advantages are obtained in a compact magnetic focusing and centering device or unit embodying a permanent magnet core surrounded by a cylindrical shunt, which is adjustable with respect to the core to vary the strength of the flux field for focusing the electron beam, a slidable auxiliary magnetic ring being mounted on one end of the core which is adjustably movable in transverse directions to accurately center the beam along the axis of the cathode ray tube.

In a specific embodiment of the invention a rotatable sleeve is associated with the shunt, the sleeve being actuated by a gear shaft to reciprocally adjust the shunt with respect to the sleeve and core magnet. The auxiliary centering ring is transversely shifted with respect to the axis of the focusing device by slidable plates encompassing the ring. These plates are actuated by cams to alter the axis of the ring eccentrically with respect to the axis of the focusing magnet structure.

In another form, the sliding plates engage pins on the centering ring and the plates are con-

2

trolled by link members coupled to rotating cam shafts extending through the structure.

In both forms of the invention the shunt is efficiently controlled to eliminate waste motion and to achieve a uniform variation of field strength in order that the magnetic unit may be employed with a tube over an operating range of large magnitude. Similarly, the centering ring in both forms is controlled uniformly through the transversely movable plates to insure displacement of the ring in two directions perpendicular to each other to eliminate curvilinear travel of the beam in centering it with respect to the axis of the cathode ray tube. These arrangements reduce the time necessary for centering the beam and contribute to the stable directive control of the beam on the axial center of the screen of the cathode ray device.

A feature of the embodiments of this invention relates to the uniform adjustment of the shunt member reciprocally with respect to the core to vary the strength of the flux field in the gap and thereby increase the operating range of the device between focusing voltages from 3,000 to 7,000 volts. This is accomplished by providing pins on the shunt which travel in angularly directed slots in the rotatable sleeve surrounding it and the pins slide in guideways formed by upright members clamping the core magnet between the end pole-pieces. The rotation of the shunt is thereby prevented so that frictional forces do not affect the reciprocal movement of the shunt and the control thereof is more easily attained.

Another feature of one construction involves the positive displacement of the centering ring with respect to the axis of the magnet structure in which the sliding plates are mounted between bearing plates having edge guide portions which engage the movable plates and insure uniform transverse travel of the centering ring. In the other form the slidable plates are accurately guided in their transverse travel by the same guide members controlling the travel of the pins on the reciprocally movable shunt member.

These and other features of the invention will be set forth more in detail in the following description which, together with the accompanying drawings, discloses two examples of the devices embodying the concepts of this invention.

Fig. 1 shows the focusing and centering device of this invention mounted on the neck of a cathode ray oscillograph tube;

Fig. 2 is a side elevation view of the focusing and centering device according to this invention with portions broken away to show the relation of the internal elements of the device;

Fig. 3 is a plan view taken on the line 3—3 of Fig. 2 to show the mounting of the shunt and outer sleeve actuated by the gear and rack;

Fig. 4 is a plan view taken on the line 4—4 of Fig. 2 to show one of the cam operated plates controlling the shifting of the centering ring shown in cross-section;

Fig. 5 is another plan view taken on the line 5—5 of Fig. 2 for the movement of the centering ring by the other slidable plate;

Fig. 6 is a partial plan view in cross-section taken on the line 6—6 of Fig. 2 showing the relation of the core, shunt and sleeve and the guides for the pins projecting from the shunt;

Fig. 6a is a cross-sectional view on the line 6a—6a of Fig. 6 to illustrate the core magnet clamped between the end pole-pieces;

Fig. 7 is a plan view showing the relation of the superimposed sliding plates as viewed from the rear of the device and is taken on the line 7—7 of Fig. 2, the centering ring being removed and the plates shown in dotted line;

Fig. 8 illustrates in a side elevation view another form of the invention with a portion in cross-section to show the internal assembly;

Figs. 9 and 9a are two rear plan views of the device of Fig. 8 showing the various positions of the link controls for shifting the centering element of the device;

Fig. 10 is a front plan view of the device of Fig. 8 showing the location of the group controls at the lower end thereof;

Fig. 11 shows in cross-section a view along the line 11—11 of Fig. 8 to illustrate the drive for the rotating sleeve and the relation of the reciprocal shunt with respect to the sleeve and magnet core;

Fig. 12 is a cross-sectional view taken on the line 12—12 of Fig. 8 showing the sliding plates for shifting the centering element;

Fig. 13 is a perspective view illustrating the cooperative relation of the sliding plates with the centering element having pins engaged by the plates;

Fig. 14 is a cross-sectional view in elevation of the plates and centering element as shown in Fig. 13; and

Fig. 15 shows in perspective the relation of the rotating sleeve, shunt and top pole-piece of the device, shown in Fig. 8.

Referring to Fig. 1 of the drawings, the compact adjustable magnetic focusing and centering structure or unit 20 of this invention is shown mounted on the cylindrical neck portion 21 of a cathode ray oscillograph device or tube provided with a terminal base 22 at one end and a conical portion 23 at the other end which terminates in a dome-shaped screen 24 of large diameter. The screen is provided with an internal coating of material which becomes fluorescent when an electron beam is projected from an electron gun or source, not shown, but situated in the lower end of the neck portion 21. The magnetic structure 20 of this invention is employed to influence the beam of electrons projected toward the screen by a magnetic focusing field which increases the definition of the fluorescent spot appearing on the screen and to adjustably correct the directive

flow of the beam along the axis of the device or tube to counteract the effect of external magnetic forces and to realign the beam or center it along the axis of the tube to compensate for manufacturing inaccuracies produced in the mounting of the electron gun in the device or to position the spot on the screen in central relation to a scale superimposed on the screen.

The constructional details of the compact assembly of one embodiment of the adjustable magnet structure or unit, according to this invention, are shown in Figs. 2 to 7, inclusive, Fig. 2 showing the combined unit and the other figures showing specific details of the unit. The structure has a central annular core or permanent magnet 25 of magnetic material having high flux density, such as iron-nickel-aluminum alloys, of small mass and large magnetizing forces. A specific desirable material for the purposes of this invention is "Alnico No. 2 or 5" having the general composition of 17 per cent nickel, 11 per cent aluminum, 12 per cent cobalt, 6 per cent copper and the remainder iron. Such an alloy, when suitably subjected to heat treatment, is characterized by high magnetism retentivity regardless of wide temperature conditions of operation and susceptibility to impact forces which usually cause material deterioration in the magnetic properties of other types of permanent magnets.

The core 25 which forms the main component of the adjustable magnetic focusing and centering structure or unit is coaxially mounted between top and bottom ring pole-pieces 26 and 27, respectively, of magnetic material, such as steel. The ring pole-piece 26 is provided with a central opening 28 having a diameter substantially equivalent to the diameter of the neck portion 21 of the cathode ray device and a cylindrical projecting portion 29 which extends exterior to the upper end of the core magnet 25. The bottom pole-piece 27 has a larger diameter central opening coaxial with the core and top pole-piece and is larger in diameter than the top pole-piece. This pole-piece is provided with a rearwardly extending portion 30 around the inner rim and the outer periphery is provided with a recess or shelf portion 31 on the surface opposite the extending portion 30. A rectangular bearing plate 32, of non-magnetic material, such as brass or aluminum, having a circular opening is fitted over the extension 30 of the pole-piece 27 to rest on the flat surface of the pole-piece. The bearing plate 32 and bottom pole-piece 27 are secured together by bolts 33 distributed in pairs in uniformly spaced relation and extending vertically around the exterior of the core 25 to the extension 29 of the top pole-piece 26 and are threaded therein, as shown in Fig. 6a, to rigidly clamp the pole-pieces together and the core coaxially therebetween. The bolts are surrounded by non-magnetic spacer sleeves 34, preferably of aluminum, between the opposed surfaces of the top and bottom pole-pieces. A mounting plate 35 having a central opening coincident with the opening 28 of the top pole-piece and an angular extension at the lower end is secured on the front of the top pole-piece to rigidly support the permanent magnet structure on a suitable base.

A cylindrical metallic shunt member 36, preferably of steel, surrounds the extension 29 of the top pole-piece and is in slidable engagement therewith. The shunt extends beyond the lower end of the extension 29 and the projecting portion is provided with a plurality of radial pins 37 which extend through the shunt in equally

5

6

spaced relation so that they project from the inner and outer surfaces thereof. These pins are positioned between the pairs of sleeves 34 on the bolts and are slidably movable in reciprocal relation in the guides formed by the sleeves, thereby preventing rotational movement of the shunt with respect to the magnet core. The shunt, however, is reciprocally movable to vary the flux field in the gap between the pole-pieces, the position of the shunt, as shown in Fig. 2, 10 representing maximum flux density and the position of the shunt when near the bottom pole-piece 27 representing minimum flux density. This arrangement permits the magnet structure of this invention to be variably adjusted to facilitate the control of the focusing of the beam over a wide range of operating focusing voltages for the tube, for example, from 3,000 to 7,000 volts. Furthermore, the adjustment of the shunt is accurately controlled with a minimum of frictional loss in the manipulation of the shunt with respect to the pole-pieces and core magnet of the structure.

The shunt is actuated by a rotatable metallic sleeve 38 of non-magnetic material, such as brass, which surrounds the shunt member. This sleeve is of such diameter that it is seated on the shelf 31 on the periphery of the bottom pole-piece 27 and the opposite edge is in contact with a wave-form phosphor bronze resilient ring 39, 25 surrounding the top pole-piece 26 and lying against the mounting plate 35, to prevent end-play in the sleeve and to compensate for expansion and contraction in the structure or unit. The sleeve 38 is provided with a plurality of angularly directed slots 40 extending upwardly from one edge and these slots form guideways for the travel of the pins 37 on the shunt member. The sleeve is also provided with a gear rack 41 which is soldered to the exterior surface of the sleeve above one of the slots 40. A spur gear 42 carried by a rotatable shaft 43 engages the rack to impart movement to the sleeve when the shaft is rotated. The shaft 43 extends between the bearing plate 32 and the mounting plate 35 and is locked in longitudinal position by a stop collar 44 below the mounting plate. The extension of the shaft beyond the front of the mounting plate permits a suitable control knob to be attached thereto or a flexible cable 45 may be coupled to the shaft so that the sleeve may be rotated by remote control, for instance, from a panel adjacent the screen 24 of the cathode ray device.

An auxiliary ring member 45, preferably of steel, is mounted in facing contact with the annular extension 30 of the bottom pole-piece 27 in coaxial relation to the opening in the pole-pieces and magnet core 25. The ring 45 is slidably controlled to eccentrically offset the axis of the ring with respect to the axis of the unit to counteract the main flux field thereby shifting the beam of the cathode ray device to compensate for the effect of the earth's magnetic field and also to correct axial symmetry of the beam with respect to the axis of the screen 24, due to manufacturing inaccuracies in mounting the electron gun in the neck of the cathode ray tube.

The magnetic ring 45 is offset with respect to the axis in one diametrical direction by a slidable plate 46 and in a transverse direction by a similar slidable plate 47, to shift the ring in directional paths perpendicular to each other and thereby eliminate curvilinear travel of the ring 75

member 45 which would cause the beam to rotate about the axis of the tube in the centering operation. The slidable plates are formed of non-magnetic material, such as brass or aluminum, and provided with an oval-shaped large central opening 48 which encompasses the centering ring 45, the small dimension of the opening in each plate being the same diameter as the ring member 45 so that the plates have only a limited contact with the ring and the contacts on one plate being oriented 90 degrees with respect to the contacts on the other plate. It will be noted from an inspection of Figs. 4 and 5 that the contacting edges of the plates with the centering ring are perpendicular to the direction of travel of the slidable plates 46 and 47 so that positive transverse movement of the ring is assured without loss of motion in the shifting operation of the ring. The free space within the opening of each plate permits the ring to be shifted by either plate depending on the direction intended to center the beam in the cathode ray tube. The thickness of each of the slidable plates is one-half the thickness of the ring member 45 so that the surrounding movable plates are flush with the ring.

The plate 46 slides across the rigidly mounted bearing plate 32 between a pair of edge guiding strips 49 and the slidable plate is provided with an elongated recess 50 adjacent one edge in contact with a guide strip to form a pocket for an arcuate wire spring 51, to prevent binding of the plate in the guideway of the bearing plate and to compensate for expansion and contraction of the contacting parts of the unit. The slidable plate 46 is also provided with a slot 52 of U-shaped contour in one corner thereof opposite the recess 51 and the slot is centrally extended, as shown at 53, to form a relief opening to prevent binding in the slot 52. The opposite corner of the plate 46 on the same edge as the slot is cut out, as shown at 54, to form a clearance slot. The slidable plate 47 engages guide strip 55 on a back bearing plate 56, also of non-magnetic material, the strips 55 extending along opposite edges of the plate perpendicular to the strips 49 on the front bearing plate. One edge of the plate 47 is provided with a central elongated recess 57 to receive an arcuate tension spring 58 and the left-hand corner of the plate is cut out, as shown at 59, to form a clearance slot. The slidable plate 47 is also provided with a corner slot 60 of U-shaped configuration with a relief opening 61 similar to the other slidable plate, the slot 60 being in the right-hand lower corner of the plate, as viewed in Fig. 5, but when the plates are assembled in facing relation on the bottom pole-piece, as shown in Fig. 7, the slot 60 is oppositely disposed with respect to the slot 52 at the lower end of the unit and extends in transverse direction thereto. The back bearing plate 56 is secured in facing relation to the front bearing plate 32 by screws 62 with the guide strips thereon in perpendicular parallel relation with respect to each other and the slidable plates held therebetween for movement in transverse relation.

A circular cam member or disc 63 is located in slot 52 in the slidable plate 46 and is connected eccentrically to a rotatable shaft 64 which extends through the mounting plate 35 and front bearing plate 32, the cam disc being in frictional contact with the movable plate 46 to reciprocally slide the plate horizontally in the guideway of the bearing plate. Another cam disc 65 is located in the slot 60 and is connected to a parallel shaft

66 extending through the mounting plate 35, the cam operating the sliding plate 47 reciprocally in a vertical direction in the guideway in back bearing plate 56. The relief openings in the cam slots eliminate binding of the cams in the slots and thereby permit free operation of the cams to slidably adjust the movable plates and the centering ring therewith eccentrically with respect to the axis of the unit, whereby the beam in the cathode ray tube is accurately centered on the screen 24. A resilient ring member 67 is secured between a metallic retainer ring 68 and the back bearing plate 56 by screws 69 prior to the attachment of the plate to the unit. The resilient ring, usually of rubber or similar material, aids in centering the neck of the cathode ray tube in the magnet structure and compensates for irregularities in the diameter thereof.

Another form of the invention is shown in the assembly of Figs. 8 to 12, inclusive, and certain details thereof as shown in Figs. 13 to 15, inclusive. The principal difference in this construction is the grouping of the controls for the movable elements of the unit at the bottom thereof and the coupling of the controls to the elements. As shown in Fig. 8 the central permanent magnet core 25 is mounted coaxially between a top ring pole-piece 26 and a bottom ring pole-piece 70 with a front mounting plate 71 superimposed on the top pole-piece and the combined elements securely clamped in coaxial relation by a plurality of bolts 72 located in spaced relation between the periphery of the core 25 and the extension 29 of the top pole-piece. The bottom pole-piece 70 is provided with an annular recess 73 on the outer surface adjacent the inner edge and is also provided with a plurality of diagonal slots 74, as shown in Fig. 12, distributed in spaced relation around the periphery of the pole-piece. A back mounting plate 75 having the same configuration as the front mounting plate 71 is secured in suitable spaced relation thereto adjacent the bottom pole-piece 70 by a plurality of bolts 76 disposed exterior to the top pole-piece 26 and extending through the slots 74 of the bottom pole-piece to secure the mounting plates in uniform parallel relation, the bolts being provided with non-conducting spacer sleeves 77 to insure uniform relation between the mounting plates. A similar pair of bolts and cooperating sleeves extend between the mounting plates to space the extensions of the plates in uniform relation.

A reciprocally movable shunt member 36 of magnetic material, such as steel, is slidably positioned around the extending portion 29 of the top pole-piece 26 and is provided with a plurality of pins 37 adjacent the exterior upper edge to extend radially into slots 40 of the rotatable sleeve 38 which is disposed between the front mounting plate 71 and the bottom pole-piece 70, the sleeve 38 being provided with a gear rack 41 in the same manner as described in connection with Fig. 2. An auxiliary ring member 78, of magnetic material, such as steel, is also slidably positioned in the annular recess 73 of the bottom pole-piece 70 and is provided with a plurality of outwardly projecting pins 79 disposed in rectangular relation adjacent the inner edge of the ring member.

The movable ring member 78 is controlled eccentrically with respect to the axis of the magnet unit in a vertical direction by a slidable non-magnetic plate 80 having a central rectangular cut-out portion 81, opposed parallel edges of the plate in the opening perpendicular to the travel

of the slidable plate engaging the projecting pins 79 of the slidable ring 78, and the outer edges of the plate parallel to the direction of travel of the plate being in contact with the guide sleeves 77 extending across the gap between the back mounting plate 75 and the bottom pole-piece 70. A similar non-magnetic slidable plate 82 is mounted in transverse relation to slidable plate 80 and is provided with a central rectangular cut-out portion 83 having parallel edges perpendicular to the direction of travel of the plate 82 in contact with the projecting pins 79 of the ring member 78 and the outer edges parallel to the direction of travel of the plate in contact with the guide sleeves 77 to reciprocally actuate the plate 82 in transverse relation to the vertical slidable plate 80 to eccentrically displace the auxiliary magnetic ring member 78 with respect to the axis of the unit. Both plates are provided with relief slots 84 at both ends adjacent one edge to compensate for expansion and contraction of the plates and to prevent binding between the common guide sleeves for the plates. The slidable plate 80 is provided with an outwardly projecting cylindrical metallic block 85 rigidly secured to the lower end of the plate and the slidable plate 82 is provided with a similar cylindrical block 86, the blocks extending through circular openings 87 and 88, respectively, in the back mounting plate 75. The back mounting plate 75 is provided with a recess 89 on the inner surface adjacent the inner edge to provide a free path for the movement of the projecting pins 79 on the centering ring 78.

The reciprocally movable shunt member 36 and the transversely movable magnetic ring 78 are controlled remotely by a plurality of flexible cables 90, 91 and 92, shown in Fig. 10, extending into the lower portion of the front mounting plate 71 for actuating the controls coupled to the movable elements of the unit. The cable 90 is connected to a rotatable shaft 93 extending between the mounting plates 71 and 75 and a spur gear 94 affixed to the shaft in line with the gear rack 41 on the rotatable sleeve 38 is coupled to the rack through an intermediate larger gear 95 attached to a shaft 96 extending between the mounting plates to rotatably actuate the sleeve 38 through a definite arc whereby the angularly directed slots 40 in the sleeve induce the pins 37 on the shunt member 36 to ride in the slots and thereby displace the shunt member 36 reciprocally with respect to the pole-pieces to vary the strength of the flux field in the gap of the magnet structure. The shunt member 36 is prevented from rotational movement due to the fact that the pins 37 are in contact with the guide sleeves 77 disposed between the shunt member and the sleeve 38, as shown in Fig. 11, so that the flux of the magnet unit may be accurately varied to focus the electron beam with high definition regardless of the range of voltages applied to the focusing electrodes of the cathode ray tube.

The control cable 91 extends into a shaft 97 in parallel relation to the center shaft 93 between the end mounting plates and is rigidly affixed to a cylindrical cam member or disc 98 extending from the rear of the back mounting plate 75. The cam disc 98 is provided with an offset aperture to receive a shoulder screw and an elongated link member 99 having a slotted end portion engages the shoulder screw in the cam disc 98 and is coupled at the other end to the cylindrical block 86 by a similar shoulder screw centrally attached to the block which projects from

the left-hand side of the sliding plate 82, as shown in Fig. 12. The link member 99 is centrally pivoted on the back mounting plate 75 by a shoulder screw 100. As shown in Fig. 9, the movable centering ring 78 is coaxially mounted in relation to the central opening in the rear mounting plate 75 with the link member 99 in normal position for obtaining such concentricity. However, when the cam disc 98 is rotated through the flexible cable coupling, as shown in Fig. 9a, the pivoted link member 99 converts the rotating movement of the cam disc to a shifting movement imparted to the sliding plate 82 to offset the axis of the ring member 78 with respect to the axis of the opening in the magnet unit. The control cable 92 is coupled to a shaft 101 extending between the mounting plates parallel to the shafts 93 and 97 and is affixed to a circular cam member or disc 102 projecting from the outer surface of the back mounting plate 75. The cam 102 is provided with an offset aperture to receive a shoulder screw coupling a short link member 103 thereto with the other end of the link member attached by a shoulder screw to the center of the cylindrical block 85 on the vertical sliding plate 80. The cam disc 102 controls the reciprocal movement of plate 80 through the linkage of member 103 whereby the rotation of the cam disc 102 is converted to a shifting movement of the plate 80 through the link member 103 to adjust the position of the slidable ring 78 in transverse relation to the shifting movement imparted to the ring by the sliding plate 82. This arrangement permits the slidable ring 78 to be eccentrically displaced with respect to the axis of the magnet unit in reciprocal relation through two transverse directions by the cooperative action of the cams, links and sliding plates to insure accurate control of the movable auxiliary magnetic ring with respect to the axis of the unit. Furthermore, the controls both for the shunt and the slidable ring are grouped together so that flexible cables may be conveniently brought in a straight line to a panel adjacent the screen of the cathode ray tube and thereby facilitate reliable control of the movable elements of the magnet structure.

While the invention has been disclosed in several specific embodiments to achieve the reciprocal movement of the shunt member within the magnet structure and the slidable centering ring on one end of the magnet unit in transverse directions and to prevent curvilinear travel of the centering ring, it is, of course, understood that various modifications may be made in the detailed assembly of the structure without departing from the scope of the invention as defined in the appended claims.

What is claimed is:

1. In combination, a cathode ray tube including a source of electrons for projecting a beam along the length of the tube and a fluorescent screen receptive to the beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing said beam on said screen comprising a cylindrical core of magnetic material, a cylindrical magnetic shunt member surrounding said core having pins extending radially therefrom, a metallic sleeve surrounding said shunt having guideways therein for said pins, and means for rotating said sleeve to reciprocally actuate said shunt with respect to said sleeve and core.

2. In combination, a cathode ray tube including a source for projecting an electron beam

and a fluorescent screen excited by the beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing said beam in relation to said screen comprising a cylindrical core of magnetic material, a cylindrical magnetic shunt member surrounding said core having pins extending radially therefrom, a metallic sleeve surrounding said shunt having guideways therein for said pins, means for rotating said sleeve to reciprocally actuate said shunt with respect to said sleeve and core, and vertical guide means between said sleeve and core in contact with said pins.

3. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by the beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing said beam in relation to said screen comprising a cylindrical core of magnetic material having high flux density, a cylindrical magnetic shunt member surrounding said core having pins extending radially therefrom, top and bottom ring pole-pieces on the ends of said core, said top ring having a downwardly projecting extension, a non-magnetic sleeve surrounding said shunt member having guideways therein for said pins, and means for rotating said sleeve to reciprocally actuate said shunt with respect to said pole-pieces, said shunt being in slidable engagement with said extension.

4. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing said beam in relation to said screen comprising a cylindrical core of magnetic material having high flux density, top and bottom ring pole-pieces on the ends of said core, a magnetic shunt member surrounding said core having pins extending therefrom, a metallic sleeve surrounding said shunt member having guideways therein for said pins, means for rotating said sleeve to reciprocally actuate said shunt member with respect to said pole-pieces, and parallel guide rods extending between said pole-pieces in the space between said sleeve and shunt member.

5. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by the beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing said beam in relation to said screen comprising a cylindrical core of magnetic material having high flux density, a cylindrical magnetic shunt member surrounding said core having pins extending radially therefrom, top and bottom ring pole-pieces on the ends of said core, a metallic sleeve surrounding said shunt having guideways therein for said pins, means for rotating said sleeve to reciprocally actuate said shunt member with respect to said pole-pieces, and pairs of rods clamping said core between said pole-pieces, said rods forming vertical guides for the pins on said shunt member.

6. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing and positioning said beam in relation to said screen comprising an annular mag-

11

netic core having pole-pieces at opposite ends thereof, a cylindrical shunt member surrounding said core, a cylindrical rotatable sleeve having angular slots therein coupled to said shunt member for slidably moving said member with respect to said pole-pieces, a separate centering ring of magnetic material on one end of said core and coaxial therewith, and a pair of slidable plates engaging said centering ring and movable in transverse directions at right angles to each other to shift said ring with respect to the axis of said magnet structure.

7. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing and positioning said beam in relation to said screen comprising a cylindrical core of magnetic material, an auxiliary magnetic ring member on one end thereof, a pair of superimposed plates having openings therein mounted about said ring member, and means for slidably shifting said plates in transverse directions to displace said ring member with respect to the axis of said core.

8. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent structure surrounding said tube for focusing and positioning said beam in relation to said screen comprising a cylindrical core of magnetic material, an auxiliary ring member on one end thereof, a pair of superimposed plates having openings therein mounted about said ring member, and cam members coupled to said plates for reciprocally actuating said plates in transverse directions perpendicular to the axis of said core to eccentrically adjust said magnetic ring member with respect to the axis of said core.

9. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing and positioning said beam in relation to said screen comprising a cylindrical core of magnetic material, a cylindrical magnetic shunt member surrounding said core having pins extending radially therefrom, a metallic sleeve surrounding said shunt member having guideways therein for said pins, means for rotating said sleeve to reciprocally actuate said shunt with respect to said sleeve and core, an auxiliary ring member on one end thereof, a pair of superimposed plates having openings therein mounted about said ring member, means for slidably shifting said plates in transverse directions to displace said ring member with respect to the axis of said core, and guide means for said pins and plates supported by said core for reciprocal movement of said shunt with respect to said core and said plates in transverse directions with respect to each other.

10. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam for producing a spot thereon, and an adjustable permanent magnet structure surrounding said tube for focusing and positioning said beam in relation to said screen comprising a cylindrical core of magnetic material, top and bottom ring pole-pieces on the ends of said core, an auxiliary ring member in contact with said bottom pole-piece,

12

a pair of superimposed plates having openings therein mounted about said ring member, and rotatable cam members engaging said plates to slidably shift said plates in transverse directions to offset said ring member with respect to the axis of said core.

11. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure embracing said tube for focusing and positioning said beam in relation to said screen comprising a cylindrical core of magnetic material, top and bottom ring pole-pieces on the ends of said core, an auxiliary ring member in contact with the face of said bottom pole-piece, a pair of superimposed plates having openings therein mounted about said ring member, means for slidably shifting said plates in transverse directions to displace said ring member with respect to the axis of said bottom pole-piece, and rigidly mounted guide means projecting from said bottom pole-piece engaging the edges of said plates.

12. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure embracing said tube for focusing and positioning said beam in relation to said screen comprising a cylindrical core of magnetic material, top and bottom pole-pieces on the ends of said core, an auxiliary ring member in contact with said bottom pole-piece, a pair of slidable plates in facing relation around the periphery of said ring member, bearing plates in contact with the outer surfaces of said slidable plates, each of said bearing plates having parallel guide strips on the edges thereof, the guide strips on one bearing plate being perpendicular to the strips on the other bearing plate, and cam members extending through one of said bearing plates and engaging said slidable plates.

13. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure having a cylindrical core of magnetic material embracing said tube for influencing said beam in relation to said screen, an auxiliary ring on one end of said core, a pair of slidable plates in facing relation around the periphery of said ring, bearing plates in contact with the opposite surfaces of said slidable plates, each of said bearing plates having parallel guide strips on the edges thereof, the guide strips on one bearing plate being perpendicular to the strips on the other bearing plate, tension means interposed between adjacent edges of said slidable plates and guide strips, and rotatable cam members engaging said slidable plates to shift said plates in transverse directions perpendicular to the axis of said core.

14. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure including a cylindrical core of magnetic material embracing said tube for influencing said beam in relation to said screen, an auxiliary ring member on one end of said core, a pair of slidable plates in facing relation around the periphery of said ring member, bearing plates in contact with the opposite surfaces of said slidable plates, each of said bearing plates having

parallel guide strips on the edges thereof, the guide strips on one bearing plate being perpendicular to the strips on the other bearing plate, said slidable plates having open elongated recesses on one edge thereof, arcuate springs located in said recesses and engaging the guide strips adjacent thereto, and rotatable cam members engaging said slidable plates for shifting said plates in transverse directions perpendicular to the axis of said core.

15. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by the beam to produce a spot thereon, and an adjustable permanent magnet structure including a cylindrical core of magnetic material embracing said tube for influencing said beam in relation to said screen, an auxiliary ring member on one end of said core, a pair of slidable plates in facing relation around the periphery of said ring member, bearing plates in contact with the opposite surfaces of said slidable plates, each of said bearing plates having parallel guide strips on the edges thereof, the guide strips on one bearing plate being perpendicular to the strips on the other bearing plate, said slidable plates having open elongated recesses on one edge thereof, arcuate springs located in said recesses and engaging the guide strips adjacent thereto, said slidable plates also having a slot in one corner thereof opposite said recess, and cam members located in said slots and frictionally engaging said plates for reciprocal movement thereof in transverse directions perpendicular to the axis of said core.

16. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure including a cylindrical core of magnetic material embracing said tube for influencing said beam in relation to said screen, an auxiliary ring member on one end of said core, a pair of slidable plates in facing relation having oval-shaped openings therein disposed about the periphery of said ring member, bearing plates in contact with the opposite surfaces of said slidable plates, and cam members extending through one of said bearing plates and engaging said slidable plates, the portions of said slidable plates having the least diameter across said openings engaging said auxiliary ring member for initial movement thereof eccentric to the axis of said structure.

17. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure including a cylindrical core of magnetic material surrounding the neck of said tube to influence said beam in relation to said screen, an auxiliary ring member on one end of said core, a pair of superimposed plates having openings therein mounted about said ring member, means for slidably shifting said plates in transverse directions to displace said ring member with respect to the axis of said core, and a yieldable cushion ring on the rear of said magnet structure adapted to engage the neck of the cathode ray device thereby centering the structure thereon and compensating for inequalities in the diameter of said neck.

18. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and an adjustable permanent magnet structure embracing said tube for

focusing said beam in relation to said screen comprising a cylindrical core of magnetic material, top and bottom ring pole-pieces on the ends thereof, upright members extending between said pole-pieces and clamping said core centrally therebetween, a cylindrical shunt surrounding said core having spaced pins projecting from the exterior surface, a rotatable metallic sleeve surrounding said shunt having angular slots extending from one edge thereof, said pin being located in said slots and being slidably in contact with said upright members, a gear rack on said sleeve, a pair of end plates secured to said pole-pieces in spaced relation, a rotatable shaft extending through said plates at one end, and a spur gear on said shaft coupled to said rack and supported between said plates.

19. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and a magnetic focusing and centering device for influencing the electron beam of said cathode ray tube and surrounding the neck thereof, comprising an annular permanent magnet core of high flux density, top and bottom ring pole-pieces coaxially mounted on the ends of said core, a cylindrical magnetic shunt member surrounding said top pole-piece and core, said shunt having pins extending radially therefrom, a mounting plate on said top pole-piece having an opening coaxial with said pole-pieces and core, a non-magnetic sleeve having a plurality of angularly directed slots extending from one edge for receiving said pins, said sleeve being mounted between said mounting plate and bottom pole-piece, an annular resilient metallic ring in contact with said mounting plate and sleeve, a gear rack on said sleeve, a rotatable gear shaft extending through said mounting plate coupled to said rack, an auxiliary flat ring member mounted on the exterior of said bottom pole-piece, a pair of slidable plates having large central openings adjacent said auxiliary ring member and supported by said bottom pole-piece, said plates being reciprocally movable in transverse directions perpendicular to the axis of said bottom pole-piece to shift said auxiliary ring member eccentrically, cam members coupled to said slidable plates, and rotatable shafts extending through said mounting plate and attached to said cam members.

20. In combination, a cathode ray tube including a source for projecting a beam of electrons and a fluorescent screen excited by said beam to produce a spot thereon, and a magnetic focusing and centering device for influencing the electron beam of said cathode ray tube and surrounding the neck thereof, comprising an annular permanent magnet core of high flux density, top and bottom ring pole-pieces coaxially mounted on the ends of said core, a cylindrical magnetic shunt member surrounding said top pole-piece and core, said shunt having pins extending radially therefrom, a mounting plate on said top pole-piece having an opening coaxial with said pole-pieces and core, a non-magnetic sleeve having a plurality of angularly directed slots extending from one edge for receiving said pins, said sleeve being mounted between said mounting plate and said bottom pole-piece, longitudinally mounted guide rods clamping said core between said pole-pieces and disposed between said core and sleeve, said pins being in slidable contact with said rods to prevent rotational movement of said shunt member, a gear rack on said sleeve, a rotatable geared

15

shaft extending through said mounting plate coupled to said rack, an auxiliary flat ring member mounted on the exterior of said bottom pole-piece, a pair of plates having large central openings therein adjacent said auxiliary ring member and supported by said bottom pole-piece, metallic guide members in contact with said plates to direct said plates slidably in transverse reciprocal directions, individual cam members for each of said plates, and rotatable shafts extending through said mounting plate and attached to said cam members.

PHILIP T. SPROUL.

16

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,224,933	Schlesinger	Dec. 17, 1940
2,336,837	Bedford	Dec. 14, 1943
2,219,193	Mynall	Oct. 22, 1940

FOREIGN PATENTS

Number	Country	Date
523,439	British	Jan. 3, 1939
472,165	British	Mar. 11, 1936