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Early Thermal Spray Application—*JTST* Historical Patent #13

United States Patent Office
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APPARATUS FOR PROJECTING MOLTEN PULVERIZED BODIES
1,998,217. Patented 16 April 1935. Application 25 Feb 1933. Serial No. 658,531. In France 21 June 1932.

This invention relates to a process of and apparatus for projecting at high speed molten and pulverized bodies on articles to which is to be applied a coating layer.

The processes and apparatus generally heretofore employed use metals in the form of ribbons or filaments and suffer from the drawback that on the one hand the metal is melted slowly and non-uniformly and that on the other hand there are projected relatively voluminous particles of irregular form admixed with air bubbles. But if the metal is previously reduced to the form of an impalpable powder, not only is fusion effected more easily and rapidly, but it is also more regular and gives extremely fine deposits.

The process according to the invention, consists in first bringing the bodies to be projected into a state of very fine division by any suitable treatment, suitable for the body in question and then in bringing these bodies into suspension in a current of compressed air with a continuous whirling movement, without suction, to a blow pipe or pistol for effecting fusion and projection.

In consequence, the fusion of the bodies in an atomized sate is effected rapidly, regularly and easily, so that it is practicable to project hard metals of high fusion points, such as copper, bronze, nickel, iron, steel, tungsten, etc., on any surfaces to be metallized, as well as other non-metallic bodies which are fusible with difficulty, such as silica and quartz for example, to obtain vitreous coatings. It is thus possible to produce enamels of suitable consistency and color by making powdered silica or powdered quartz and metallic powders or powders of suitably chosen metallic oxides.

In order that the pulverization may be regular and effected without oxidation, reducing substances may be incorporated in the metallic powders.

On the other hand, during projection of the atomized materials their penetration into the articles to be coated, if more or less permeable such as fabrics, hides and wood, may be facilitated by setting up at the face opposite that to be coated with the pulverized material a powerful attractive force, for example, by means of an electro-magnet when metal is being projected, or by means of a suction fan.

With the adoption of the process there may be obtained coating of hard metals of variable thickness which are very dense and adherent and of extremely fine grain by utilizing metallic powders or mixtures of metallic powders. Vitreous coatings and enamelled coatings may be produced on any surfaces to render them non-combustible and able to resist attack by corrosive substances and oxidation; particularly the enamelling gives varied decorative effects.

As the coatings obtained are constituted by particles of great fineness, these coatings may be applied not only to solid rigid bodies but also to yielding bodies, and even to deformable bodies such as elastic bodies, plastic bodies and soft bodies. There may be thus obtained a wide range of new industrial products among which may be mentioned apparatus, instruments and articles for medical and surgical use.

The improved apparatus for performance of the process comprises three main parts, namely a powder reservoir, a tube for effecting suspension of the powder in air and for leading it to the blow pipe, and a pistol used for projection.

The blow pipe is fed by three tubes supplying acetylene, oxygen and compressed air, or other combustible and combustion-supporting media. These tubes are fitted with cocks which are separately controlled for obtaining, depending on the powders used, flames of different temperatures, but in case of need they may be also adapted to be closed simultaneously. The propulsion and control of the supply of powder are ensured by the compressed air coming from the powder receptacle the delivery from which latter is controllable.

Fig. 1 is an axial section of the powder reservoir.

Fig. 2 is a plan of the lower half of this reservoir.

Fig. 3 represents partly in section a modified form of one of the internal fitments of the reservoir.

Fig. 4 is a view in longitudinal axial section of the device for conducting the powder to the blow pipe burner.

Figs. 5, 6 and 7 are perspective views of different constructions of helicoidal vanes for imparting a whirling movement to the air stream.

Fig. 8 is a view of the burner seen from the rear.

Fig. 9 is a side elevation of the pistol with means for cooling the stream.

Fig. 10 is a perspective view showing separately the cooling device.

Referring to Fig. 1, it will be seen that the powder reservoir is constituted by a receptacle formed in two parts **1** and **2** interconnected at **3,** for example, by interengaging screw threads, of which the lower part **2** receives the reserve of powder introduced by the funnel **4** adapted to be closed by the stopper **5.**

At the moment of use the powder is put in suspension in a current of air introduced into the receptacle **2** by the conduit **6** connected to a source of supply of compressed air which is not shown and which may be heated by a suitable device also not shown. This compressed air, the delivery of which is controlled by means of the cock, **7,** enters the tubular column **8** and passes

*This series of historical patents concerned with thermal spray technology has been compiled by C.C. Berndt (SUNY at Stony Brook, NY) and K.A. Kowalsky (Flame-Spray Industries, Inc., NY).

along the lateral branches **9** which terminate in nozzles **10** and which also present small orifices in the form of nipples **11;** these branches **9** are of substantially helicoidal form so that the jets of compressed air which escape from the orifices **10, 11** are given a turbulent movement in the reservoir **2** and thereby are caused to entrain the powder in a state of suspension.

The air charged with powder enters the upper part **1** of the reservoir where it meets the dispersing cone **12** in the form of an inverted dish or funnel which brakes and steadies the current of powder-laden air which latter then escapes by way of the orifices **13** in the tube **14** that supports the disperser **12** and terminates exteriorly of the reservoir in a nipple **15** connectible by a rubber tube, for example, to the pistol or gun used for projecting the powder.

To permit control of the position of the disperser **12** fixed to the lower end of the tube **14,** the said tube, which is threaded at **16** is screwed into a cover **17** which in turn is screwed on to the receptacle **1.** The tube **14** is adjusted to suitable position causing it to penetrate the cover **17** more or less and is fixed in position by means of the nut **18** provided with wings **18.**

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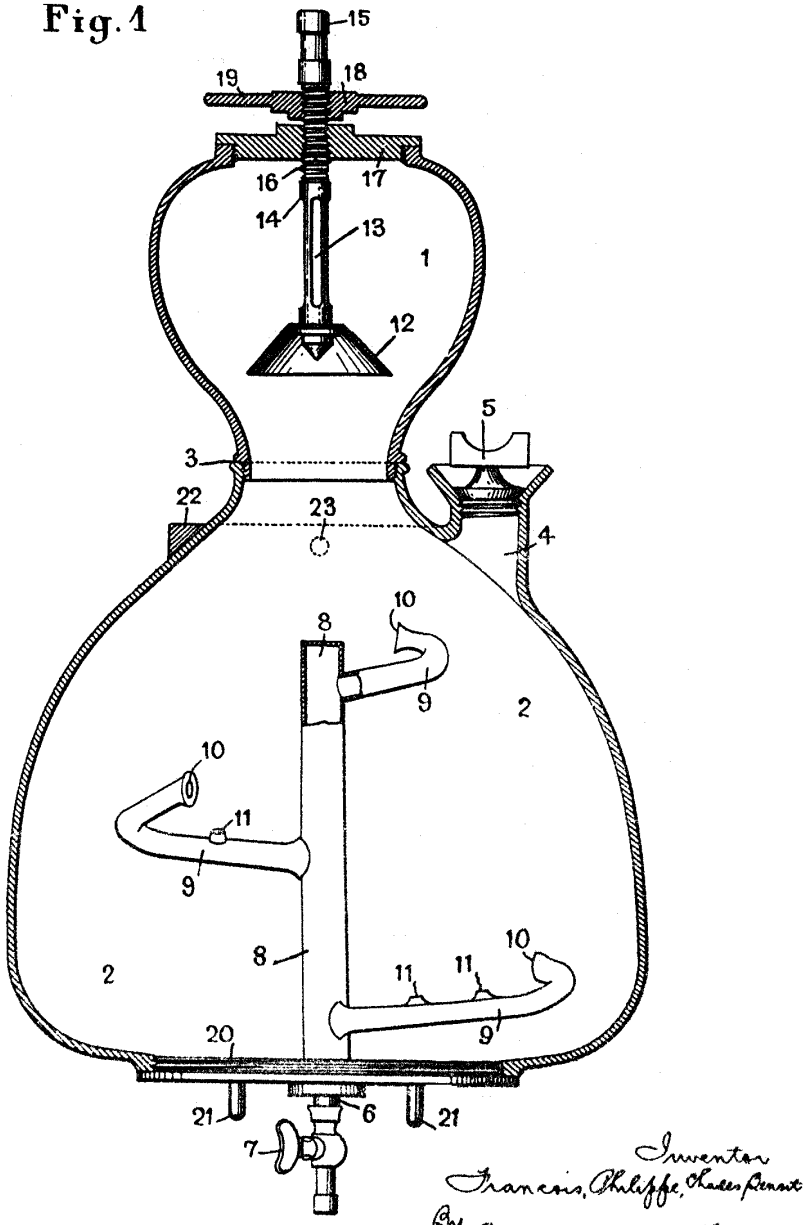
Fig. 1



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The base **20** of the lower receptacle **2** which is represented separately in plan in Fig. 2 is screwed on to the receptacle and carries the tube **8** with the cock **7;** it is adjusted by means of the pegs **21,** it being understood that these details may be varied.

The powder reservoir is provided with a collar **22** provided with pivots or gimbals **23** so that it may be hung vertically, for example, by means of a device of the Cardan type, it is also provided with means not shown of any known type for im-

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Fig. 2

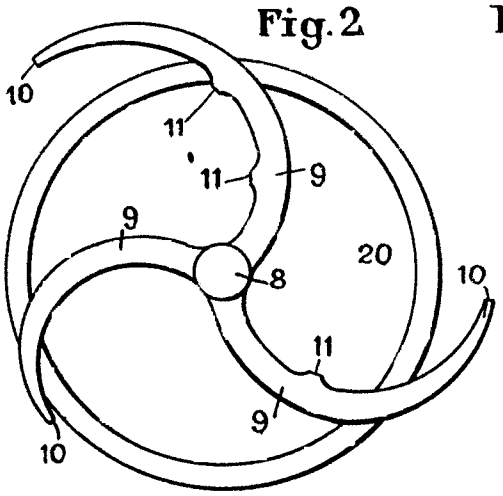


Fig. 3

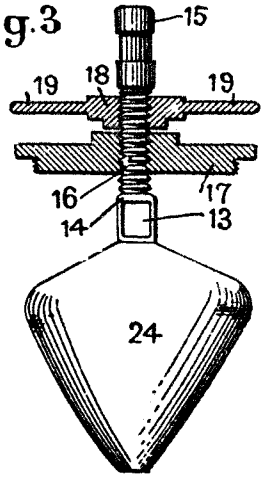


Fig. 4

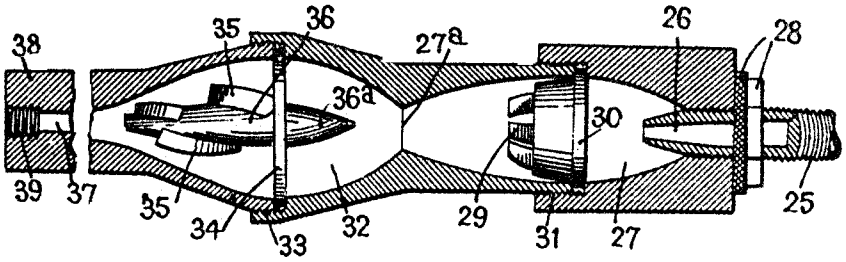


Fig. 5

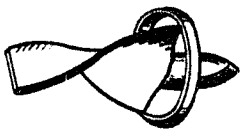


Fig. 6

Fig. 7

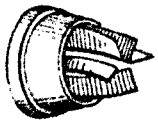
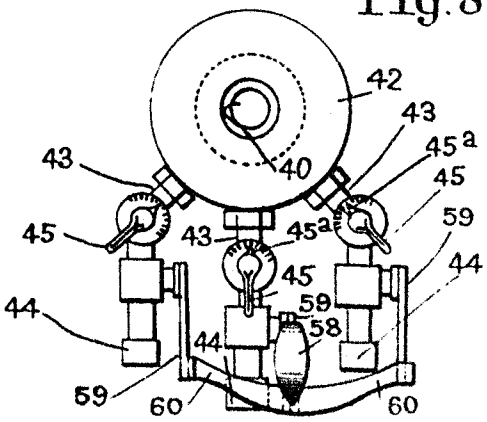


Fig. 8



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parting vibrations thereto in order to facilitate dissemination of the powder.

Fig. 3 shows a modified construction of the disperser. The tube **14** with the orifices **13** and the cover **17** are similar to the corresponding elements of the first described construction, but the disperser proper indicated at **12** is replaced by a body of revolution **24** presenting substantially the form of two truncated cones united at their bases by a toroid. The profile of this disperser may be varied depending, for example, on the nature of the powder used.

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Fig. 9

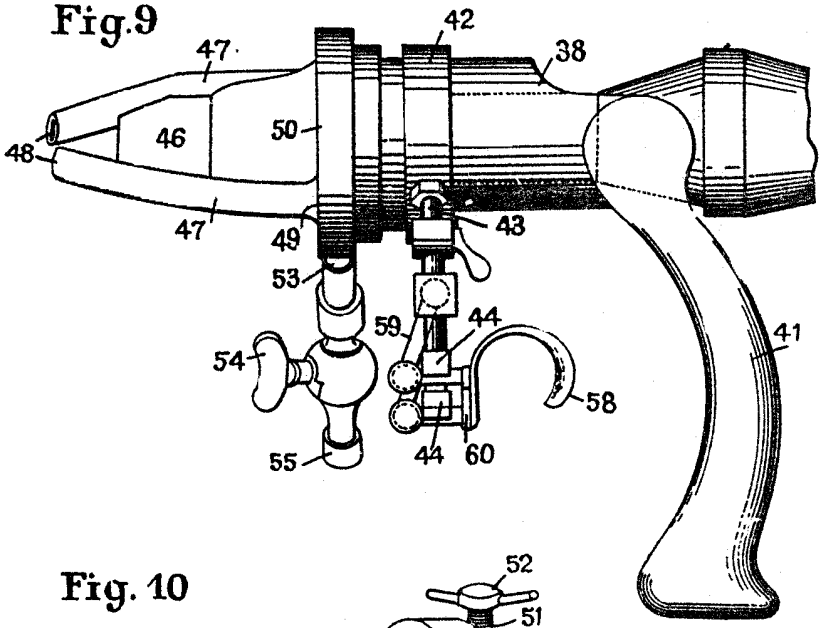
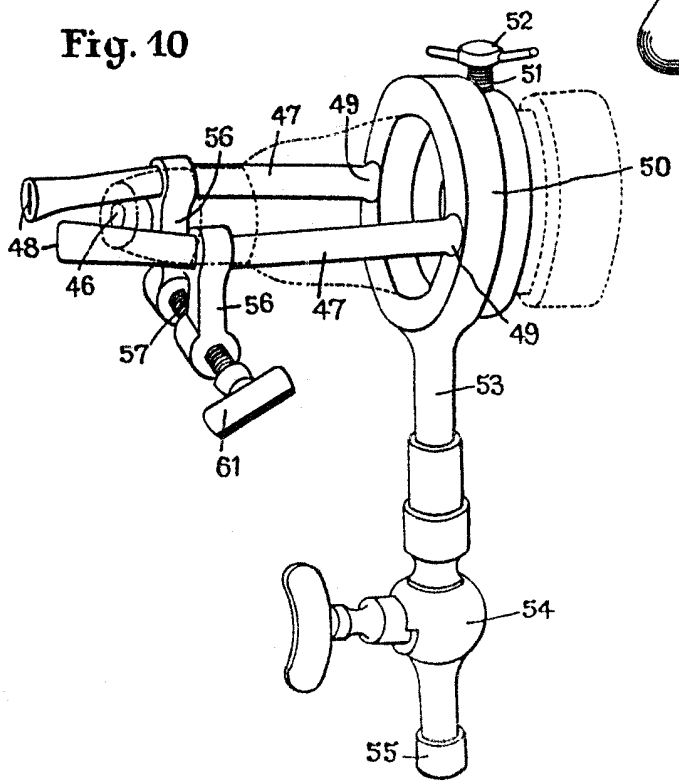


Fig. 10



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As already stated, the powder reservoir is connected by a rubber tube not shown to a device adapted to ensure whirling movement, such device being represented in longitudinal section in Fig. 4. The rubber tube is fixed to a nipple at the free extremity of the tube **25** which is shown hatched in Fig. 4. This tube **25** which terminates in a cone **26** opens into a first chamber **27** of ovoid internal profile. In order to be able to regulate the extent of its penetration into this chamber the tube **25** is screw-threaded and engages the correspondingly threaded wall of the chamber, being fixed in position by jam nuts **28.**

In the chamber **27** is arranged a first series of helicoidal vanes **29** which are fixed to a ring **30** and which give to the air a gyratory or whirling movement. To hold the ring **30** in place so that it may be exchanged when desired, the chamber **27** is formed in two parts screwed one on to the other at **31** and nipping the ring **30** between them.

A constriction **27***a* separates the chamber **27** from the second similar chamber **32** also formed in two parts which are screwed on to one another at **32** and which nip between them a ring **34** carrying helicoidal vanes **35;** these vanes are welded to a boss **36** of stream-line form of which the ogival head **36***a* is presented to the air stream so as to direct it towards the peripheral wall while avoiding the formation of eddies.

These devices for producing a whirling movement of the air stream may be modified to suit the nature of the powder used. By way of example certain modified constructions are shown in Figs. 4, 5, 6 and 7. They comprise generally helicoidal vanes fixed to a ring either directly or through the medium of a truncated conical ferrule; they are arranged to be interchangeable and may be mounted selectively in one or other of the chambers **27** and **32.**

When leaving the chamber **32** the air current flows through a passage **37** bored axially in a cylindrical tube **38** which is fixed by a screw thread **39** on to the part **40** solid with the handgrip or butt **41** of the pistol burner (Figs. 8 and 9).

The blow pipe burner consists of a circular box **42** to the under side of which are fixed three separate tubes **43** serving respectively for the passage of compressed air, oxygen and acetylene in the case of an oxy-acetylene burner and supplied through rubber tubes fixed to the connections **44.** Each of these tubes **43** is provided with its own regulating cock, while an additional operating device is provided for effecting the simultaneous closing or opening of the three cocks by means of the index finger of the hand holding the burner. Passages formed in the body of the box **42,** preferably concentric with one another, lead the gas to the tip of the burner **46;** further, a passage in the burner forming a prolongation of the passage **37** leads to the nose of the burner the compressed air which entrains the powder in suspension.

The three regulating cocks **45** are fitted with pointers **45***a* each moving over a dial.

Simultaneous closure of the cocks is effected by three arms **59** articulated to a common bridgepiece **60** solid with a trigger **58** which may be operated by the index finger of the hand which holds the handle **41.**

In Fig. 9 there is indicated a cooling device which is represented separately in perspective in Fig. 10 and which has for its object to permit the fusion of pulverized metals or other bodies requiring a very hot flame and their projection on to articles very sensitive to heat such as paper, fabrics, skins, leather, plastic materials and moulded materials.

This cooling device is composed of two lateral tubes **47** each flattened to form a nozzle at its free extremity **48** and welded or otherwise fixed at **49** to a collar **50** incorporated in the rear part of the burner. This collar **50** may be fixed to the burner by a screw **51** with a finger-operated head **52** (Fig. 10) or by any other equivalent device.

Compressed air enters by way of the conduit **53** fixed to the collar **50** in which the latter are pierced channels which establish communication between the supply tube **53** and the tubes **47.** Regulation of the quantity of air is effected by a cock **54.** A connection **55** permits the device to be connected to a source of supply of compressed air.

It is advantageous to be able to vary the position of the nozzles **48** relatively to the head of the blow pipe or to be able to vary the spacing of the nozzle **48.** With this object the tubes may have a certain elasticity either on account of the nature of the constituent metal or by reason of their form or their mode of attachment to the collar **50,** while means is provided for moving them towards or away from one another.

By way of example, Fig. 10 shows the nozzles **48** as being solid with arms **56** having internally threaded orifices engaged by a turn-buckle member **57** having screw threads of opposite hand at its two ends and adapted to be turned by means of a finger-piece **61.** This device permits the projection of a jet of cold compressed air parallel to the jet of metallic vapours, thus conserving for the jet all its metallizing power without altering even the most delicate substances.

What I claim is:

1. Apparatus for use in projecting in a molten atomized state hard bodies fusible with difficulty, comprising, in combination with a blow-pipe burner, connections for supply of combustible and combustion-supporting media to said burner, a reservoir comprising interconnected upper and lower receptacles, said lower receptacle serving as a container for powder, means for introducing a regulatable quantity of compressed air into said lower receptacle, means for setting up a whirling current of air in said lower receptacle to bring the powder therein to a state of suspension, a disperser in the upper receptacle, and a connection between said upper receptacle and said burner for leading to said burner a stream of air carrying powder in suspension.

2. Apparatus as claimed in claim 1 in which the means for setting up a whirling current of air within the lower receptacle comprises an air supply pipe with helicoidal branches terminating within said lower receptacle.

3. Apparatus as claimed in claim 1 in which there is interposed in the connection between the upper receptacle and the burner a succession of ovoid chambers containing sets of helicoidal vanes.

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