Sept. 2, 1958 K. R. MacKENZIE 2,850,638

ION PRODUCING MECHANISM

Filed Jan. 4, 1946 2 Sheets-Sheet 1

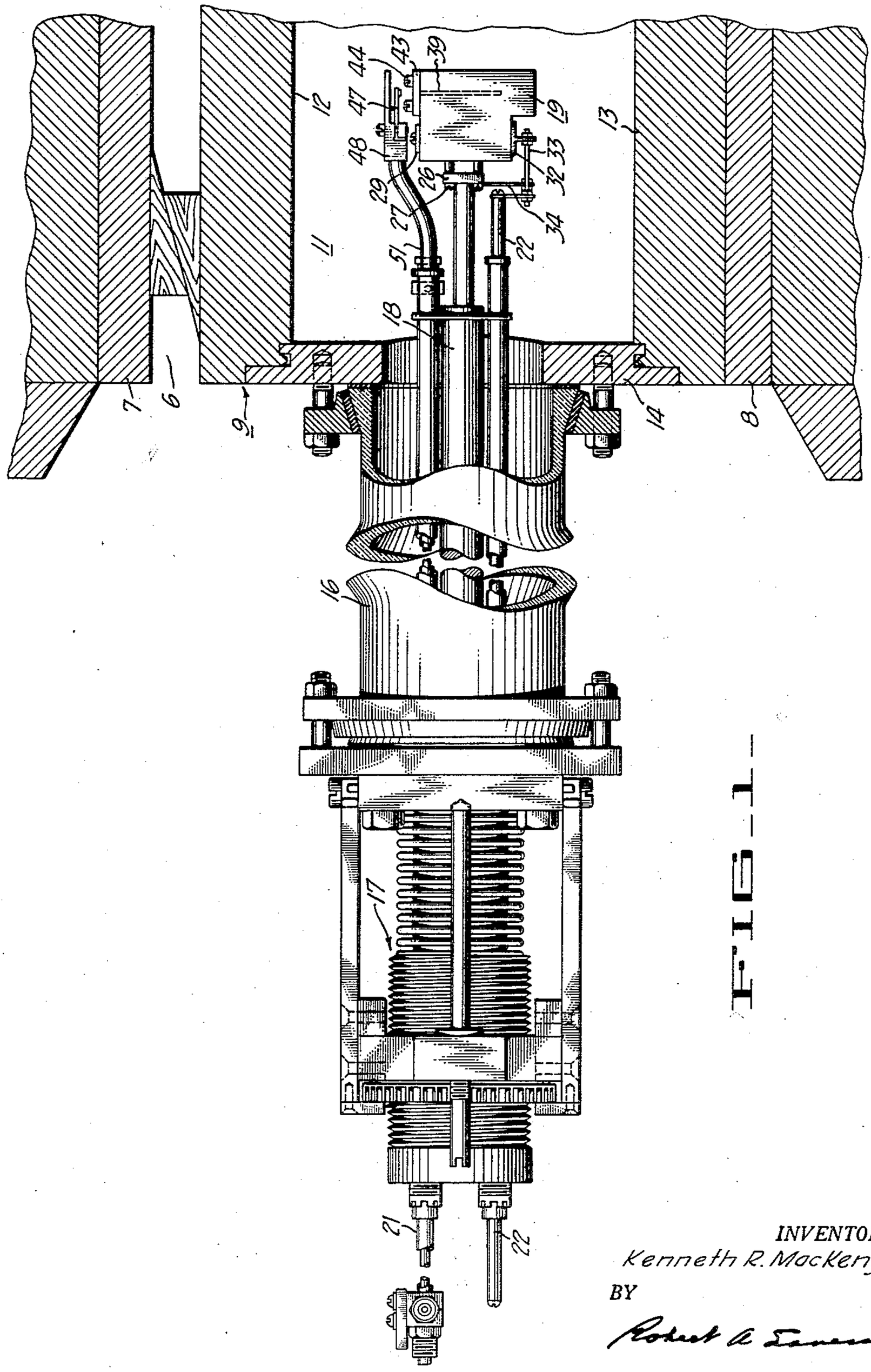

FIG. 1

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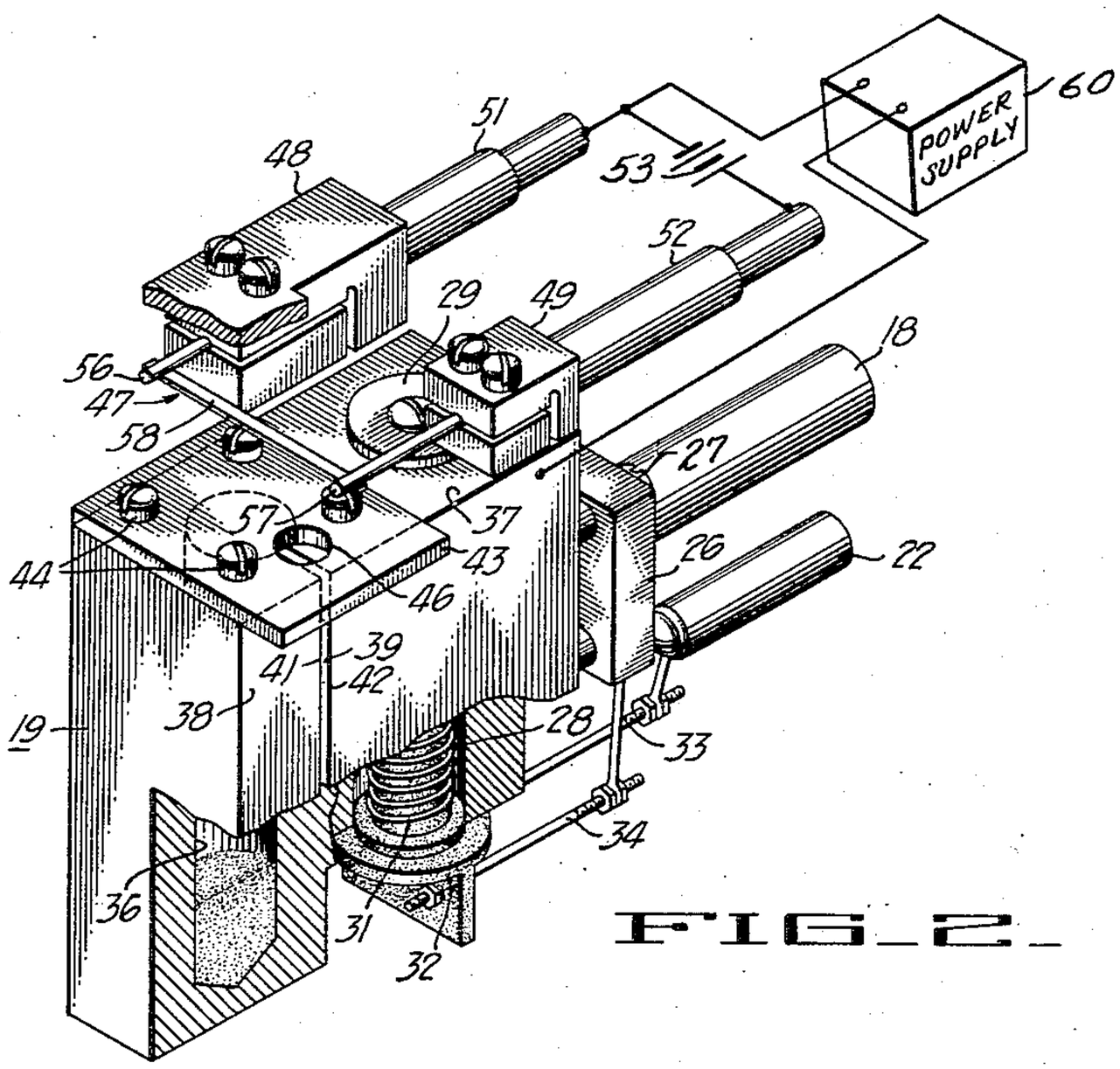

FIG_2_

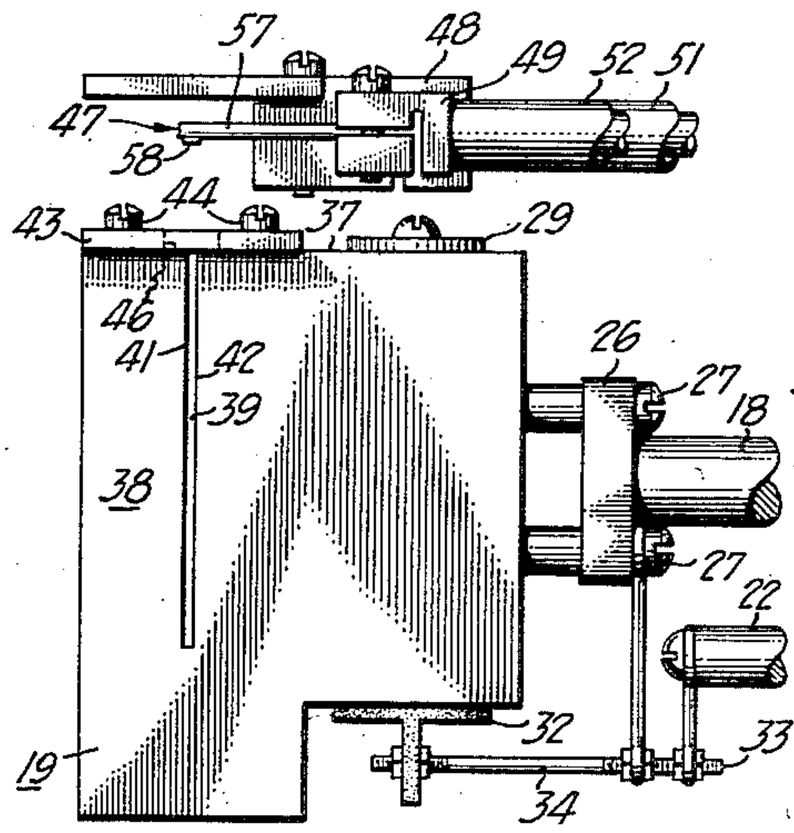

FIG_3_

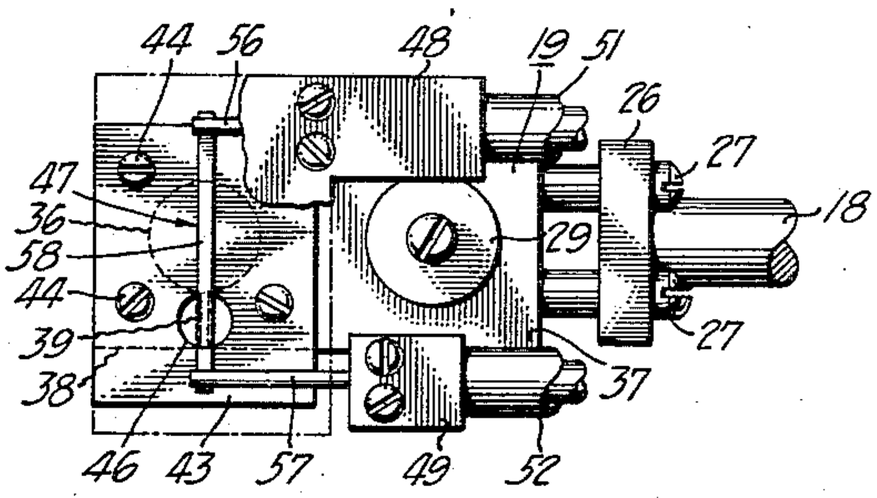

FIG_4_

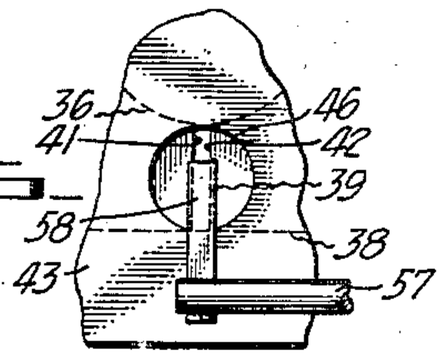

FIG_5_

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ION PRODUCING MECHANISM

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4 Claims. (Cl. 250—41.9)

This invention relates to ion forming mechanisms and particularly to ion generators of the type sometimes referred to as "calutrons." There is a disclosure of such a structure in United States Patent No. 2,709,222, issued May 24, 1955, to Ernest O. Lawrence, in which Figures 3 to 5 inclusive, particularly disclose an embodiment of a calutron with which the present invention is especially suited for incorporation.

In the operation of an ion forming mechanism there are a number of factors immediately concerned with the production and maintenance of an electric arc utilized for the execution of the ionizing function. In a calutron the electric arc operates in a magnetic field and extends between a filament, serving as a cathode, and an anode disposed away from the cathode in the direction of the magnetic field. The filament is called upon not only to emit electrons but also to resist bombardment by returning positive particles and also to resist displacing forces due to the fact that the filament carries an electric current while being situated in a magnetic field. It is also a general requirement in mechanisms of this type to minimize as much as feasible the consumption of electrical energy by the ionizing structure and it is therefore desirable that the size of a conductor such as a filament be maintained at a low value. It is furthermore desirable to provide a filament in which the return bombardment by positive particles does not cause localized overheating and failure of the filament.

It is, therefore, an object of the invention to provide an improved filament arrangement for a calutron.

Another object of the invention is to provide a filament that is resistant to deleterious effects produced by return particle bombardment.

An additional object of the invention is to provide a filament having the foregoing qualities yet one that is frugal in the use of electricity.

An additional object of the invention is to provide a filament that can readily be mounted in the customary gripping devices and yet will be provided with the special attributes above mentioned.

An additional object of the invention is to provide a filament of small cross section yet of considerable mechanical strength.

A further object of the invention is in general to improve calutrons.

Other objects, as well as the foregoing, are attained by the embodiment of the invention described in the following description and illustrated in the accompanying drawings in which:

Figure 1 is a fragmentary view of a portion of a calutron showing especially the source unit and its appurtenances, portions of the drawing being in cross section on a central vertical plane and other portions being broken away to reduce the size of the figure;

Fig. 2 is an isometric perspective of a source block as illustrated in Fig. 1, portions of the structure being broken away to show the interior arrangement;

Fig. 3 is an elevation of the mechanism shown in Fig. 2;

Fig. 4 is a plan of the structure shown in Fig. 2, a portion of a top plate being removed; and

Fig. 5 is a fragmentary plan to an enlarged scale of the filament and adjacent block, portions being broken away to reduce the figure size.

While a calutron is described in considerable detail in the above-identified patent of Lawrence, a brief review of that structure will suffice for an understanding of the present development and is given in connection with Fig. 1.

In a calutron there is provided a volume 6 permeated by a uniform or homogeneous magnetic field established between the upper pole 7 and the lower pole 8 of an electromagnet. Disposed between the poles 7 and 8 and situated within the magnetic field is a tank or vessel 9 enclosing a chamber 11 connected to suitable pumping mechanism such as a diffusion pump (not shown) effective normally to evacuate the chamber 11 to a pressure of approximately 10^{-4} mm. of mercury. The tank 9 includes a top wall 12, a bottom wall 13, and a face plate 14.

Secured removably to the face plate is an insulator 16 serving also as a support for a mounting and adjusting mechanism 17 not described in detail herein as its detailed functioning is not of consequence in connection with the present invention. The structure 17, however, acts as a support for a mounting stem 18 of a source block 19. A number of conductors 21 and leads 22 included in the structure 17 pass with vacuum tightness from the atmosphere into the interior of the chamber 11. The stem 18 is preferably related to the source block 19 by a terminal flange 26 and suitable fastenings 27 so that while some thermal insulation is afforded there is nevertheless good electrical contact.

The source block 19 is at its inner end provided with a heater cavity 28 closed by a disk 29 at its upper end and receiving through its lower end an electric coil heater 31 mounted on an insulating core 32. The heater coil is connected to a pair of leads 33 and 34 one being joined to one end of the conductor 22 and the other being connected to the block or flange 26. Upon the imposition of a suitable potential difference between the conductors 18 and 22 the heater 31 is effective to increase the temperature of the block 19. The source block preferably is of metal so that heat from the coil 31 is generally conducted in a uniform fashion to a charge cavity 36 formed within the block 19. The charge cavity extends nearly through the under side of the block and entirely through the top face 37 thereof.

Establishing communication between the cavity 36 and the exterior face 38 of the block 19 is a gas passage 39 defined by a pair of parallel planar walls 41 and 42 so that the passage is a straight one extending from within the block to the outside thereof and thus merging not only with the face 38 but also with the adjacent face 37. When charge material is placed in the cavity 36 it is heated and evolves gas or vapor that travels from the cavity 36 rather uniformly through the passage 39 to the exterior of the block.

To close the cavity 36 and a part of the passage 39 there is provided on the face 37 in abutment therewith a plate 43 fastened to the block 19 by suitable screws 44 and effective to seal one end of the cavity and one end of the passage. The plate 43 preferably extends beyond the face 38 and overhangs the edge of the block 19. The plate is provided, in registry with the passage 39, with an aperture 46 preferably symmetrically disposed with respect to the passage.

More particularly in accordance with the present invention, there is provided above the top plate 43 and substantially overlying the aperture 46 therein and also in

alignment in the direction of the magnetic field with the passage **39** a filament generally designated **47**. The filament is mounted in a pair of grippers **48** and **49**, respectively, fastened on the ends of supporting conductors **51** and **52** extending outside of the tank **11** through the support **17** to an external circuit of a customary type, such as a battery **53**. When the circuit is energized, current flows and a potential is established between grippers **48** and **49** so that the filament **47** is energized.

In accordance with the invention the filament is comprised of a pair of legs **56** and **57**, respectively, preferably formed of metallic rods circular in cross section adapted to be firmly held for mechanical support and electrical conduction within the jaws of the grippers **48** and **49**. The legs **56** and **57** extend substantially parallel to each other and terminate in a plane slightly beyond the plane of the passageway **39**. The cross section of the legs **56** and **57** is such that with respect to the current flowing their temperature at no time exceeds, and preferably does not even approach, the temperature at which thermo-emission occurs.

Spanning the space between the legs **56** and **57** and secured to them for mechanical support and electrical connection, is a flat emitting portion **58** preferably fabricated of a metallic ribbon rectangular in transverse cross section and having a cross sectional area somewhat less than the cross sectional area of the legs **56** and **57**. The ribbon **58** is preferably secured to the legs by any convenient means, for example, spot welding, so that the resistance of the connection is negligibly low. When properly positioned, the ribbon **58** extends transversely of the direction of the magnetic field and is situated, in the direction of the field, in registry with the discharge slot **39**. The width of the ribbon **58** is somewhat greater than the width of the slot and preferably the overlap on both sides is substantially the same.

When the leads **51** and **52** are included in an arc electric circuit, such as a power supply **60**, in connection with the block **19**, an arc is struck between the emitting portion **58** of the filament **47** and extends through the aperture **46** in the plate **43** and into and through the slot **39** to the block **19** serving as an anode. Positive particles that travel from the arc toward the filament are collimated or confined by the magnetic field and by the side walls of the relatively narrow slot **39** so that they bombard or impinge upon the emitting portion **58** of the filament in only a restricted area, thus leaving a substantial amount of material in the filament available for a thermal transfer to equalize the filament temperature and to avoid local overheating. The shape of the ribbon filament **58** is such

that when a current is being carired there is afforded a resistance to mechanical displacement consequent upon the effect of the magnetic field. The ararngement of the ribbon emitting portion **58** on the parallel legs **56** and **57** renders the filament of a character for installation in the standard mounting grippers **48** and **49**.

In accordance with the invention, there is provided a filament resistant to return bombardment, effective to give a copious supply of electrons, resistant to magnetic displacement, and usable in connection with standard calutron filament mechanism. It is effective to assist in producing a stable, long-lived arc and contributes to the general improvement of calutron operation.

What is claimed is:

1. In an ion source for a calutron having a magnetic field, the combination comprising an arc block having an elongated gas ionizing passage open along two sides of said block, said passage having a predetermined width measured across said magnetic field and the elongated portion extended parallel to said magnetic field, a filament disposed transversely of said magnetic field, parallel to one of said two sides of said block, and overlying said passage, said filament having a width greater than the predetermined width of said passage, means provided to develop a flow of an ionizable gas through said passage, means connected to said filament for rendering the same electron emissive, and means for including said filament and arc block in an electric arc circuit whereby said electric arc fills the entire passage to maximize the quantity of ions produced by said gas flowing through said electric arc.

2. The combination of claim 1 wherein said filament is further characterized by having a thickness substantially less than the width thereof.

3. The combination of claim 1 wherein said filament is further characterized as having an electron emissive portion in the form of a ribbon supported at either end by a pair of current-carrying rods.

4. The combination of claim 1 wherein said filament is further characterized as having a ribbon-like emissive portion supported at either end by a pair of current-carrying rods, and a pair of adjustable clamps for supporting said rods in spaced-apart relation with respect to each other and with respect to said arc block.

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