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EUROPEAN PATENT APPLICATION

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⑤④ Improvements relating to methods of spraying metallic coatings and apparatus for use in the spraying of metallic coatings.

⑤⑦ The surface of a workpiece is coated with a metallic material by the use of a spraying device in which an electric potential is applied across two metallic wires (W1, W2) to establish an arc therebetween, the wires being progressively advanced towards the arc as they are melted by the arc. Gas under pressure is fed towards the arcing zone, the gas including a carrier stream to cause molten metal droplets produced by the arc to be carried away from the arcing zone towards the surface to be sprayed, and optionally one or more supplementary streams such as may be operative to constrain the carrier stream to a desired (e.g. conical) shape. In accordance with the invention, one or more of the streams of gas includes, or is provided by, a modifying agent, afforded by a substance or composition which is effective to modify the coating sprayed onto the workpiece, compared with the coating produced by the use solely of air. The modifying agent may produce a chemically or physically modifying effect in relation to the conditions pertaining at or in the vicinity of the arcing zone, and/or a chemically or physically modifying effect in relation to the coating sprayed onto the workpiece.

EP 0 051 869 A1

Title: "Improvements relating to methods of spraying
metallic coatings and apparatus for use in the
spraying of metallic coatings"

5 This invention is concerned with improvements
relating to the spraying of a coating of a metallic
material onto a surface, particularly metallic spraying
of the kind (hereinafter referred to as being of the kind
specified) utilising a metal spraying device in which an
electric potential is applied across two metallic wires
to establish an arc therebetween, the wires being
progressively advanced towards the arc as they are melted
by the arc, gas under pressure being fed toward the
10 arcing zone, such gas including a carrier stream to cause
molten metal droplets produced by the arc to be carried
away from the arcing zone towards the surface to be
sprayed, and optionally one or more supplementary streams
such as may be operative to constrain the carrier stream
15 to a desired shape.

Apparatus for carrying out metal spraying of the
kind specified is described in the Specification of our
International Patent Application No. WO 80/00544.

20 Conventionally used for the carrier stream and the
supplementary stream or streams is air under pressure.

25 According to this invention there is provided a
method of spraying a metallic coating onto a surface,
utilising a metal spraying device in which an electric
potential is applied across two metallic wires to
establish an arc therebetween, the wires being progress-
ively advanced towards the arc as they are melted by the
arc, gas under pressure being fed towards the arcing
zone, such gas including a carrier stream to cause molten
metal droplets produced by the arc to be carried away

from the arcing zone towards the surface to be sprayed, and optionally one or more supplementary streams such as may be operative to constrain the carrier stream to a desired shape, in which the or one of the streams of gas fed towards the arcing zone includes, or is provided by a modifying agent other than air.

By the term "modifying agent" we mean a substance or composition which is effective to modify the coating sprayed onto the workpiece, compared with the coating produced by the use solely of air. Thus the modifying agent may produce a chemically or physically modifying effect in relation to the conditions pertaining at or in the vicinity of the arcing zone, and/or a chemically or physically modifying effect in relation to the coating sprayed onto the workpiece.

The modifying agent may be effective to modify the temperature of the arcing zone, such as to increase or decrease said temperature.

The modifying agent may alternatively or additionally be effective to modify the arcing atmosphere, such as to make the arcing atmosphere oxidising or reducing.

The modifying agent may be operative to modify the coating obtained by the use of the apparatus, such as by causing additional materials to be carried on the or one of the streams of gas towards the surface to be coated, in admixture with the metallic coating materials.

The modifying agent may be gaseous, or liquid, or solid (preferably in the form of a fine powder) or may be a combination of any of these. The modifying agent may be included in the carrier stream which is directed towards the arcing zone, particularly where modification of the arcing temperature is required, or the carrier stream may be provided by a modifying agent in gaseous

form. The modifying agent may be included in or may provide one or more of the supplementary stream or streams, particularly where the arcing atmosphere is to be modified, or the coating is to be modified.

5 Thus the modifying agent may comprise reducing agents in gaseous, liquid or solid (powder) form, oxidizing agents, combustible gases, hydrogen peroxide, water, ceramic material, metallic materials in finely divided form, metallic fillers in finely divided form,
10 metallic carbides, metallic borides, metallic oxides, copper alloy, plastics material.

 This invention also provides apparatus for use in the spraying of a metallic coating comprising a body, feeding mechanism for simultaneously feeding two
15 metallic wires or rods through two guide passages which converge forwardly in the direction of wire feed, connecting means which may be connected to a supply of electricity to cause an arc to be established between the wires where they emerge from said guide passages so as to
20 melt the wires, first delivery means for delivering a stream of gas under pressure to the arcing zone so as to cause molten metal droplets to be carried away from the arcing zone on the carrier stream from the device towards a surface to which a coating is to be applied, and second
25 delivery means to deliver a stream of gas under pressure towards the vicinity of the arcing zone, to constrain the carrier stream to a desired shape, the first and second delivery means being separate, whereby modifying agents may be added to, or may provide one of, said streams of
30 gas under pressure separately from the other.

 There will now be given a detailed description, to be read with reference to the accompanying drawings, of a metal spraying apparatus for use in carrying out this invention, and several examples of performance of the
35 invention.

In the accompanying drawings:-

FIGURE 1 is a vertical sectional view of the device which is the preferred embodiment of this invention, taken along a longitudinal centre line thereof;

5 FIGURE 2 is a part plan view of the device, part being shown in horizontal section; and

FIGURE 3 is a front elevation of the head of the device, as viewed in the direction of the arrow A in Figure 2.

10 The device which is the preferred embodiment of this invention is a metal spraying device generally of the kind illustrated by way of example in the Specification of our International Patent Application No. WO 80/00544, to which reference may be made for further details not
15 disclosed herein.

The device comprises a housing 6, a manifold assembly 8 secured to a forward end of the housing, a stem portion 14 secured to an extending forwardly from the manifold assembly, and a head 16 secured to a forward
20 end of the stem portion 14. The device also comprises two supply conduits 18, in the form of rubber hose of 10mm diameter, each of which defines an interior supply passage and which is connected to the manifold assembly 8 by screw fittings.

25 In the use of the apparatus, air under pressure is delivered through the conduits 18 to the manifold assembly 8 and by way of a conduit 32 to an air motor 42. Air is also delivered, under the control of a spool valve 9, from the two conduits 18 to a passage 34 in the stem
30 portion 14.

The head 16 is formed in one piece from an insulating material, preferably a ceramic material, by a machining operation. Extending through the head is an air passage 60 which constitutes first delivery means, through which compressed air may be fed from the passage 34 of the stem portion.

Extending through the head, lying in an axial plane thereof, are two guide passages 62, 62, said guide passages converging towards and exiting through a forwardly presented end face 58 of the head.

Extending through the housing 6 are two guide tubes 36, each defining an interior guide passage 38. At the forward end region of the apparatus, the guide tubes converge, and at a point adjacent to the head 16, the guide passages 38 are each in alignment with one of the guide passages 62 of the head.

In the use of the apparatus, operation of an air motor 42 may be triggered by a trigger lever 43, the air motor driving gear wheels 44 and 46 to axially rotate a central spindle 48. These in turn are connected to feed wheels 50 which extend through slots in the guide tubes 36, the air motor, together with the gear wheels 44 and 46, the central spindle 48 and the feed wheels 50 constituting feeding mechanism of the apparatus.

In the use of the apparatus, metallic wires in the form of elongate rods of circular cross-section W_1 and W_2 , are fed through the guide passages 38 in the guide tubes 36, and into the guide passages 62 of the head 16. By operation of the air motor 42, the feed wheels 50 grip the metallic wires and feed them along the guide tubes 36 in the direction of forward convergence of the guide tubes and into the head.

Extending through each of the supply conduits 18 is a conductor means in the form of a plurality of conductor rods (not shown) of solid, conveniently circular cross-section, through which a supply of electricity is delivered to the spray gun, for connection to the metallic wires.

Connected to the head 16 is a second delivery means, comprising a conduit 110 connected to the head at a fitting 112. The fitting 112 connects the conduit 110 to a peripheral bore 114, from which gas under pressure may be delivered firstly to two forwardly extending passages 118, 118, and secondly to a frusto-conical chamber 124 extending around the central part of the nozzle (see Figure 2). Thus, gas under pressure delivered to the head 16 through the conduit 110 will firstly be ducted to afford a convergent frusto-conical stream extending around the arcing zone, to constrain the carrier stream exiting from the duct 60 to a desired shape, viz, to prevent the carrier stream from spreading. Secondly, gas emerging from the two passages 118 on either side of the arcing zone (see Figure 3) will tend to cause the carrier stream to adopt a somewhat vertically elongated fan-shape, as is described in more detail in the Specification of our U.K. Patent No. 1,540,810.

However, by the use of the present invention, since the delivery means afforded by the two conduits 18 is separated from the delivery means afforded by the conduit 110, the constitution of the primary, carrier gas stream may differ from that of the secondary, shaping gas streams. In this manner, one or both of the streams may be modified, to achieve desirable arcing and/or spraying conditions, and/or to modify the composition or characteristics of the spray coating produced from the metallic wire rods.

EXAMPLE 1

5 The carrier stream ducted to the apparatus through the conduits 18 is provided by a hydrocarbon gas, or by carbon monoxide, either totally or in admixture with air, to maintain the atmosphere at the arcing zone reducing, to prevent or minimise the tendency of the metallic material produced to oxidise.

The gases which may be utilised as or as part of the carrier stream are as follows:-

10 Carbon monoxide
Hydrogen
Methane
Ethane
Propane
Butane
15 Acetylene

EXAMPLE 2

20 The carrier stream ducted to the apparatus through the conduits 18 may be oxygen-enriched, and the shaping gas streams ducted to the apparatus through the conduit 110 may be afforded by a combustible gas, such as one of those listed in Example 1. In this manner, not only may the temperature of the materials being sprayed onto the surface be increased, but also oxidation of the materials may be assisted, where this is desired.

EXAMPLE 3

25 Either the carrier stream or the shaping gas streams may be enriched with hydrogen peroxide. In liquid form, this may ensure high oxygen content at the arcing zone, whilst the heat required to boil the liquid tends to reduce the temperature at the arcing zone.

EXAMPLE 4

A reducing atmosphere at the arcing zone with a smaller increase in temperature thereat may be achieved by including a reducing material in solid (pulverant) form in the carrier gas stream. Thus, pulverant material may be introduced in air under pressure, prior to admission to the conduits 18. Such solid materials are conveniently of the type which will have an improving effect on the physical properties of the coating, such as increasing the hardness and/or abrasive resistance thereof. Solid reducing materials which may be used include Iron carbide (Fe_3C); Aluminium carbide (Al_4C_3); Chromium carbide (Cr_3C_2); Nickel carbide (Ni_3C); Tungsten carbide (WC).

EXAMPLE 5

Improvement in the physical properties of the material being coated, such as increasing the hardness and/or abrasive resistance thereof, may be obtained by including a pulverant metallic material in one or other of the gas streams. Thus, a metallic boride in highly divided form may be introduced into a stream of air under pressure, whether including a further modifying agent or not, prior to entry into the conduits 18 or 110. Such metallic borides may include Chromium boride (CrB); Molybdenum boride (Mo_2B); Titanium boride (TiB_2); Tungsten boride (W_2B ; WB ; W_2B_5). Additional metallic materials may be added to the coating by inclusion in the carrier stream; such materials may afford metallic fillers, and may include Manganese bronze; Silican bronze; Phosphur bronze; Aluminium bronze; Cupro-nickel.

EXAMPLE 6

5 Ceramic material in dust-like form may be included in one or other or both of the gas streams, such as Aluminium oxide (Al_2O_3); Zirconium dioxide (ZrO_2); a ceramics material comprising a mixture of Zirconium dioxide (ZrO_2) and Silicon dioxide (SiO_2); a ceramics material comprising a mixture of Aluminium oxide (Al_2O_3) and Silicon dioxide (SiO_2).

EXAMPLE 7

10 Plastics material may be incorporated in the metallic coating being sprayed by the inclusion of a plastics filler material in finely divided form in one of the air streams delivered to the apparatus. Such plastic fillers may include Nylon, Polyethylene, Polytetrafluoroethylene, or polycarbonate materials.

EXAMPLE 8

15 A reduction in the arcing temperature may be obtained by the addition of water (e.g. water vapour) to one or both of the gas streams; such addition may be used to advantage where other modification treatments to the arcing environment may produce an undesired rise in temperature, which may be counteracted by the inclusion
20 of such water in, for example, the primary carrier stream.

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25 It will be appreciated that the above examples may be utilised with metallic wires of widely differing compositions and this, in conjunction with the diversity of possible additives, provides a means of considerably increasing the range of coatings it is possible to produce.

CLAIMS:

- 5 1. A method of spraying a coating of a metallic material onto a surface, utilising a metal spraying device in which an electric potential is applied across two metallic wires to establish an arc therebetween, the wires being progressively advanced towards the arc as they are melted by the arc, gas under pressure being fed towards the arcing zone, such gas including a carrier stream to cause molten metal droplets produced by the arc to be carried away from the arcing zone towards the surface to be sprayed, and optionally one or more supplementary streams such as may be operative to constrain the carrier stream to a desired shape, in which the or one of the streams of gas fed towards the arcing zone includes, or is provided by, a modifying agent other than air.
- 10 2. A method according to Claim 1 wherein the modifying agent is effective to modify the temperature of the arcing zone.
- 15 3. A method according to one of Claims 1 and 2 wherein the modifying agent is effective to modify the arcing atmosphere.
- 20 4. A method according to any one of Claims 1, 2 and 3 wherein the modifying agent is operative to modify the coating obtained by the use of the spraying device.
- 25 5. A method according to any one of the preceding claims wherein the modifying agent is in gaseous, or liquid, or solid form, or a combination of any of these.
6. A method according to any one of Claims 1 to 5 wherein the modifying agent is included in or provides the carrier stream.

7. A method according to any one of Claims 1 to 6 wherein the modifying agent is included in or provides one or more of the supplementary streams.

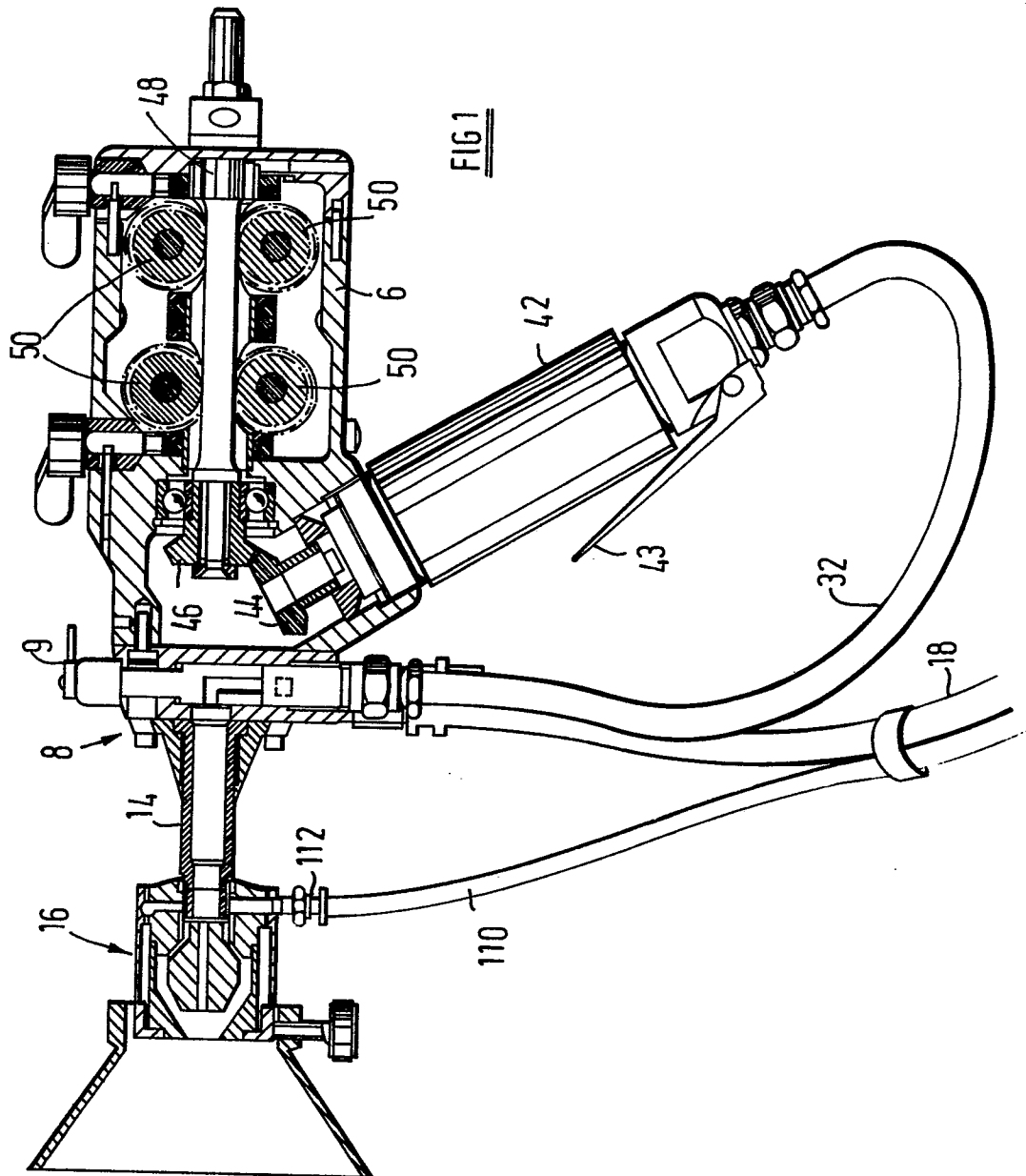
8. A method according to Claim 1 wherein the modifying agent is selected from one or more of the following:-

- (a) reducing agents in gaseous, liquid or solid powder form;
- (b) oxidizing agents in gaseous, liquid or solid powder form;
- (c) combustible gases;
- (d) hydrogen peroxide;
- (e) water;
- (f) ceramic materials in finely divided form;
- (g) metallic materials in finely divided form;
- (h) metallic fillers in finely divided form;
- (i) metallic carbides in finely divided form;
- (j) metallic borides in finely divided form;
- (k) metallic oxides in finely divided form;
- (l) copper alloys in finely divided form;
- (m) plastics materials in finely divided form.

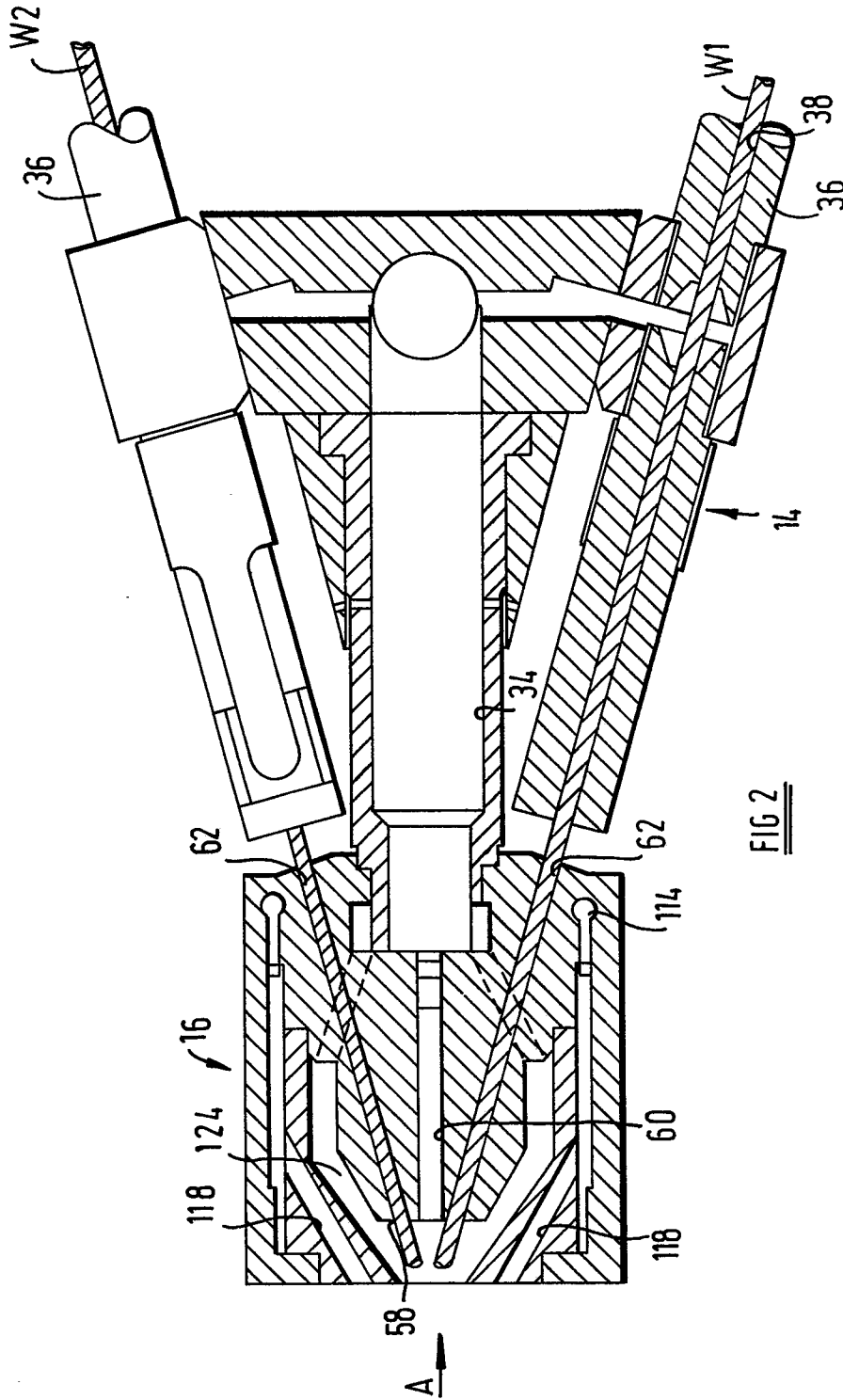
9. Apparatus for use in the spraying of a metallic coating, comprising a body (6), feeding mechanism (50) for simultaneously feeding two metallic wires (W1, W2) or rods through two guide passages (62) which converge forwardly in the direction of wire feed, connecting means which may be connected to a supply of electricity to cause an arc to be established between the wires (W1, W2) where they emerge from the guide passages (62) so as to melt the wires, first delivery means (18, 34, 60) for delivering a stream of gas under pressure to the arcing zone so as to cause molten metal droplets to be carried away from the arcing zone on the carrier stream from the device towards the surface to which a coating is to be applied, and second delivery means (110, 124; 114, 118) to deliver a stream of gas under pressure towards the

vicinity of the arcing zone, to constrain the carrier stream to a desired shape, the first and second delivery means being separate, whereby modifying agents may be added to, or may provide one of, said streams of gas under pressure separately from the other.

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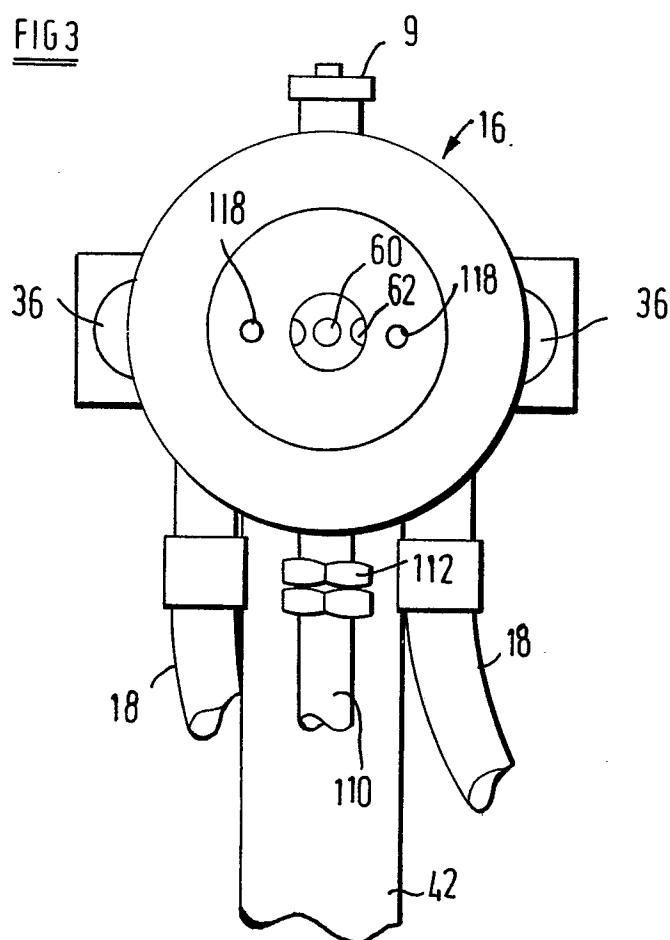


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FIG 3





European Patent
Office

EUROPEAN SEARCH REPORT

0051869

Application number

EP 81 10 9553

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
XY	<u>US - A - 2 003 167</u> (P. ALEXANDER) * Claims 1-3; page 1, right-hand column, lines 34-47; page 2, left-hand column, lines 11-14; page 2, right-hand column, lines 25-38 * --	1-9	C 23 C 7/00 B 05 B 7/22
XY	<u>DE - A - 1 813 349</u> (SOCIETE DES SOUDURES CASTOLIN) * Claims 1-6,8; figure 3, page 9 * & <u>FR - A - 1 594 394</u> --	1-9	TECHNICAL FIELDS SEARCHED (Int.Cl. 3) C 23 C B 05 B
XY	<u>FR - A - 516 567</u> (SOCIETE DE METALLISATION) * Claims 1-3,6; figure 2 * --	1-9	
Y	<u>DE - C - 811 899</u> (DEUTSCHE EDELSTAHLWERKE) * Claims 1-5; page 3, lines 10-78; lines 108-126; page 4, lines 1-4 * --	1-9	
AD	<u>WO - A - 80 /00544</u> (METALLISATION LTD.)		
A	<u>GB - A - 1 277 488</u> (FLAME-SPRAY INDUSTRIES INC.)		
A	<u>GB - A - 899 275</u> (UNION CARBIDE CORP.) ----		
☒ The present search report has been drawn up for all claims			CATEGORY OF CITED DOCUMENTS X: particularly relevant if taken alone Y: particularly relevant if combined with another document of the same category A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: earlier patent document, but published on, or after the filing date D: document cited in the application L: document cited for other reasons &: member of the same patent family, corresponding document
Place of search The Hague		Date of completion of the search 09-02-1982	Examiner RIES