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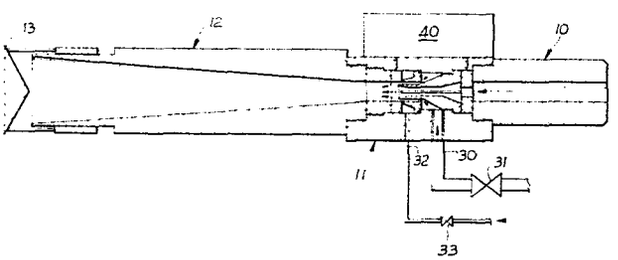
(54) Coating apparatus.

(57) Electrostatic or electrogasdynamic coating apparatus includes a coating gun, e.g. for use with dry powder, whose structure defines a through passage leading from an inlet tube (10) operatively connected to a source of particulate coating material to a discharge barrel (12). A central needle cathode electrode (15) is mounted in a constricted region of the passage, its tip being adjacent an annular porous metal anode electrode (25) whose central opening defines part of the passage. A flow of the material is induced along the passage by a first pressurized gas (e.g. air) stream fed from a first supply formation (24) to enter the passage in the region of the electrodes, in which region the particles receive an electric charge from the latter. At the same time a second pressurized gas steam, which is controlled independently of the first stream, is fed from a second supply formation (24) through the porous electrode itself to prevent build-up of particles on the acting portion thereof.



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COATING APPARATUS

This invention relates to apparatus for coating a workpiece by applying a coating material as electrically charged particles which are attracted onto the surfaces of the workpiece. The invention has particular application to coating processes using a dry powder coating material but it is contemplated that it may also have application to material applied as a liquid in which case the particles will be droplets or a mist.

Electrostatic and electrogasdynamic coating apparatus is well known and widely utilised as a means of applying a finish or other coating to components or finished articles particularly as part of a continuous production operated automatically or semi-automatically.

One problem associated with this type of apparatus, particularly when employed in substantial continuous production runs, is the prevention of build-up of particles which would otherwise seriously degrade or prevent effective operation of electrodes positioned in a stream of the particles to electrically charge the latter.

Attempts have been made to overcome this problem by directing or diverting part of a gas flow (usually pressurized air), which is otherwise applied to maintain said stream, to sweep over or pass through exposed faces or tips of the electrodes to resist particle build up on their acting portions. Examples of such arrangements are described in British patents 1449998 and 1498486.

The object of the present invention is to provide coating apparatus which is particularly efficient, reliable and consistent in operation over substantial periods of service without need for cleaning or attention, and whose operation can be readily adjusted or adapted to suit a wide range of operating requirements.

The invention provides a coating apparatus including non-electrically conductive structure defining a through passage leading from an upstream inlet for receiving a flow of particles of coating material from a source in use to a downstream outlet from which said particles are operatively discharged towards an article to be coated; anode and cathode electrodes within said passage across which an electrical potential is operatively applied for charging the particles in said flow; a first supply formation communicating with the passage for operatively feeding a first pressurized gas stream thereinto to induce and/or maintain said particle flow; a second supply formation connected to feed a second pressurized gas stream through an acting portion of at least one said electrode to oppose build-up of particles thereon; and means for selectively varying the output of pressurized gas fed from at least one of said supply formations in use independently of the output operatively fed from the other of said formations.

Preferably said at least one electrode, for example the anode electrode, has a through opening forming part of said passage and through which the particle flow passes and at least the

acting portion defining said opening is formed from a porous material through which the second gas stream passes into the passage.

With the latter arrangement the other electrode, e.g. the cathode electrode, may take the form of a needle centred in the passage to extend longitudinally of the direction of particle flow and having a point or tip as its acting portion disposed in spaced relationship to said acting portion of the other electrode.

A needle type electrode, whether used in combination with the last mentioned arrangement or otherwise, may be hollow and the or a portion of the second gas stream, or possibly a third independently regulated gas stream, may be fed therethrough.

It is also preferred that the first gas stream is, at least in part, directed along the passage in the immediate vicinity of and so that it sweeps along or across the acting portion of at least one said electrode before or in a region of the passage where said stream entrains the particle flow, thus contributing to prevention of particle build-up on said portion. The latter stream may be directed along the passage in the downstream direction through an annular or other nozzle constituting the first supply formation so as to induce inflow of gas borne particles from said source.

One practical embodiment of the invention is now more particularly described with reference to the accompanying drawings wherein:-

Figure 1 is a longitudinal section of a powder coating gun
and

Figure 2 is a longitudinal section of a median region of the gun shown in Figure 1 in greater detail.

The coating gun shown in the drawings is of the electrogasdynamic type for use in applying coating material as a dry powder onto an article. Commencing at the upstream end the gun is in three main sections which can be dismantled by unscrewing, an inlet tube 10, a sleeve 11 at the median region, and a barrel 12 whose bore diverges toward the outlet end, the latter carrying an adjustable diffuser 13.

The median region shown in greater detail in Figure 2 has a number of components retained in axial relationship within sleeve 11 but which can be disassembled for cleaning or maintenance. These components define a through passage between the exit from tube 10 and the entry to barrel 12 and, starting at the upstream end, comprise a metal needle mounting block 14 carrying a cathode electrode in the form of a needle 15 projecting downstream along the central axis. Through passages 16 in block 14 lead to a central passage 17 defined by a rear cone member 18 in screw engagement with sleeve 11. The outer periphery of member 18 is shaped as to its rear portion as a cone converging to merge with a reduced diameter cylindrical front portion 19.

A front cone member 20 has a radial rear face carrying a sealing washer 21 locating against

an interior flange 22 of sleeve 11 and a central bore positioned co-axially of front portion 19 to define an annular nozzle 23 extending forwardly from a first air chamber 24 defined within sleeve 11 and between the coned face of member 18 and the rear face of member 20.

Cone member 20 also has a radially outer forwardly extending coned periphery converging in the downstream direction and whose forward or downstream end abuts an anode electrode ring 25. A spacer 26 is screw engaged with sleeve 11 to abut the front face of ring 25 and is in turn located against the rear end of barrel 12. Components 20, 25 and 26 have co-axial through bores of uniform diameter to match and align with the rear end of the bore of barrel 12 so that flow through them is subjected to minimum turbulence.

Ring 25 is, in this example formed from fine grain sintered bronze, i.e. it is porous and a major portion of its rear face is exposed to a second air chamber 27 defined at the front of the coned part of member 20 within sleeve 11.

All the components referred to above other than the two electrodes 15, 25 and needle mounting block 14 are formed from electrically insulating material, typically a plastics material.

The central passage 17 of member 18 is constricted to define a narrow annular opening around the stem of needle 15 diverging at both ends, the tip of needle 15 lying just within the downstream

mouth of said passage and axially spaced slightly upstream of the rear face of electrode ring 25.

A single air inlet 30 in the side wall of sleeve 11 communicates with the first air chamber 24 and is operatively connected to a source of pressurized air through a first control valve 31 (Figure 1).

A pair of diametrically opposed second air inlets 32 (and only shown in Figure 2) in the wall of sleeve 11 communicate with the second air chamber 27 and these are connected through branch pipes to a common second air control valve 33. The same source of pressurized air connected, e.g. by a flexible hose, may serve both valves 31 and 33.

Inlet tube 10 of the gun is connected, e.g. by a further flexible duct to a source of the powder material and the electrodes 15 and 25 are connected to an electrical power circuit of known kind indicated diagrammatically at 40 operable to apply an electrical potential at high voltage across the electrodes for charging the particles passing through the gun in known manner.

In use pressurized air is admitted to first chamber 24 to exit into the through passage by way of the annular nozzle 23. As the annular flow exits from nozzle 23 it sweeps over the exposed face of electrode ring 25 and at the same time induces an inflow of air and entrained powder particles along passage 17 and past the tip of needle 15. By reason of the constriction

of passage 17 the velocity of flow in the region of the needle will be substantial and this assists in keeping the needle tip free of powder build-up which would otherwise degrade or prevent the effective charging. The flow exiting from nozzle 23 also helps to prevent build-up on the operative face of ring 25.

More importantly the latter build-up is substantially reduced or prevented during continued operation of the gun by the admission of pressurized air to the second chamber 27 from which it is forced through the porous ring material to exit into the through passage from its operative face. This latter air flow tends to free any adherent particles from said face so that they can be swept away by the other air flow, has a cooling effect on said face which again prevents or discourages particles from melting onto it, and contributes to the through flow along the central passage. It will be noted that said air can pass into the rear face of ring 25 at a short axial distance from its central opening, thus it does not have to percolate through the full radial extent of the ring but can reach the operative face quickly, particularly toward the upstream end of the ring through opening.

The air pressure applied in chamber 27 can be regulated by means of valve 33 entirely independently of the pressure applied in the first chamber for inducing powder flow, thus control of the latter pressure can be varied e.g. to control the quantity of powder being picked up and the total air velocity through the gun, without adversely affecting the purging of ring 25. It has been

found in practice that substantial improvements in gun performance are achieved with little or no powder build-up on the electrodes if the air pressure applied in chamber 27 is some three times that applied in the first chamber 24.

Use of a plurality of inlets, for example the diametrally opposed inlet 32, to the second air chamber is preferred as ensuring even distribution of the high pressure electrode purging air around the ring 25.

Alternative arrangements for providing the particle inducing or maintaining air flow along the central passage could be employed, i.e. other forms of nozzle or venturi arrangement and/or possibly supply of the air powder mixture under pressure into the inlet tube 10 e.g. from a fluidised bed arrangement, rather than induced flow as described above. In some applications the air and powder mixture might be induced into an annular nozzle such as 23 by injecting the air flow along a central passage such as 17.

Air purging of a needle or other type of central electrode could be provided either in combination with the above arrangements or independently e.g. by using a hollow needle having connection to the second air chamber 27 or, possibly, to a third air or other purging gas stream which could either be controlled in common with the air supply to the second chamber 27 from valve 33 or be entirely independently controlled by a third regulating valve or other form of regulating device.

The threaded engagement of components 18 and 26 with sleeve 11, in combination with the screw engagement of tube 10 and barrel 12, locates all the components securely in precise working alignment and ensures that the first and second air chambers 24, 27 are sealed from each other while permitting the gun to be readily dismantled for cleaning or maintenance (though the effective purging of the electrodes ensures that need for dismantling is infrequent in service).

CLAIMS

1. A coating apparatus including non-electrically conductive structure (10,11,12) defining a through passage leading from a rearward upstream inlet for receiving a flow of particles of coating material from a source in use to a downstream forward outlet from which said particles are operatively discharged towards an article to be coated; first and second electrodes (25,15) within said passage across which an electrical potential is operatively applied whereby said electrodes act as anode and cathode for charging the particles in said flow; and a first supply formation (30) communicating with the passage for operatively feeding a first pressurized gas stream thereinto induce or assist said particle flow; characterized by a second supply formation (32) connected to apply a second pressurized gas stream to an acting portion of at least the first electrode (25) to oppose build-up of particles thereon; and means (31,33) for selectively varying the output of pressurized gas fed from at least one of said supply formations in use independently of the output operatively fed from the other of said formations.

2. Apparatus as in Claim 1 characterised in that the first electrode (25) is an anode and the second electrode (15) is a cathode.

3. Apparatus as in Claim 1 or 2 characterised in that the first electrode (25) has a through opening forming part of said through passage and through which the particle flow passes.

4. Apparatus as in any preceding claim characterised in that at least the acting portion of the first

electrode (25) is formed from a porous material from which the second gas stream passes in use.

5. Apparatus as in Claim 4 characterised in that the first electrode (25) is a ring formed substantially from porous material, the second supply formation defines in part an annular chamber (27) surrounding the through passage and in which the second gas stream is received, and said chamber is further defined by a major portion of one radial face of the ring into which said stream passes in use to exit from the acting portion thereof.

6. Apparatus as in Claim 5 characterised in that the second gas stream is fed into said chamber (27) through a plurality of inlets around the chamber.

7. Apparatus as in any preceding claim characterised by means for feeding pressurized gas to an acting portion of the second electrode (15).

8. Apparatus as in Claim 7 characterised in that said second electrode (15) is a hollow needle positioned within the through passage to extend longitudinally of the direction of particle flow and having a point or tip as its acting portion disposed in spaced relationship to the acting portion of the first electrode (25), said pressurized gas being operatively fed through the hollow needle.

9. Apparatus as in Claim 7 or 8 characterised in that said feeding means associated with the second electrode (15) is a connection to the second supply formation (32) whereby the second pressurized gas stream is applied to the acting portions of both electrodes (25,15).

10. Apparatus as in Claim 7 or 8 characterised in that said feeding means associated with the second electrode (15) comprises a third supply formation connected to apply a third pressurized gas stream to an acting portion of said electrode (15).

11. Apparatus as in any preceding claim characterised in that the first supply formation (30) is arranged to direct the first gas stream along the passage in the immediate vicinity of and so that it sweeps along or across the acting portion of at least one electrode (15,25) before or in a region of said passage in which said stream operatively entrains the particle flow.

12. Apparatus as in Claim 11 characterised in that the first supply formation includes a nozzle (23) within the passage operatively directing the first gas stream along the passage in the downstream direction and acting to induce the flow of particles from a remote source in use.

13. Apparatus as in Claim 12 characterised in that said nozzle (23) is annular and in surrounding relationship to an upstream portion of the through passage, the flow of particles being operatively induced along the latter.

14. Apparatus as in any preceding claim characterised in that the operative pressure of the second gas stream is substantially three times that of the first gas stream.

15. Apparatus as in any preceding claim characterised in that the through passage is constricted in the region of the electrodes.

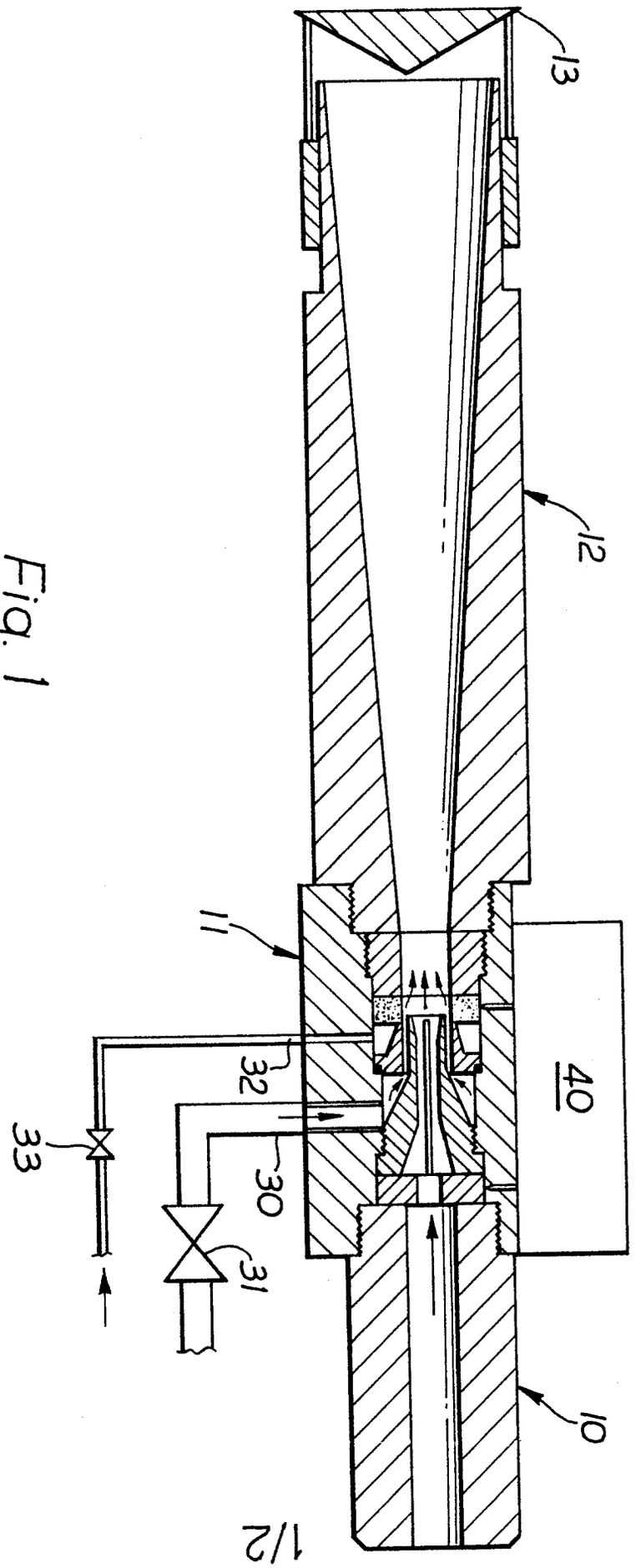

Fig. 1

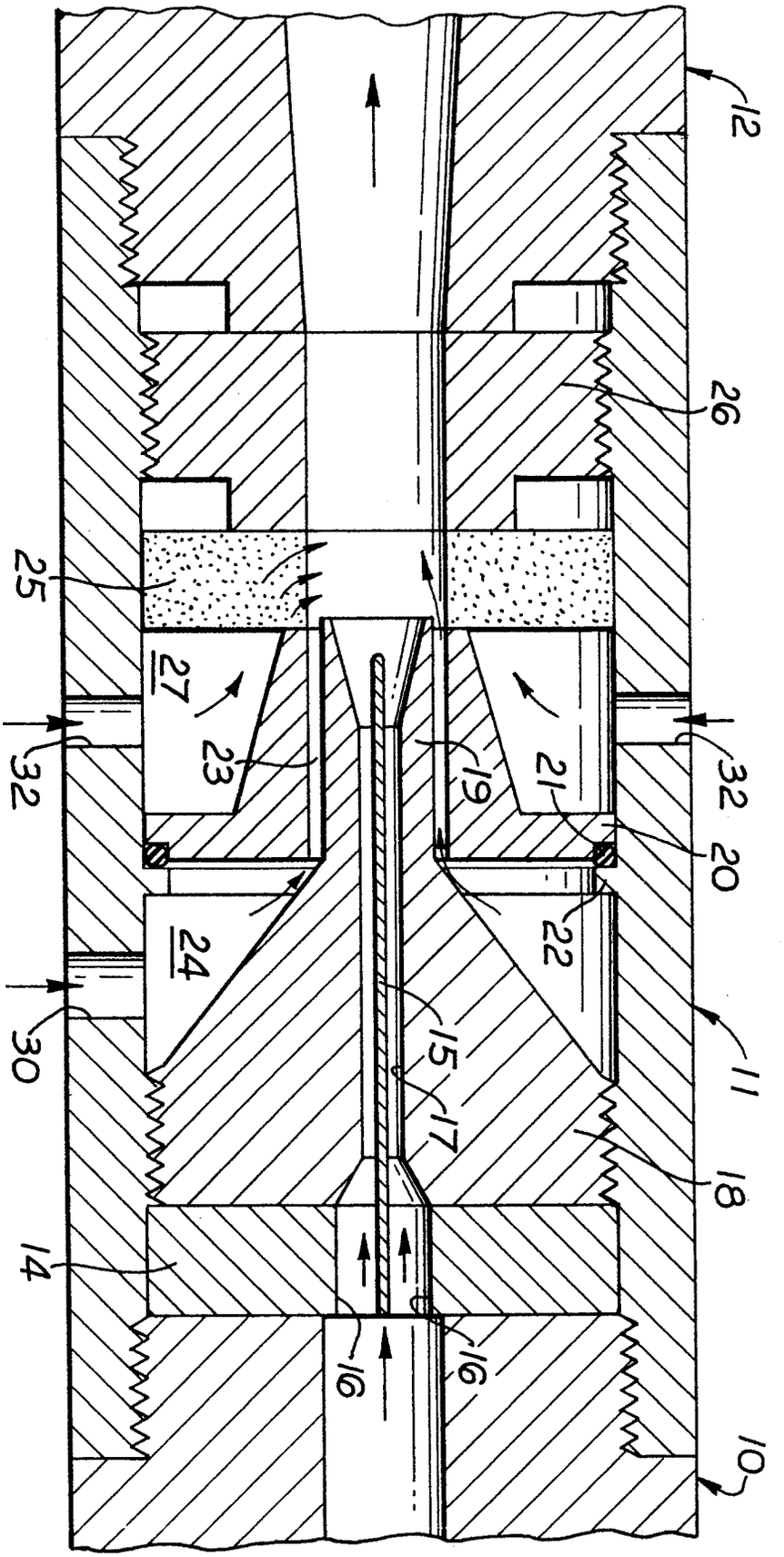

Fig. 2