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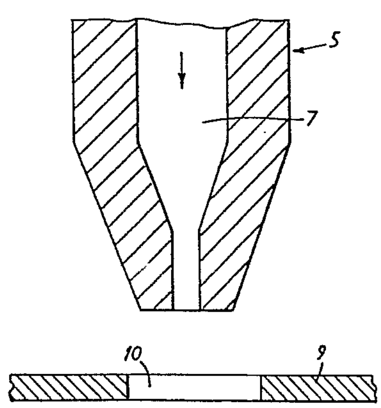
(54) **Gas ion source.**

(57) A gas ion source in which a high density electric field is established between a first electrode in the form of a hollow needle 5 through which gas to be ionised may pass and a second extractor electrode 9 which has a through-aperture 10 through which the ions flow on their way to a target (not shown).

FIG. 2



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"GAS ION SOURCE"

The present invention relates to a gas ion source such as used in industry for material processing and surface analysis in vacuum.

In known ion sources ion beams are generated either by a glow discharge, electron bombardment excitation or radio frequency (RF) excitation. In the present invention, a gas stream is ionised by an electric field set up between a first electrode in the form of a hollow needle through which a gas to be ionised may flow and a second electrode situated adjacent the needle in such a manner that gas issuing from the interior of the needle is ionised by electrons excited by the electric field. Typically, the gas used is argon, but the ionisation of other gases and volatile metals is also possible.

Satisfactory ionisation of gas depends on two factors: gas pressure and excitation force. The structure of the preferred embodiment of the ion source of this invention localises these two factors to provide a well-defined origin of ionisation unlike, for example, the conventional gas discharge source which can ionise anywhere between two spaced plates. The existence of a well-defined origin of ionisation leads to improved focussing of the ion beam and greater current density.

Thus, in the preferred embodiment of the invention, the relatively narrow needle orifice opens into a large space, with the second, or extractor, electrode positioned in front of, but spaced from, the open end of the needle. This construction leads to the two necessary conditions for satisfactory ionisation of the gas: firstly, emergence of gas from the narrow orifice into the large space leads to a localised region of relatively high gas pressure in the immediate area of the orifice; secondly the physical narrowness of the needle about the orifice means that the electric field set up between the needle and the extractor electrode is also in the same area.

As the atoms of gas emerge from the needle, they enter the high pressure region and are ionised by electrons traversing the inter-electrode space. The resulting ions are then accelerated away from the needle in a well-defined narrow beam by means of the extractor electrode. The extractor electrode is formed with an aperture through which the ion beam may pass.

In order that the invention may be better understood, an embodiment thereof will now be described by way of example only and with reference to the accompanying drawings in which:-

Figure 1 is a general side elevation of a gas ion source constructed in accordance with the invention;

Figure 2 is an enlarged sectional view of part of the gas ion source of Figure 1; and

Figure 3 is a diagrammatic view of an experimental system designed to test the gas ion source.

Referring to Figures 1 and 2, the gas ion source comprises a needle assembly 1 and extractor 2 which are carried on a mounting flange 3 by means of a pair of spaced pillars 4. The needle assembly comprises a hollow needle 5 made of refractory metal such as tungsten which is mounted in an insulating support 6.

Gas is supplied to the interior passage 7 within the needle 5 via a tube 8 which passes through the flange 3. If desired preheating of the gas may be carried out by means of a heater (not shown) associated with the tube 8. Such preheating may be desirable in certain circumstances in order to prevent the condensation of volatile vapours in the tube. The needle tapers at its free end to a diameter typically of 75μ. The outlet end of passage 7 likewise tapers at the free end of the needle to provide a constriction having a diameter typically of 25μ.

The extractor 2 comprises a flat circular extractor electrode 9 having a through-aperture 10, typically of 100μ diameter, at its centre. The electrode 9 is supported by a generally cylindrical electrode support member 11 in such a way that the aperture 10 lies directly in front of the exit of the needle 5. The distance between the extractor electrode and the tip of the needle is typically 1mm.

The extractor electrode and needle are connected by way of pillars 4 to respective terminals of an electrical power supply unit (not shown) so that, in use, the needle has a positive potential with respect to the extractor electrode. The voltage applied between the needle and the extractor electrode is typically between 5,000 and 10,000 volts.

To use the ion source, a suitable gas such as argon is passed along the tube 8 to the passage 7 within the needle. The constricted portion at the mouth of the passage 7 has a self-regulating effect and ensures that a well defined stream of gas emerges into the space between the needle and the extractor electrode. The sudden emergence of gas from the constricted portion of passage 7 into the relatively wide space within the extractor results in a localised region of relatively high pressure at the exit of the passage 7 and it is in this high pressure region, subjected as it is to the electric field existing between the needle and the extractor electrode, that the ionisation of the gas takes place. The ions are created in a highly localised self contained and self sustaining discharge which is initiated by some random external event. Usually this is attributable to a cosmic ray ionising a single atom - the resulting electron is then accelerated in the high electric field to cause more ionisation and a cascade of electrons within the region close to the exit of the needle. The resulting ions are accelerated through the aperture 10 in the extractor electrode in a narrow beam. There is, however, no net electron flow between the needle and the extractor electrode.

In practice the ion source is used in an evacuated atmosphere, with ambient pressures no greater than 10^{-5} mm Hg. Typically the ambient pressure is 1 millionth of an atmosphere while the pressure in the localised high pressure region adjacent the exit to the passage 7 is typically ¼ atmosphere. This leads to a very considerable pressure gradient in the 1 mm space between the tip of the needle and the extractor electrode.

Figure 3 shows a typical experimental test set-up. The ion source is mounted within a vacuum chamber 12 above a collector electrode 13. Gas to be ionised is supplied to tube 8 form a cylinder 14, the inlet gas pressure being monitored by a gauge 15. An electrical power supply 16 has positive and negative outputs connected to the needle 5 and extractor 2 respectively in order to produce a high electric field between the two. The collector electrode is likewise connected to the negative output, via a microammeter. The ion beam is drawn out of the ion source by means of the electric field existing between the extractor electrode and the needle. The extractor electrode is intended to provide the high electrical gradient needed for ionisation and also to provide the acceleration of the ion beam as it leaves the region of ionisation. The collector electrode is intended to represent a target workpiece which is to be bombarded, and is not part of the ion source per se. The energy of the ion beam as it strikes the collector electrode is dependent upon the magnitude of the voltage between the needle and the collector electrode. Thus, in practice, the potential of the collector electrode will be capable of adjustment independently of that of the extractor electrode in order to take account of varying requirements in use.

The ion source described above can be used with a wide variety of gases and volatile metals. Examples are argon, helium, neon, nitrogen, hydrogen, deuterium, oxygen or volatile arsenic or boron. In the case of oxygen, problems can arise due to erosion of the needle, and the source should be operated at a lower current to reduce this. Typically the gas pressure, as recorded on gauge 15, is in the region of 120 to 280 mm Hg.

The ion source described above will produce a reliable high intensity beam of ions and finds wide application in industry in particular for material processing and surface analysis. In use, the ion source is mounted within a vacuum chamber and the beam of ions for example argon ions, produced by the source is directed at the target material. The resultant ion bombardment will sputter or etch away material from the target. Electrons and ions released by the target during ion bombardment can be analysed to determine the existence and concentration of the various elements present.

CLAIMS

1. A gas ion source comprising a first electrode in the form of a hollow needle having a bore through which a gas to be ionised may flow and a second electrode positioned immediately in front of, but spaced from, said first electrode, said second electrode having a through aperture in line with said bore, and means for establishing an electric field between said first electrode and said second electrode whereby gas emerging from said needle is ionised by the electric field.

2. A gas ion source as claimed in claim 1 wherein the size of the end of the needle through which, in use, gas emerges is small to give a high density electric field in the region where gas emerges from the needle.

3. A gas ion source as claimed in claim 2 wherein the end of the needle through which gas emerges tapers.

4. A gas ion source as claimed in claim 3 wherein the end of the needle through which gas emerges is about 75μ in diameter.

5. A gas ion source as claimed in any one of the preceding claims wherein the bore of the needle has a region of smaller diameter at that end of the needle through which gas emerges in order to tend to regulate the flow of gas through the needle.

6. A gas ion source as claimed in any one of claims 1 to 4 wherein the needle is made of tungsten.

7. A gas ion source substantially as hereinbefore described with reference to the accompanying drawings.

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FIG. 1

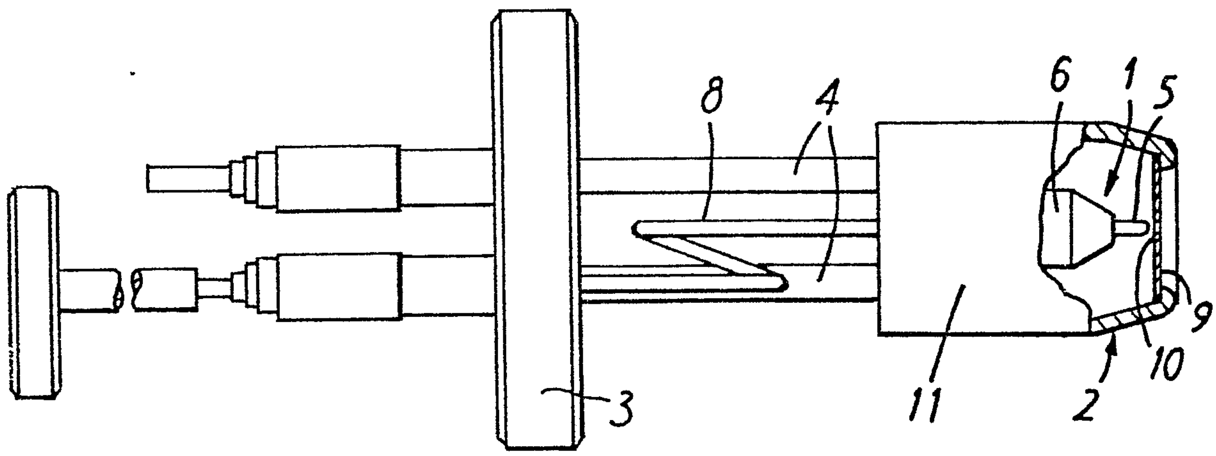
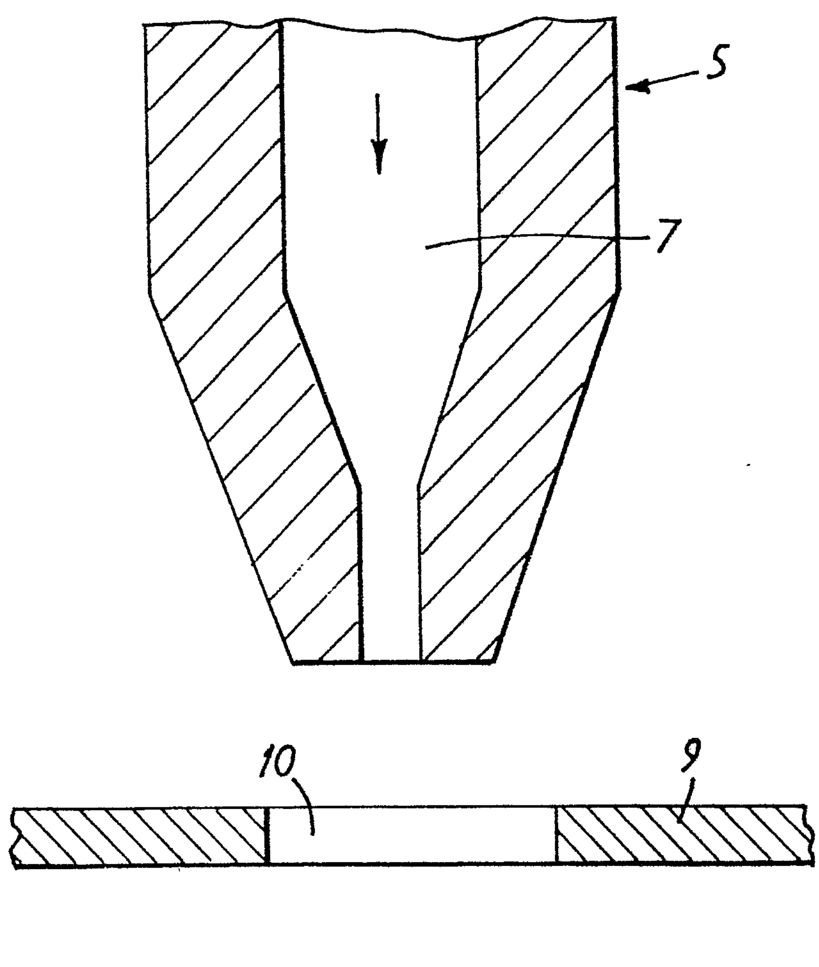


FIG. 2



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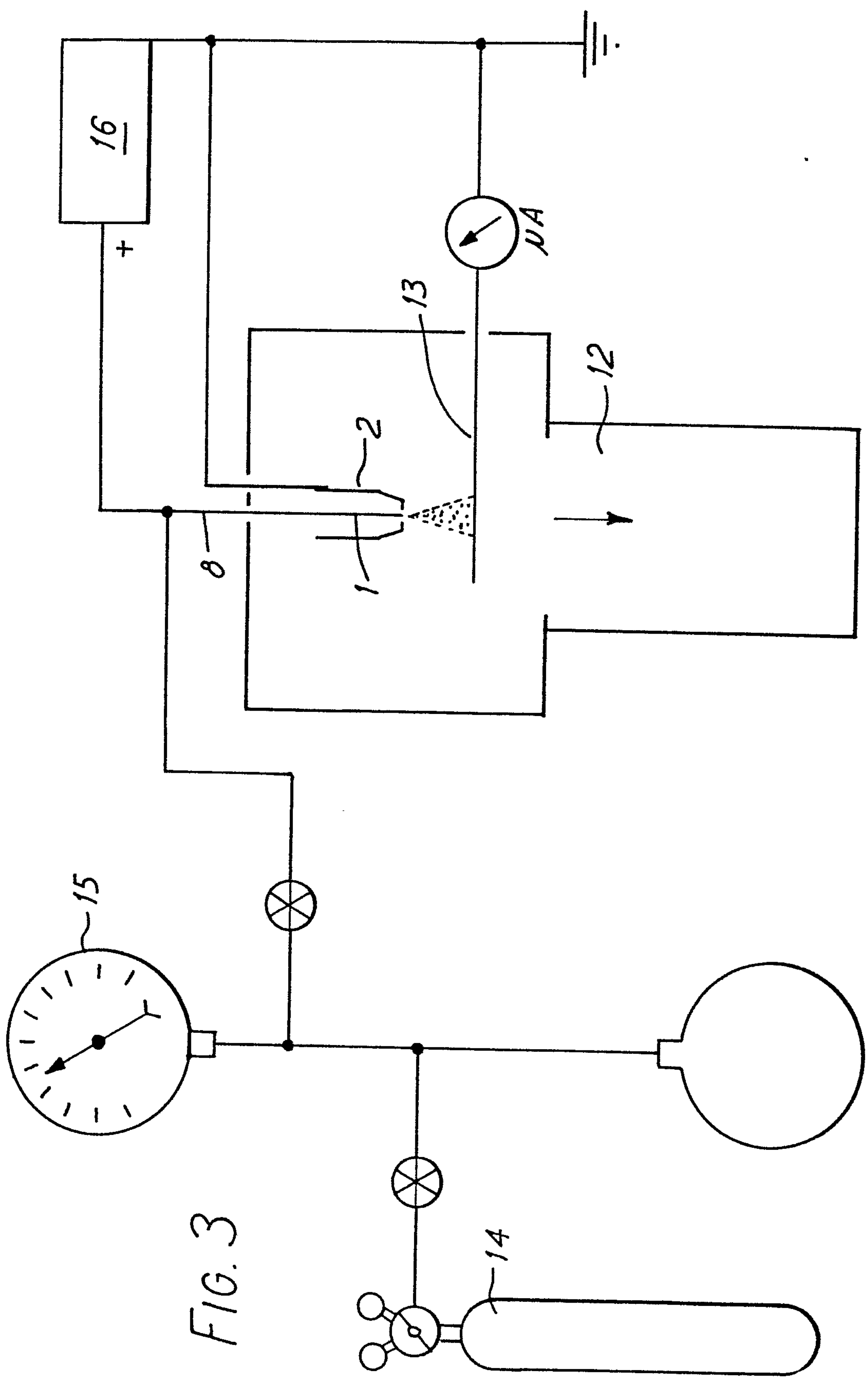

FIG. 3

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EUROPEAN SEARCH REPORT

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Application number

EP 81305685.0

Category	DOCUMENTS CONSIDERED TO BE RELEVANT Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Y	DE - B2 - 2 701 395 (FRANZEN) * Fig. 1,2 * --	1-3,5,7	H 01 J 49/10 H 05 H 1/00
Y	FR - A1 - 2 344 116 (GESELLSCHAFT FUR SCHWERIONENFORSCHUNG) * Fig. 1-5 * & GB-A-1 578 167 --	1-3,5,7	
A	US - A - 3 955 090 (ASTLEY) * Fig. 2 * --		TECHNICAL FIELDS SEARCHED (Int.Cl. 3)
A	US - A - 3 309 873 (CANN) * Fig. 1-6 * ----		H 01 J 27/00 H 01 J 37/00 G 01 N 27/62 G 01 N 27/64 H 05 H 1/00 H 05 H 9/00 H 01 J 3/00 H 01 J 49/00

CATEGORY OF CITED DOCUMENTS

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D: document cited in the application
L: document cited for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	01-03-1982	VAKIL