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PROTECTIVE SHIELD FOR ELECTRON GUN

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Fig. 1

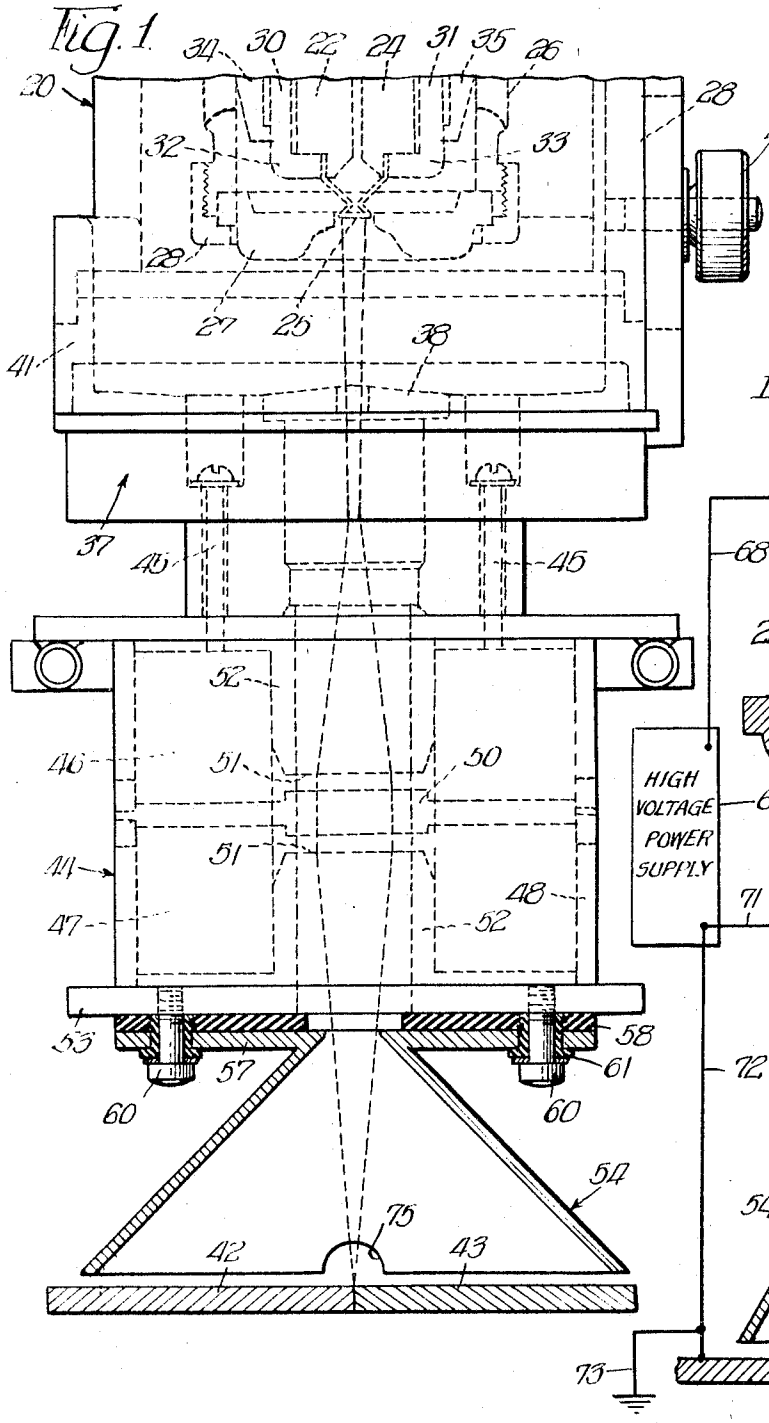
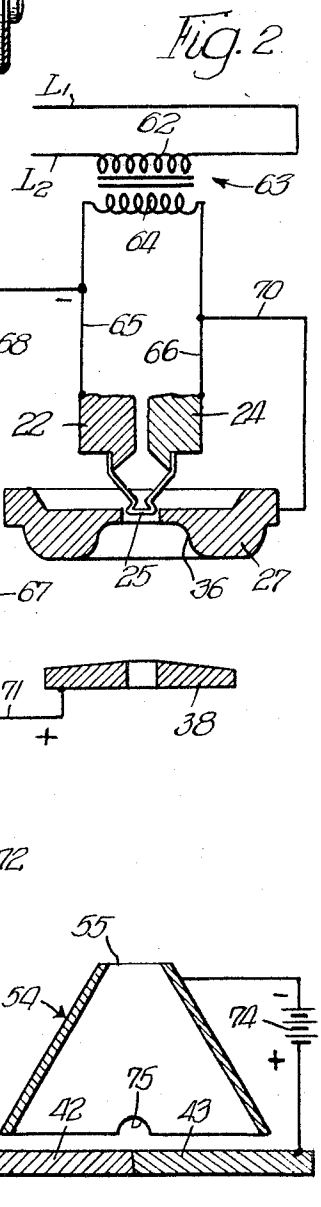


Fig. 2



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PROTECTIVE SHIELD FOR ELECTRON GUN

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Original application May 12, 1961, Ser. No. 109,575, now Patent No. 3,187,216, dated June 1, 1965. Divided and this application July 7, 1964, Ser. No. 380,746

1 Claim. (Cl. 219—121)

This application is a division of my copending application Ser. No. 109,575, filed May 12, 1961, and entitled "Electron Gun," now Patent No. 3,187,216.

The invention relates to the art of electron beam guns and has reference in particular to an electrostatic shield for such guns for improving the stability of the gun during welding operations.

An object of the invention resides in the provision of a protective shield for electron guns having location adjacent the workpieces and through which a stream of electrons are projected onto the workpieces. The stream of electrons pass through a relatively small opening in the apex end of a preferably funnel-shaped shield and the relatively large bottom opening of the shield is disposed above, but in close relation to the workpieces. The shield serves to collect any metallic vapors created during the welding process and the shield also functions as an absorbing medium for X-rays. Said X-rays unless absorbed might otherwise act on residual gases within the vacuum chamber, causing the gases to ionize and create a voltage breakdown between terminals especially if a high voltage exists between said terminals.

Another and more specific object of the invention resides in the provision of a protective shield for electron guns having close proximity to workpieces to be welded and through which a stream of electrons are projected onto the workpieces, and wherein by maintaining the shield negative with respect to the ground potential the shield can be caused to attract positive ions formed in the area under the shield and between the same and the workpieces. Should the ions find their way to the filament area, they are very likely to have a deteriorating effect on the filament with a resulting destructive effect on the generation of electrons.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation as will be more fully described and particularly pointed out in the specification, drawings and claims appended thereto.

In the drawings which illustrate an embodiment of the device and wherein like reference characters are used to designate like parts—

FIGURE 1 is a fragmentary view of an electron gun having a shield depending therefrom so as to have an operative associated position with the workpieces to be welded; and

FIGURE 2 is a schematic view illustrating the electrical connections for the various elements of the electron gun and the electrical connection for maintaining the shield negative with respect to the ground potential.

Referring to the drawings, the embodiment of electron gun **20** selected for illustrating the invention includes a body portion, not shown, from which the various parts of the gun are suspended. The said body portion is formed of insulating material having good dielectric strength, good heat conductivity and the insulating material of the body portion is also mechanically strong, having low moisture and gas absorption. The said body portion suspends a pair of electrodes **22** and **24** for supplying current to the filament **25**. An inside cage **26** is also suspended from the body portion and the cage, in turn, supports the cathode **27** which is releasably held to the cage by the threaded

ring **28**. The current conducting electrodes **22** and **24** and the inner cage **26** comprise a unit which is supported from the said insulating body portion. The electrodes are disposed in depending side-by-side relation relatively adjacent each other and which requires the use of spacers of insulating material, not shown, for maintaining the electrodes in the desired spaced relation. A current which may have a voltage of five volts with an amperage which may measure approximately forty amperes is suitably supplied to the electrodes **22** and **24** from an external source.

Each electrode has a clamping bar such as **30** and **31** disposed in contact with its outside surface and each bar provides a lower flange **32** and **33**, respectively, adapted to contact a shoulder on its respective electrode. Clamping members **34** and **35** are provided for said bars and the same contact the bars at spaced location along the length of the bar, one clamping contact being located adjacent the flange **32** for member **34** and the other clamping contact being located adjacent flange **33** for member **35**. The clamping members are preferably formed of metal such as copper and the same have some resiliency. Also by tightening bolts, not shown, the clamping members are releasably secured to their respective electrodes. It will be understood that a spring loading action is applied to each clamping bar, thus forcing and securely maintaining the flanges **32** and **33** against their respective electrodes to provide a good mechanical and electrical clamp for the filament **25**.

The threaded ring **28** releasably retains the metal cathode **27** in place on the bottom of the cage **26**. Said cathode is preferably maintained at a negative potential of approximately fifty-thousand volts and the same is provided with a center opening which substantially accommodates the axially positioned filament **25**. It is important that the filament have an accurately aligned relation with the opening in the cathode for the most efficient production of the electrons and also that the undersurface of the cathode is characteristically shaped at **36**, as best shown in FIGURE 2, for the same purpose.

The outside shell or cage **28** is suitably suspended from the body portion of the electron gun and said cage at its lower end supports the ring **37** of insulating material and which preferably has the same desirable characteristics as the material of the body portion. The metal anode **38** is supported and accurately positioned by the ring **37** with the center opening in the anode in axial alignment with the opening in the cathode **27** and with the filament **25**. The anode is given a positive potential and for the most satisfactory results in operation it is preferred to make the anode of tantalum. Since the spacing of the anode **38** from the cathode **27** determines the power ratings for electron gun, or in other words the maximum value of beam current at maximum voltage, the electron gun includes an adjustable hanger **40** and a spacing ring such as **41** which in combination determines the cathode-anode distance. Preferably two hangers **40** are provided diametrically spaced around the periphery of the gun and in the event it is desired to vary the cathode-anode distance, a spacing ring of different depth may be substituted in place of the ring **41**.

For focusing and directing the electron beam so as to direct a beam of maximum density for welding the workpieces **42** and **43**, a focusing coil **44** is suspended by the screws **45** from the anode supporting ring **37**. The focusing coil essentially consists of a pair of coil windings such as **46** and **47** encased in an enclosing shell **48** of iron. An armature **50** also of iron is located between the adjacent inner edges of the coils **46** and **47** and it will be observed that an air gap **51** exists on each side of the armature between the same and the interior cylinder of iron **52** as provided for the respective coils. The air gaps are thus located at the central plane of the focusing

coil. A relatively low voltage direct current is caused to flow through the coils **46** and **47** to provide a magnetic effect within the central passage formed by the interior cylinders **52**. The focusing coil is located below the anode where the electron beams start to divert. The action of the magnetic flux from coil to armature is such as to cause the beam to converge, and by adjusting the current flowing in the coils the beam of electrons can be caused to impinge on the workpieces **42** and **43** with maximum density for the most satisfactory welding operation.

From the focusing coil the beam is directed onto the workpieces **42** and **43** for welding the said pieces together. As a result of the generation of the electron beam and the fusion of the metal workpieces, gases and metal vapors will be produced and some ionization will also occur. If the ions find their way into the filament areas they tend to interfere with the generation of the electrons, and they also have a deteriorating effect on the filament. If the metal vapors are disposed on the surfaces of the gun shorter creep distances develop and arcing may occur. To minimize these conditions and to thus improve the stability of the electron guns during operation a shield **54**, preferably funnel-shaped and of any suitable metal, is employed. The shield has an opening **55** at its apex end and through which the electron beam is directed onto the workpieces. The enlarged bottom end **56** of the shield is located over and relatively in close proximity to the top surfaces of the workpieces.

As shown in FIGURE 1 a horizontal flange **57** is formed integral with the shield and disposed adjacent the apex end **55**. The flange is suitably secured to the metal base **53** of the focusing coil. A member **58** of insulating material is located between the metal base **52** and the flange **57** and the securing screws **60** are provided with insulating collars **61**. Thus the supporting structure for the shield completely insulates the shield from the focusing coil.

During the welding operation the electrostatic shield will function to collect any metallic vapors created during the welding process. Also, the shield will act as an absorbing medium for X-rays which might otherwise ionize residual gases within the chamber. If such is allowed to take place, a voltage break-down between terminals might occur especially if a high potential exists. The electrostatic shield of the invention when given a negative potential with respect to the ground will also function as an ion trap. As an ion trap the shield will attract positive ions formed in the area under the shield and the work, and which if allowed to escape could impair the filament. For this purpose the shield is required to be insulated from the focusing coil as shown in FIGURE 1.

The electrical circuit for the elements of the gun and for the shield is schematically shown in FIGURE 2. The alternating power supply indicated by the leads L–1 and L–2 includes the primary windings **62** of a transformer **63** having a secondary winding **64**. The secondary winding **64** is connected to conductors **65** and **66** which in turn supply a heating current at the desired voltage to the electrodes **22** and **24**, and thus to the filament **25**. The high voltage power supply **67** furnishes a direct current of the desired voltage for maintaining the required electrical field between the cathode and the anode. The negative conductor **68** from the power supply is connected to conductor **65** and the conductor **70** completes the circuit to the cathode **27**. The positive conductor **71** from said power supply is electrically connected to the anode **38** and a second positive conductor **72** has connection with the workpieces and the same is grounded by the conductor **73**. In order to maintain the shield **54** at a potential which is negative with respect to the workpieces, a direct current battery **74** is suitably connected between the shield and the workpieces with the negative terminal of the battery having electrical connection with the shield.

The shield as shown in FIGURES 1 and 2 is preferably formed with one or more slots or bottom edge openings **75** so as to permit a clear view of the weld area whenever the shield is placed very close to the work. Also the protective shield may be covered with a layer of special material where it is desired to provide more effective absorption of X-rays than that provided by the metal of the shield.

What is claimed is:

The combination with an electron gun for directing a stream of electrons onto a workpiece for welding the same, of a shield in the shape of a cone secured to the lower end of the electron gun and depending from the same, said shield having a relatively small opening at its top end through which pass the electron stream and said shield having a relatively large bottom opening disposed above and in minimum spaced relation with respect to the workpiece, said cone-shaped shield being formed of metal and being secured to and insulated from the electron gun, and means in electrical connection with the shield so that the shield has a negative potential with respect to the grounded workpiece, whereby said shield serves to collect any metallic vapors created during the welding process, said shield also providing an absorbing medium for X-rays such as may be produced during the welding process, and said shield additionally functioning as an ion trap by attracting positive ions formed in the area under the shield and between the same and the workpiece.

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