April 20, 1965 H. SCHWERINER 3,179,849

SHOCKLESS IONIZING AIR NOZZLE

Filed July 15, 1964 3 Sheets-Sheet 1

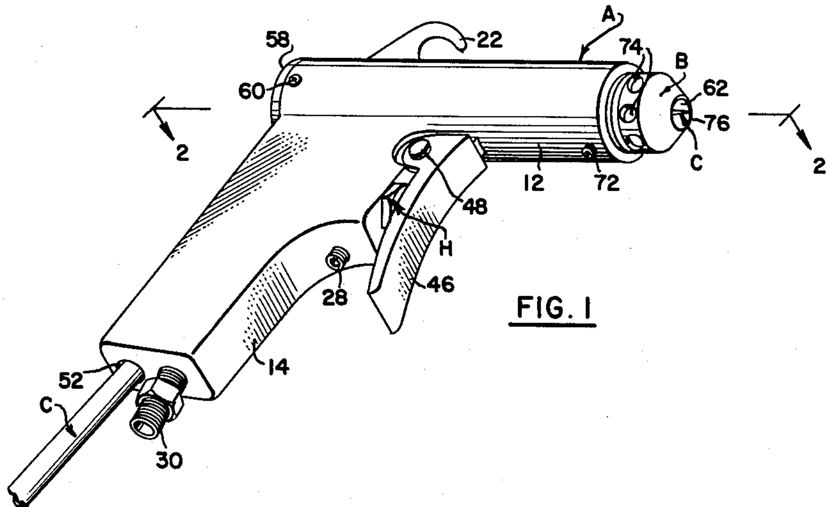

FIG. 1

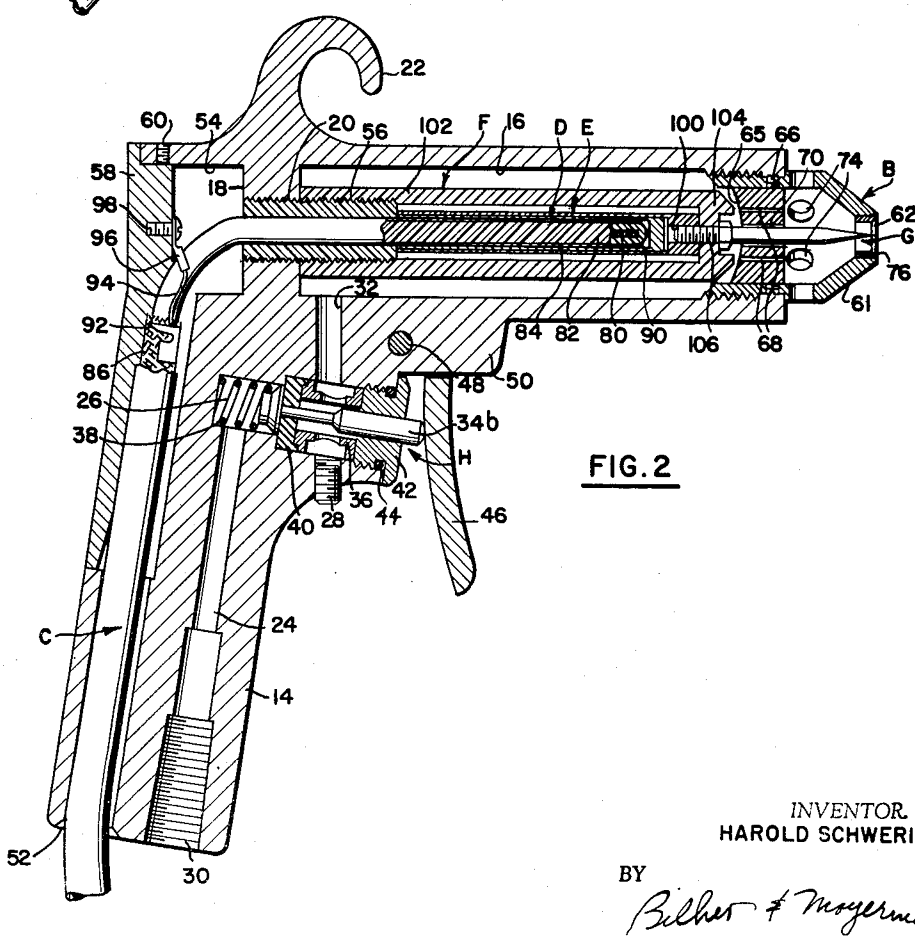

FIG. 2

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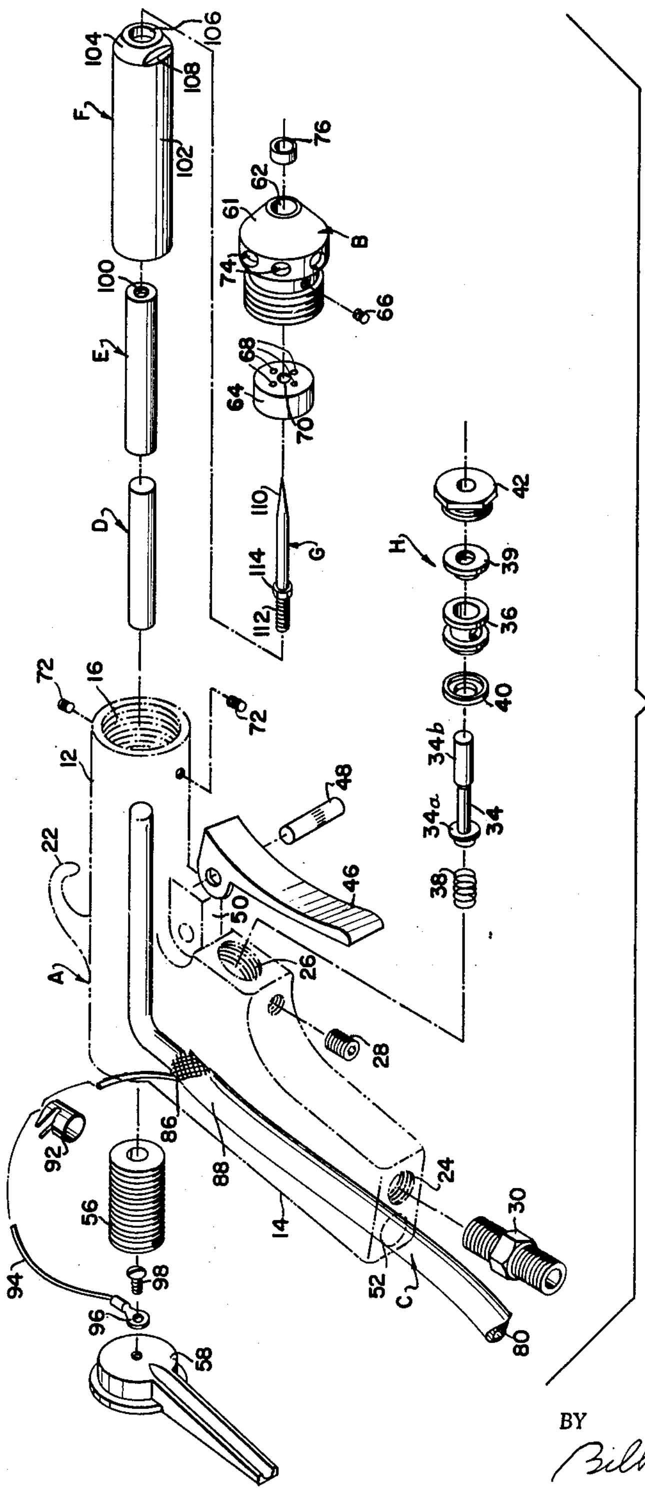

FIG. 3

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SHOCKLESS IONIZING AIR NOZZLE

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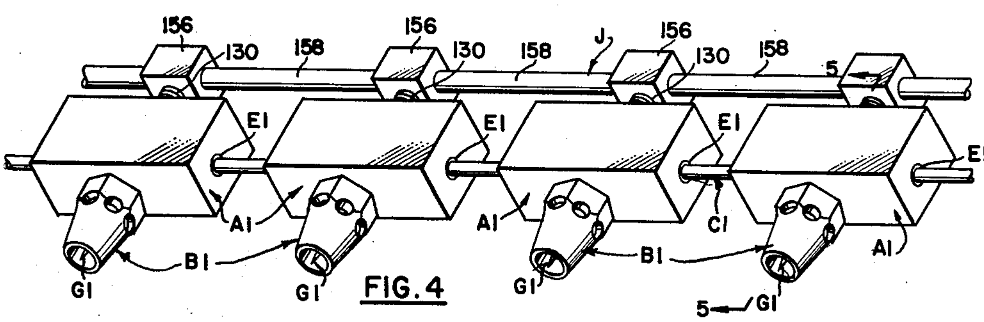

FIG. 4

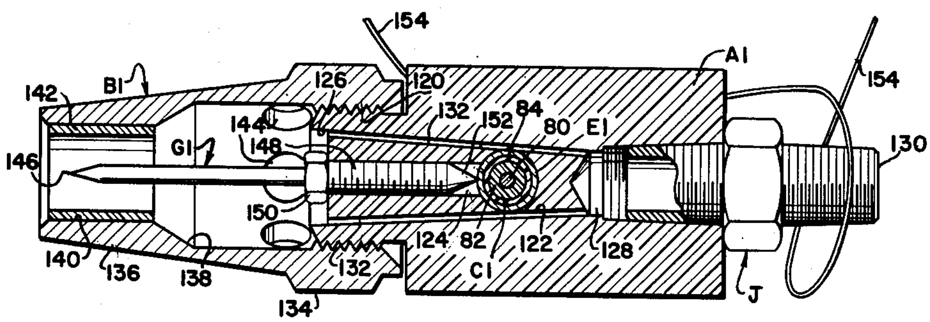

FIG. 5

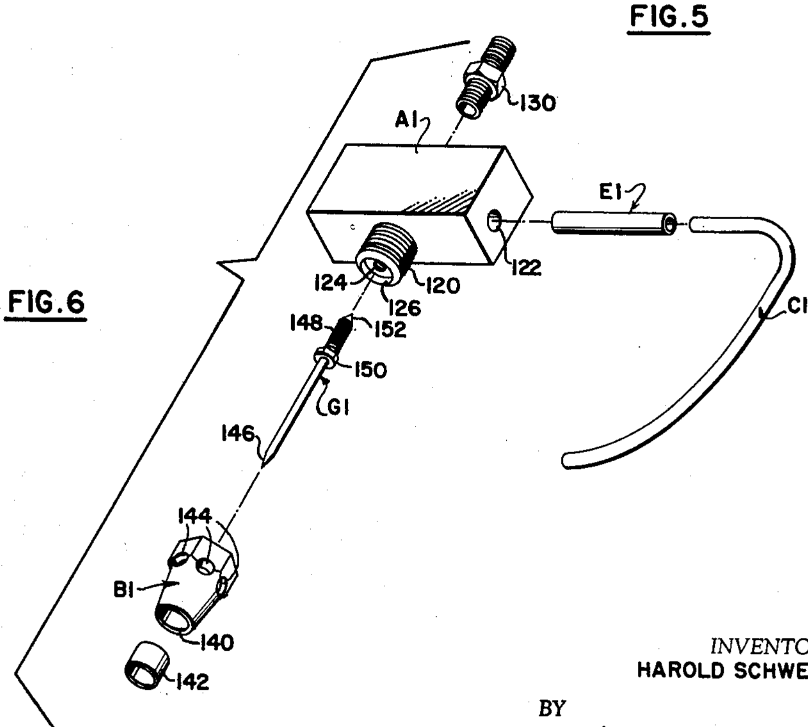

FIG. 6

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SHOCKLESS IONIZING AIR NOZZLE

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6 Claims. (Cl. 317—2)

This invention relates to static eliminators, and more particularly relates to a shockless ionizing air nozzle for directing a jet stream of ionized air at a specific zone or into an area in order to blow particles from surfaces to which they attractively cling and simultaneously neutralize the particles and surfaces.

This invention is a continuation-in-part of my prior co-pending patent application filed April 21, 1960, Serial No. 23,675, now Patent Number 3,156,847, issued Nov. 10, 1964.

In the parent application there is shown an ionizing air nozzle in which a high voltage A.C. generator source is connected directly across a needle and the nozzle itself, the needle being interposed co-axially within the nozzle but electrically isolated therefrom. A stream of air from a compressed air line is directed through the nozzle parallel with the needle and becomes ionized in its passage through the conically oriented high voltage field. Since the air stream synergistically reinforces the pattern of the field of ionization, an extended range of ionized air is delivered from the nozzle so as to be highly effective not only in dislodging particles clinging to a surface by electrostatic attraction but also in effectively neutralizing the charges on the particles and/or the surfaces so as to remove the forces tending to re-attract the particles to the surfaces.

Because the high voltage was directly connected to the needle in my prior ionizing air nozzle constructions, some limitations and precautions were required in its use. First of all, there was a possibility that personnel who were operating the apparatus could accidentally touch the directly energized needle with a finger for example and thereby receive an electrical shock. Secondly, a likelihood always existed in a spark or arc being drawn from the needle as a result of dielectric breakdown of the air gap between the needle point and the nozzle. Accordingly, the use of my prior construction was prohibited in a volatile or flammable environment because of the danger of explosion created by such a spark. Lastly, the direct imposition of high voltage upon the needle itself produced appreciable corona glow thereabout. Thus, when the earlier apparatus was employed in neutralizing light sensitive photographic film, it was necessary to incorporate a light baffle or shield around the nozzle so as to avoid fogging of the film which would otherwise occur from its direct exposure to the corona glow.

It is therefore an object of this invention to provide a shockless ionizing air nozzle.

Another object of this invention is to provide an ionizing air nozzle which can be utilized in a volatile or inflammable environment.

Still another object of this invention is to provide an explosion-proof and shockless ionizing air nozzle which is capable of neutralizing and cleaning light sensitive film without causing fogging thereof in the absence of a light baffle or shield.

Yet another object of this invention is to provide an explosion-proof, shockless ionizing air nozzle which is equally adaptable for incorporation upon an air gun or a fixed conduit air line.

Still a further object of this invention is to provide a shockless static eliminator which can be placed remotely from the parts to be neutralized.

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Other objects of this invention are to provide an improved device of the character described which is easily and economically produced, which is sturdy in construction and both highly efficient and effective in operation.

With the above and related objects in view, this invention consists of the details of construction and combination of parts as will be more fully understood from the following detailed description when read in conjunction with the accompanying drawings in which:

FIGURE 1 is a perspective view of a shockless ionizing air gun embodying this invention.

FIGURE 2 is a sectional view taken along lines 2—2 of FIGURE 1.

FIGURE 3 is an exploded perspective view of the shockless ionizing air gun.

FIGURE 4 is a perspective view of a shockless ionizing air nozzle embodying this invention.

FIGURE 5 is a sectional view taken along lines 5—5 of FIGURE 4.

FIGURE 6 is an exploded view of the shockless ionizing air nozzle.

Referring now in greater detail to the drawings in which similar reference characters refer to similar parts, I show in FIGURES 1, 2 and 3 a shockless ionizing air gun comprising a barrel casing, generally designated as A, an orificed nozzle B secured to the end of the barrel, a cable C co-axially extending within the barrel and having its distal end axially spaced from the nozzle, an insulator sheath D encapsulating the distal end of the cable, a conductive sleeve E annularly supported about the sheath, a tube F concentrically spaced about the sleeve and longitudinally supporting the cable within the barrel, and a conductive needle point G extending from the end of the sleeve through the tube and co-axially projecting within the nozzle orifice.

The casing A is an integrally formed metal casting, preferably of aluminum, having a barrel portion **12** extending substantially at right angles to a hand grip portion **14** in the manner of a pistol. The barrel **12** has a longitudinal bore **16** which is internally threaded at its distal end and an interior neck portion **18** with a drilled and tapped opening **20** communicating with the bore. A hook **22** is formed on the exterior of the barrel **12** for convenience in hanging the gun when it is not in use.

The hand grip **14** has a drilled hole **24** which extends from its butt to a centrally disposed chamber **26**. A spring loaded normally-closed valve H is threaded within the chamber **26** and is retained therein by a set screw **28**. A fitting **30** at the base of the hole **24** is coupled to a hose (not shown) which is connected to a source of air under pressure. An internal canal **32** interconnects the chamber **26** through valve H with the longitudinal bore **16** in the barrel. The valve H itself is a conventional, normally-closed pneumatic stop-cock including a piston **34** reciprocable within an apertured stem **36**. The piston **34** is urged by spring **38** from left-to-right, as shown in FIGURES 2 and 3, so that its head **34*a*** normally abuts against washer **40** and seals off the longitudinally extending aperture therein and that of the stem **36**. A cap **42** is threaded within a complementary tapped opening in the chamber **26** and acts to both seal the chamber by way of grommet **44** and also to support the entire valve assembly H.

An activator pin **34*b*** integrally formed on the piston **34** projects through a gland in the cap and is adapted to be depressed by trigger **46**. The trigger **46** is pivotally supported upon dowel **48** pressed within boss **50** at the bottom of the barrel **12**. Pulling back the trigger **46** by finger pressure depresses the piston **34** so that its head **34*a*** is no longer seated against washer **40**. Accordingly, air under pressure from its source passes from the hole

24 through the apertured stem 36 in the chamber 26 and thereafter through the channel 32 where it is discharged through the barrel bore.

A second passageway 52 is formed within the heel portion of the hand grip 14 and extends upwardly to an atrium 54 at the rear of the barrel. The cable C is passed through passageway 52 into the atrium 54 and thence substantially at right angles through an externally threaded nipple 56 which is screwed and supported within the internally tapped neck 18. The atrium 54 facilitates the right angle bending of the cable C and passing the cable into the barrel bore 16. A back cover plate 58 acts as a closure for the atrium 54 after the cable C is inserted within the barrel 12. Suitable set screws 60 retain the cover plate 58 in place.

The nozzle B is also a metallic member, such as aluminum, and is generally tubular in construction having a conically tapered tip 60 with an orifice 62 at the end thereof. A circular disk 64 slip fits within the nozzle B adjacent its threaded end and is retained therein by set screws 66. The disk 64 is of an insulative or high dielectric plastic such as an acetal resin of polymerized crystalline formaldehyde sold under the trademark "Delrin." As shown in FIGURE 2, the proximal face of the disk 64 is concavely dished at 65 and a plurality of circumferentially-spaced ports 68 extend therethrough to permit smooth passage of air from the barrel. An axial bore 70 is also formed therein for radially supporting the needle G as will be described hereinafter. The threaded end of the nozzle B is screwed into the complementary internal threads at the terminus of the barrel 12 and locked in position by set screws 72. Circumferentially-spaced vents 74 extend through the cylindrical shell of the nozzle B immediately behind the tapered tip. These vents 74 permit air to be drawn from the atmosphere into the nozzle with the release of air under pressure from the line into the barrel to avoid the creation of a vacuum as the surge of compressed air is blown through the forward portion of the nozzle. As has been fully set forth in my prior U.S. patent application, Serial No. 23,675, it is desirable to have the air pass through the nozzle B longitudinally parallel to the axis of the needle G so that it will synergistically reinforce the high voltage field conically radiating from the needle point to the very tip of the orifice 62. In the latter regard, an insulative collar 76 is cemented within the orifice 62 whereby the "point" of the needle G will be shielded from the conductive surrounding surface of the orifice except at the very terminus of the nozzle tip. This assures that the high voltage potential which is applied across the needle G and the gun casing A, and, a priori, the nozzle B, will define a conical configuration extending from the point of the needle to the terminal periphery of the orifice 62.

The cable C is preferably a multi-stranded copper wire core 80 covered by a polyethylene jacket 82 and thereafter with a polyvinyl resin sheath 84. A metal grounding shield 86 is braided about the polyvinyl sheath 84, and the braided shield encapsulated by an outer insulative skin 88, again for example, a polyvinyl polymer or copolymer.

As shown in FIGURE 2, the cable C is stripped of its skin 88 and braided shield 86 so that the forward end will pass through the nipple 56 and extend approximately within 80 percent of the barrel 12. A cap 90 of polyethylene is melted over the nose end of the cable C to fully cover the previously exposed wire conductor 80 at the tip. As is apparent, the stripping of the outer skin 88 and the braided shield 86 is accomplished whereby a short exposed portion of the shield 86 will ultimately lie in the atrium 54. A pronged metallic clip 92 is pressed about the exposed portion of the shield 86 in good electrical contact therewith. A grounding strap 94 coupled to the clip 92 and having an eyelet 96 at its free end is connected to the back cover plate 58 by screw 98.

The stripped end of the cable C which projects through

the nipple 56 and into the bore 16 of the barrel is inserted within the insulator sheath D until the polyethylene nose cap 90 abuts the blind end of the sheath. The sheath D is also fabricated of a high dielectric plastic composition, such as "Delrin," and is of cylindrical configuration with an internal longitudinal blind bore accommodating the exterior diameter of the stripped end of the cable C.

The conductive sleeve E is thin walled stainless steel tubular element having an end wall with a tapped hole 100 axially extending therein. The interior diameter of the sleeve E slidably accepts the outer cylindrical wall of the sheath D. When the insulative sheath D is inserted within the conductive sleeve E, the two are substantially longitudinally co-extensive with each other and concentrically disposed about the cable C. However, no portion of the conductive sleeve E is in direct electrical contact with the wire conductor 80. Furthermore, since the nipple 56 is formed from the insulative "Delrin" plastic composition, there is no direct electrical contact of the conductive sleeve E with the grounding shield 86 or its strap 94.

Finally, the spacer tube F encapsulates the conductive sleeve E and electrically isolates the latter from the barrel 12. The spacer tube F is also fabricated of a high dielectric plastic composition, such as "Delrin" and is of cylindrical configuration having an outer wall 102 somewhat smaller in diameter than that of the barrel bore 16 to create an air space therebetween. The annular space between the tube F and the periphery of the barrel bore 16 enables the compressed air to pass through the gun barrel. The inner wall of the spacer tube F is threaded at its rearward end and screws upon the external complementary threads of the nipple 56 until in abutment with interior neck 18. The interior diameter of the spacer tube F freely interfits about the exterior of the conductive sleeve E. An end wall 104 on the tube F has an axial opening 106 therein which is counterbored to receive the shank of the needle G and its hex nut. In addition, the end wall 104 has a pair of flats 108 which are adapted to be grasped by a suitable socket wrench in order to facilitate the threading of the spacer tube F upon the nipple 56.

The needle G is of a conductive material, such as stainless steel and comprises a highly polished point 110 having a threaded shank 112 and a medial integrally formed nut 114. The shank 112 is passed through the spacer tube axial opening 106 and is threaded into the tapped hole 100 of the conductive sleeve E. The nut 114 is turned within the counterbore until the end wall of the sleeve E is drawn firmly against the inner end wall 104 of the spacer tube F. The conductive sleeve E is now firmly positioned within the tube F so that the latter will retain the various elements in secure spaced disposition with respect to the barrel 12 when threaded upon the nipple 56. Lastly, the nozzle B, with the axial bore 70 of its disk 64 passed over the needle point 110, is threaded within the barrel 12.

The shockless ionizing air gun described above is operated in a conventional manner by connecting a high voltage generator source (not shown) of approximately 5,000 to 15,000 volts A.C. across the wire conductor 80 and the grounding shield 86 at the input end of the cable C. It is to be observed that the needle G is capacitatively coupled to the conductor wire 80 through the conductive sheath E. No direct electrical contact is made between the needle G and its conductive sleeve E to either the wire conductor 80 or the casing A and its directly coupled grounding shield 86. The capacity between the sleeve E and the central conductor 80 is approximately 7 to 10 micro-microfarads. The magnitude of the capacitative coupling between the sleeve E and the cable conductor 80 is selected so as to eliminate any shock or arcing at the needle point 110 while at the same time affording a high degree of air ionization within the gap between the needle point and the periphery of the nozzle orifice **62**. The insulative collar **76** completely encircles the point of the needle G so that the circularly spaced ground at the orifice **62** is in advance of the needle point **110**. Accordingly, the potential between the needle point **110** and the nozzle B will produce a field of conical configuration. This conically disposed field will be synergistically reinforced by the general stream of air passing through the nozzle each time the trigger **46** is depressed. Thus, while the air stream blown out of the nozzle B is highly ionized, there is no corona or arcing at the point of the needle which could either light expose photographic film or ignite an explosive environment when the gun is used under such conditions. Therefore, the capacitative coupling of the needle G through its conductive sleeve E with the cable C and its central conductor **80** will provide a shockless, non-fogging, explosion-proof ionizing air gun.

In FIGURES 4, 5, and 6, I show another embodiment of the foregoing invention which differs in one respect to the extent that it is a shockless ionizing air nozzle without a trigger integrally mounted thereon and in certain other respects as follows: The modification of this embodiment comprises an insulative housing A1, a nozzle B1 secured to the front thereof, a cable C1 passing through the housing transverse to the direction of the nozzle, a conductive sleeve E1 engirdling the cable within the housing, a needle G1 co-axially disposed within the nozzle and mounted in the housing so as to positively abut against the conductive sleeve E1 transverse to the axis thereof, and conduit means J for introducing air under pressure to said housing so as to pass through the nozzle longitudinally parallel to the needle.

The housing A1 is molded of a high dielectric plastic, such as polystyrene and, as shown is of rectangular block configuration although almost any shape would perform equally as well. The front face of the block has an externally threaded cylindrical projection **120** molded integrally therewith. A bore **122** transversely extends through the block A1 into which the cable C1 is inserted. A drilled and tapped hole **124** extends from a counterbore **126** in the projection **120** into communication with the bore **122**. Co-axial with the hole **124** and spaced from the bore **122** is an internally threaded opening **128** into which is screwed a nipple fitting **130** of the conduit means J. Air ports **132** extend through the block A1 from the counterbore **126** into direct communication with the air supply opening **128**, and these ports are laterally spaced from the transverse bore **122** so as to avoid any connection thereto.

The nozzle B1 is generally comparable with the nozzle B previously described except that the disk **64** of the latter is now the projection **120** which forms part of the block A1 itself. The nozzle B1 may be of stainless steel having a hex nut body **134** from which extends an elongated tapered shell **136**. An interior chamber **138** gently necks down to a circular orifice **140** at the nozzle tip. Once again, a cylindrical tubular collar **142** of insulative plastic is cemented within the orifice **140** in order that the point of the needle G1 will not "see" any bare conductive metal immediately peripheral thereof. A plurality of circumferentially-spaced vents **144** extend through the base portion of the shell **136** to facilitate the smooth flow of the compressed air stream through the nozzle B1 without the turbulent effect created by a vacuum. As is apparent, the nozzle B1 is threadedly engaged upon the projection **130** and tightened thereon with the use of a wrench on the hex body **134**.

The cable C1 is conventional in every respect and is generally comparable to the stripped portion of the cable C which was inserted within the barrel **12** of the air gun embodiment. In the present embodiment, the shielded braid and its outer skin are eliminated, and the cable C1 comprises an inner stranded wire conductor, a polyethylene jacket, and the usual vinyl outer skin.

The conductive sleeve E1 in this example is simply a tubular element of lesser hardness than the sleeve E and may be brass for good conductivity characteristics as well as its ability to become indented by the needle G1 when the latter is urged into contact therewith. The inner diameter of the sleeve E1 is such as to freely slide over the cable C1, and its outer diameter should slidably interfit within the transverse bore **122**.

The needle G1 is substantially identical to the needle G and comprises an elongated point **146**, a threaded shank **148**, and a medial nut **150**. However, in this case the end of the shank **148** is conically ground at **152** to define a spike for dimpling engagement with the sleeve E1. Thus, after the cable C1 with its engirdling conductive sleeve E1 is inserted within the transverse bore **122**, the needle shank **148** is threaded into the tapped hole **124** until the spike **152** abuts the sleeve. Tightening down on the nut **150** with a wrench causes the spike **152** to slightly indent the sleeve E1 which not only retains it in position but also secures good electrical contact. The needle point **146** is now axially spaced from the distal end of the nozzle or orifice tip, as shown in FIGURE 5.

It is to be observed once more that no portion of the needle G1 or its sleeve E1 makes direct electrical contact with the inner conductive core **80**. On the contrary, the coupling between the sleeve E1 and the high voltage on the conductive core **80** is purely capacitative. A copper wire or grounding strap **154** is locked behind the nozzle B1 when it is threaded upon the projection, and the opposite end of the strap **154** is secured upon the metal pipe nipple **130**. As is shown in FIGURE 4, the nipple **130** is connected to a source of air under pressure by the conduit means J. The conduit means J takes the form of any series of metallic pipe or tubing which may be of a configuration to suit the needs of the installation. In FIGURE 4, a plurality of the air nozzles are secured to a common air conduit J using conventional T's or couplings **156** interconnected by lengths of tubing **158**. A suitable high voltage A.C. generator (not shown) is then connected across the cable conductor **80** and ground, i.e. the conduit means J. Note that each of the nozzles is respectively capacitatively coupled to the cable conductor **80** through its own respective sleeve E1 whereby the needles G1 will ionize the air passing through the nozzles B1 without creating any spark, arcing or corona discharge about the points.

Although this invention has been described in considerable detail, such description is intended as being illustrative rather than limiting, since the invention may be variously embodied without departing from the spirit, and the scope of the invention is to be determined as claimed.

What is claimed is:

1. A shockless ionizing air nozzle comprising a tubular conductive casing having a bore longitudinally extending therein and a tapered portion terminating in a circular orifice, an insulative disk mounted within said bore and having air ports extending therethrough, a conductive needle mounted in an axial aperture in said disk co-axially with respect to said bore and electrically insulated from said casing, said needle having a point directed toward the distal end of said casing and terminating within said orifice co-axial therewith and longitudinally spaced from the tip thereof, a tubular insulative, collar concentrically spaced about said needle point within said orifice so as to present a bare circular conductive portion of said orifice longitudinally spaced from said needle point, a bored insulative housing coupled with said nozzle, a cable having a central wire conductor jacketed within a dielectric skin, a conductive sleeve mounted in the bore of said housing and slidably engirdling the skin of said cable electrically insulated from the central wire conductor, said needle being in positive electrical contact with said conductive sleeve, means for introducing air under pressure to said ports so as to pass through said nozzle longitudinally parallel with said needle and be expelled from said orifice, and means for applying a high voltage across said wire

conductor and said conductive casing whereby said conductive sleeve and said needle will be capacitatively coupled with said wire conductor and an ionized air field will conically radiate from the point of said needle to said orifice tip in synergistic support of the air stream without sparking, arcing or corona glow intermediate said needle point and said casing.

2. A shockless ionizing air gun comprising a conductive casing having a barrel portion and a hand grip portion, said barrel having a longitudinal bore therein, a nozzle at the end of said bore, said nozzle including a generally cylindrical chamber and having a tapered tip with a circular orifice at the end thereof, a circular insulative disk interfitting within said chamber and having an axial aperture and a plurality of longitudinal air ports radially spaced therefrom, a cable having a central wire conductor jacketed within a dielectric skin, one end of said cable passing through a channel in said grip portion and extending into said bore, a tubular dielectric sheath on the end of said cable within said bore, a tubular conductive sleeve encapsulating said dielectric sheath, a dielectric tube having a cylindrical wall and an axially apertured end wall, said dielectric tube being secured within said longitudinal bore and having the cylindrical wall thereat annularly spaced intermediate said conductive sleeve and said barrel portion, a conductive needle having a shank portion and a point portion, the shank portion of said needle being secured to the end of said conductive sleeve, the point portion of said needle passing through the apertured end wall of said tube and being axially supported in the aperture of said disk, the point of said needle terminating within said nozzle orifice co-axially therewith, means for introducing air under presure into said bore and passing through the disk air ports and expelled through said nozzle orifice longitudinally parallel with said needle, and means for applying a high voltage across said wire conductor and said conductive casing whereby said conductive sleeve and said needle will be capacitatively coupled with said wire conductor and an ionized air field will conically radiate from the point of said needle to the tip of said orifice in synergistic support of the air stream without sparking, arcing or corona glow intermediate said needle point and said nozzle.

3. The ilnvention of claim 2 wherein a tubular insulative collar is secured within said orifice peripherally spaced about the point of said needle.

4. The invention of claim 2 wherein said cable includes a conductive grounding braid coupling the ground of said high voltage to said casing.

5. A sockless ionizing air nozzle comprising a tubular conductive casing having a chamber longitudinally extending therein and terminating in a circlar orifice, an insulative disk mounted within said chamber and having spaced air ports longitudinally extending therethrough radially spaced from an axial aperture therein, a bored housing coupled with said nozzle, a cable having a central wire conductor jacketed within a dielectric skin, a conductive sleeve in the bore of said housing engirdling the skin of said cable electrically insulated from the central wire conductor, a conductive needle supported in the aperture of said insulative disk in electrical contact with said conductive sleeve and having a point terminating within said orifice co-axial therewith and longitudinally spaced from the tip thereof, means for introducing air under pressure to said ports so as to pass through said nozzle and be expelled through said orifice longitudinally parallel with said needle, and means for applying a high voltage across the wire conductor and said conductive casing whereby said conductive sleeve and said needle will be capacitatively coupled with said wire conductor and an ionized air field will conically radiate from the point of said needle to the tip of the orifice in synergistic support of the air stream being expelled without arcing or corona glow in the air space between said needle point and said casing.

6. The invention of claim 5 wherein a dielectric tubular collar is mounted within said orifice annularly spaced about the point of said needle.

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