

L. P. JENSEN ET AL.
APPARATUS FOR COATING ARTICLES WITH
REFRACTORY OXIDES AND THE LIKE

2 Sheets-Sheet 1

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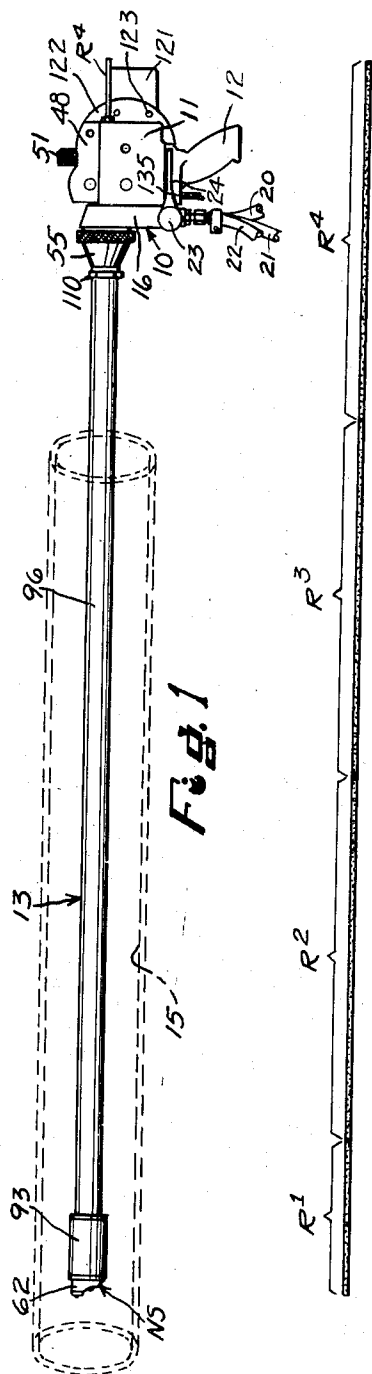
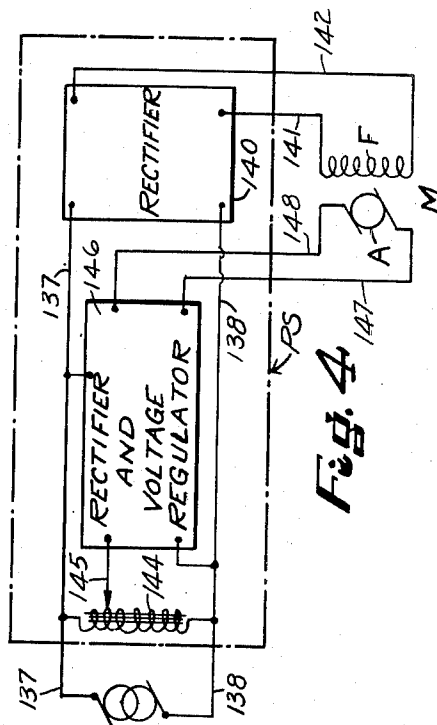
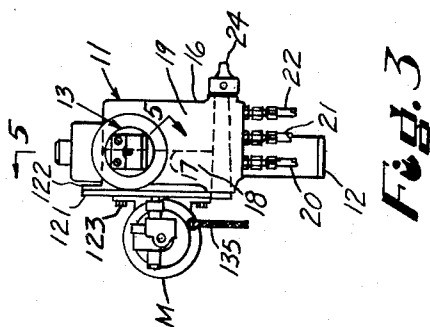


Fig. 2



4. 4



File 3

LOUIS PETER INVENTORS.
WILLIAM MAXWELL JENSEN
BY WHEILDON JR.

William T. Kneiser
ATTORNEY

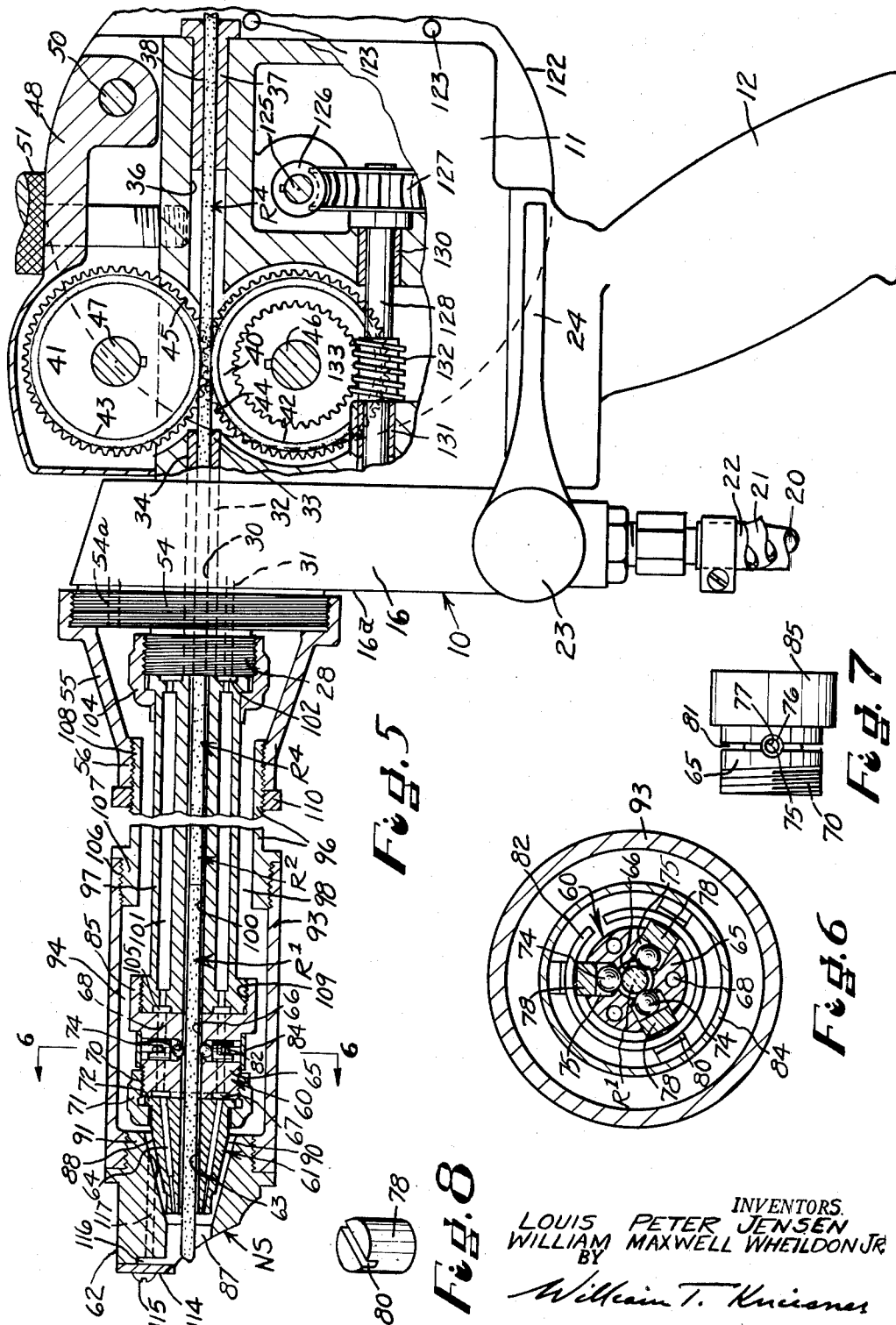
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2 Sheets-Sheet 2



INVENTORS.
LOUIS PETER JENSEN
WILLIAM MAXWELL WHEILDON JR.
BY
William T. Kniesner
ATTORNEY

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APPARATUS FOR COATING ARTICLES WITH REFRACTORY OXIDES AND THE LIKE

Louis Peter Jensen, Worcester, and William Maxwell Wheildon, Jr., Framingham Center, Mass., assignors to Norton Company, Worcester, Mass., a corporation of Massachusetts

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14 Claims. (Cl. 299—28.8)

This invention relates to the coating of metals and other materials, such as graphite, with oxide such as alumina, and more particularly to apparatus for fusing coating oxides and for applying such fused oxide to metal or other parts to coat them.

One of the objects of this invention is to provide a dependable and efficient apparatus for high-temperature fusing and atomizing, in reliable continuity, coating oxides and the like which, for effecting dependable coating, have to be provided in especially fabricated rod forms which are inflexible and breakable so that they cannot be reeled or coiled and have to be made up in relatively short lengths. Another object is to provide a practical and easily controlled apparatus for effectively and in controllable continuity bringing such rod-like oxide forms into coaction with a high-temperature flame for fusion and an air blast for directing fused particles onto the surface to be coated, in a manner to utilize, to full advantage, the structural characteristics provided in the refractory oxide rod structures; more particularly, it is another object to provide for efficient consumption of the oxide rod forms, to reduce wastage thereof, and to facilitate long-continued coating production free from frequent or detrimental interruptions for replenishment of oxide coating material.

Another object is to provide an apparatus of the above-mentioned character with ease and convenience of control of its operating characteristics so as to facilitate manual manipulation of the apparatus by the operator according to the requirements and conditions, including peculiarities of configuration, met with in the part to be coated. Another object is to provide an apparatus of the above-mentioned character constructed for ease and dependability of handling or manipulating by the operator, adapted for facility of rearrangement according to various or varying requirements met with in practices.

Another object is to provide an improved apparatus for effecting conversion of high melting point rod-like forms of oxides into strong, long lasting, and virtually integral coatings on metal parts, graphite parts, and others. Another object is to provide such apparatus that is durable against the abrasion-like surface characteristics of such rods as the latter are singly or in succession fed to the high-temperature flame and applying air blast. Other objects are to provide dependable feed of such rods to the flame; to provide an apparatus dependably adapted to handle oxide rods of different thicknesses or diameters; to provide for maximum utilization for fusion and coating-application of the trailing end of the oxide rod; to protect rod-controlling means closely adjacent to the flame-producing end of the apparatus, against detrimental temperature effects thereon and against detrimental wear; to make practicable the utilization of short lengths of such oxide rods, even broken-off pieces thereof and to provide for the practical and reliable supply, in succession, of such lengths or pieces of oxide rods for efficient consumption thereof by fusion and coating-application, free from time-consuming or otherwise detrimental interruptions.

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Other objects will be in part obvious or in part pointed out hereinafter.

In the accompanying drawings, in which is shown an illustrative embodiment of the invention and in which similar reference characters refer to similar parts throughout the several views,

Figure 1 is a small-scale side elevation of our apparatus for fusing and spraying refractory oxides and the like, the view showing diagrammatically, in broken lines, a long or deep article with the apparatus related thereto for coating it interiorly;

Figure 2 is an elevation, on the same scale as that of Figure 1, showing a number of refractory or like oxide rods in the relationship they bear in the apparatus of Figure 1;

Figure 3 is an end elevation as seen from the left in Figure 1;

Figure 4 is a simplified electrical diagram illustrating a preferred drive and speed control for certain parts of the apparatus;

Figure 5 is a large-scale side elevation of the apparatus, certain parts being broken away to shorten the view, the right-hand part being shown substantially in central vertical section and the left-hand part being shown in section as seen on the line 5—5 of Figure 3;

Figure 6 is a transverse vertical sectional view, on a larger scale, as seen along the line 6—6 of Figure 5, showing details of a gripper device and certain parts coacting therewith;

Figure 7 is a detached plan view, as seen from above in Figure 5, of a combined gripper-element carrier and coupling, and

Figure 8 is a detached enlarged perspective view of slide part of the gripper device shown in Figures 5 and 6.

Referring first to Figure 1, we have there shown, in simplified side elevation and approximately to scale, an illustrative form of our apparatus for fusing and spraying, for example onto the surfaces of metal, graphite, or other substances, a wear-resistant, heat-resistant material, such as a refractory oxide of which alumina is a good illustration, to form thereon a coating that is lastingly joined to the surface, becoming virtually integral therewith. Alumina fuses at about 2,000° C.; zirconia, which fuses at about 2,700° C., is another example and others are mentioned later.

Parts fabricated of metal, graphite, or other materials, when provided with such a coating, can be given many valuable attributes and thereby many practical advantages can be gained. For example, the coating gives the part protection against oxidation and other chemical reaction; it is electrically non-conductive and provides an insulating coating; it is highly resistant to wear; being refractory, it is also heat-resistant. There are many uses for parts so coated. Also, dependability and durability, as in gas turbines, jet engines, and rocket nozzles and chambers, where parts are subjected to high-temperature gases or hot flame or other bad effects of combustion, can be materially increased. For a full discussion of coating articles with oxide reference may be made to U. S. Patent No. 2,707,691, patented May 3, 1955, on application of the applicant Wheildon of this case which was copending herewith.

An oxyacetylene flame, though an oxyhydrogen or other high-temperature producing flame may be employed, serves as a suitably concentrated heat source, adjacent an applying air blast, and to the flame is fed the high-fusion-point refractory oxide in the form of a straight solid rod that comprises fine particles of the oxide rigidly massed or bonded together by sintering, the rod being hard, rigid, and unbendable without breaking, whereby, as it endwise enters the hot flame, its end portion is raised in temperature to fuse it and the sintered-together particles

thereof, making the heated or fused particles releasable with a time delay so that, as the fusing end portion of the rod enters the air blast, the latter, due to its velocity, picks or sweeps these releasable fused particles or other minute portions of the fused oxide off of the rod end, in effect atomizing the molten oxide and projecting its minute molten particles onto the metal or graphite or other substance to be coated. In this manner, as we now understand the just-described process, the sintered-together oxide particles are in effect not released or releasable from their sinter-bonded mass or condition until they are molten; accordingly the process assures that the air blast operates to remove from the heated end of the rod only molten oxide particles or molten small agglomerates thereof to impinge them at substantial velocity and in molten condition against the surface being coated or, as in building up the thickness of a coating, against already deposited coating material. Premature release of oxide particles, that is, of particles in still solid or non-plastic or unmolten condition, which would be detrimental if not fatal to coating formation, is thus, as we understand the process, substantially precluded from taking place. The nozzle structure for effecting such fusion and atomizing of the oxide is held between one and two inches from the surface being coated so that the molten particles impinge upon the surface and become integrally united with the metal, graphite, or other substance of the part being coated and, as such molten particles are superimposed upon each other to build up the coating to the desired thickness, they too become joined and virtually fused together. The part to be coated does not have to be preheated, yet the coating is tenaciously bonded to the base member without the use of a separate bonding agent; moreover the coating is dense and homogeneous, and will not craze, crack, spall or peel. The coating itself is integral in that the individual particles thereof are self-bonded together and produce a coating that is of itself a rigid structure independent of the backing or base member.

As above indicated, the coating material has been made up, out of small particles, in the form of rods, by sintering these small particles together under high temperatures. They are of uniform composition and of round cross-section, of a diameter on the order of $\frac{1}{8}$ of an inch though, so far as our invention is concerned, the rods may be of any other uniform cross-section, such as square, triangular, hexagonal and the like, and by the word "rod" we intend to include such and other usable shapes.

Using finely divided oxide material such as alumina or zirconia and providing a temporary binder, small diameter rods can be molded under pressure and thereafter heated or fired to a temperature to sinter the particles together while at the same time burning out the temporary binder. Strong refractory rods of pure oxide material can thus be produced, substantially free from organic matter and water or other volatile constituents. The sintering or firing operation is carried out at temperatures of at least a dark red heat, and usually temperatures of 1000° C. or more are employed.

These oxide rods are made up in lengths that are suitable for efficient manufacture thereof and may be supplied for use in oxyacetylene-airblast apparatus in usually relatively short lengths, say, about $1\frac{1}{2}$ or 2 feet long, convenient for shipment, storage and handling, for they cannot be reeled up and, while strong, are breakable and more easily so the greater their length. Because of such factors, an optimum length of oxide rod is desirable and the just-mentioned $1\frac{1}{2}$ or 2-foot length is given as an illustration. Then again a full-length rod may become broken and desirably the resultant lengths should also be usable.

For flexibility and wide adaptability of use, our apparatus, indicated as a whole by the reference character 10 in Figures 1 and 5, is preferably constructed to be manually handled by the operator, like a so-called hand power-tool, so that the operator can conveniently and freely

move the device as a whole to bring and direct the spraying action as needed; at its right-hand end the apparatus comprises a compact casting shaped and machined to form a casing or housing 11 provided, as at its underside, with a handle or handgrip 12 and having extending from its front end (the left-hand end in Figures 1 and 5) a tube-like barrel structure, generally indicated by the reference character 13, and comprising preferably a number of successively and detachably coupled parts, later described, of which the endmost part is a nozzle structure NS for the emission of the mixture of combustible gases and for the emission of the air blast as well as for coaxially relating thereto the end of an oxide rod of the kind above described. The tube-like barrel structure 13 is of composite construction and, for various reasons, is preferably of substantial length and, moreover, it is so constructed that, according to certain conditions met with in practice, its over-all length may be changed. To illustrate, it may have a length on the order of 4 feet as, for example, may be necessary for coating the interior surface of a long tube or vessel of relatively small cross-section, as indicated in broken lines in Figure 1 at 15; for shorter or longer interior reaches of surfaces to be coated, an intermediate portion of the tubular barrel structure 13 is readily replaceable by a shorter or longer portion, as will be later described. The inner or casing end of the structure 13 can serve as a convenient hand-grip, as by the left hand of the operator, and with his right hand grasping the handle 12, the operator can effect steady manual guiding control of the changing relationship of the nozzle end of the apparatus with respect to the part being coated.

At the front end (the left hand end in Figures 1 and 5) of the casing 11 there is provided or formed integrally with a wall of the casing an air and gas receiver-distributor 16 which is interiorly divided, as indicated by the broken line 17 in Figure 3, into an air chamber 18 and a gas-mixing chamber 19, the former being supplied with air under pressure through a hose line 20 and mixing chamber being supplied with acetylene and oxygen, each under suitable pressure, through the respective hoses 21 and 22. Associated with the hose lines 20, 21 and 22 are suitable adjustable pressure regulating valves (not shown) and pressure gauges (not shown). The hose lines are connected by suitable couplings provided in the bottom walls of the receiver 16 so that the hose lines are in depending relation from the apparatus and thus interfere least with the manipulation thereof; built into the bottom wall of the receiver 16 is a suitable manually controlled valve mechanism, of the cock-valve type, indicated at 23, so that the operator, as by suitable lever mechanism 24, can handily control the supply of acetylene and oxygen to the mixing chamber 19 and the supply of air to the air chamber 18. Insofar as details of these structural elements are concerned, they may be of any suitable known types of construction or arrangement such as for example those heretofore used or known in oxyacetylene manually operated devices.

As in such known constructions, the front wall 16^a of receiver-distributor 16 is provided with an externally threaded male coupling part 28 (Figure 5) that projects forwardly (to the left in Figure 5); it may be solid excepting for a central coaxial round passage 30, large enough to freely receive therethrough the oxide rods above mentioned, and excepting for a suitable number of gas passages 31 which lead to the mixing chamber 19. The central rod passage 30 extends through the receiver-distributor 16, in a tube 32 having a tube mouth 33, the tube 32 extending through a bore 34 that is drilled through a solid part of the receiver-distributor 16. The tube mouth 33 is chamfered to allow of easy entrance of a rod without sticking.

The bore 34 is aligned with a suitably formed round channel 36 (Figure 5) that opens at the rear wall of casing 11 so that a rod can be inserted from the outside of the casing 11; if desired the open end of round chan-

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nel 36 can receive an adapter or tube 37 provided with a coaxial round channel 38 diametered to suit the diameter of rods to be used in the apparatus and thus coaxially align the adapter rod passage 38 with the rod passage 30 that extends through the receiver-distributor 16 and through the coupling member 28. The adapter 37 has an external head to limit its entry into the channel 36 and to provide, as by suitable chamfering, an external mouth end for channel 38 so that the operator can with facility insert one rod after another as the oxide rods are used up.

Adjacent the tube mouth 33 (Figure 5) we provide two coating feed drums or wheels 40 and 41, one above the other and having their adjacent portions projecting, through suitable cutouts in the metal of casing 11, into the large channel 36; these feed drums 40, 41 have relatively narrow peripheral cylindrical faces which are rubber-tired as at 42 and 43 for cushion-like driving engagement with the refractory rod that is entered therebetween. At their sides more remote from the observer viewing Figure 5, the feed drums 40, 41 are provided with meshing gears 44 and 45 respectively so that one drum is driven from the other and the two are driven in opposite directions, as indicated by the arrows, to feed the rod therebetween forwardly, that is, to the left in Figure 5.

Drum and gear 40, 44 are secured to a shaft 46 which has bearings (not shown) in the casing structure 11; shaft 46 is driven through reduction gearing and in a preferred manner later described.

Feed drum 41 and gear 45 are secured to a shaft 47 that is provided with bearings, as in known constructions, provided in a movable part 48 of the casing structure 11; casing part 48 is movable in directions to shift the upper feed drum 41 toward or away from the lower feed drum 40 and for such purpose it may be pivoted on a stud shaft 50 which is suitably carried by the casing structure 11 and for adjustably setting the upper feed drum 41 there may be provided a thumb screw 51 which passes through the top wall of casing part 48 and is threaded, as shown, into a threaded hole of the casing structure 11.

Concentric with the threaded coupling part 28 is another threaded male coupling part 54 (Figure 5); it surrounds the base portion of coupling part 28 and has one or more passages 54a that lead into the air chamber 18 of the part 16. Onto the large coupling part 54 is threaded a short tapered sleeve 55 which terminates in an internally threaded coupling part 56 and accordingly coupling part 56, coupling part 28 and the rod passage or channel 30 are coaxial and, in coaction with coupling part 28 and coupling part 56, sealed mechanical connections may be made with other parts later described for extending to the remotely located nozzle structure NS (see Figure 1) a tube passage for containing a succession of oxide rods, tube passages for oxyacetylene mixture from mixing chamber 19 (Figure 3) and air under pressure from the air chamber 18, all within the tube-like barrel structure 13 of Figure 1. To reach from the casing passage 36 and feed drums 40-41 (Figure 5) in the casing 11 to the nozzle structure NS (Figure 1), a plurality of refractory or oxide rods, arranged in end-to-end succession, are necessary and to better illustrate this practical condition we have shown, in Figure 2, an illustrative succession of such rods, Figure 2 being purposely aligned with the apparatus of Figure 1 to show, on the same scale (though the thickness of the rods is somewhat exaggerated), an illustrative inter-relationship of several oxide rods. Thus, there is an endmost rod R¹ which is relatively short, illustrating a rod of which the nozzle structure NS has already fused and deposited a substantial portion, then several full-length rods R², R³, R⁴, of which rod R⁴, which projects from the rear wall of the casing 11 (Figure 1), is in between the rubber-tired feed wheels 40-41 as is shown in Figure 5, rod R⁴ being therefore the "pusher" rod of the entire succession of

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rods while the foremost rod R¹, also shown in Figure 5, is advanced through the intermediate rods R², R³ into the nozzle structure NS. To better understand these and other coating features, it will be helpful to describe first the nozzle structure NS.

Accordingly, turning now to Figure 5, the nozzle structure NS for coating with such a succession of rods comprises several coating components which, for flexibility of rearrangement as earlier above mentioned, are preferably detachably inter-related coaxially, and which preferably are closely compacted radially. These components comprise, in the order from right to left in Figure 5 which is the order in which they are encountered by the foremost rod of a succession, a rod gripper and load-applying device generally indicated by the reference character 60, a gas nozzle 61 which provides jet passages for combustible gas mixture, and an air nozzle 62 which coacts with the gas nozzle 61 to form certain coating air-emission channels.

The gas nozzle 61 is externally frusto-conical and has a coaxial round passage 63 for the rod; it has jet-like passages 64, illustratively three in number and spaced 120° apart, that extend from its large end face through its smaller end face and it is externally of the latter face where combustion of the oxyacetylene takes place as it emerges from these jet passages 64, the latter being distributed about the rod passage 63 and the rod end projecting therefrom. The rod gripper device 60 comprises a cylindrically shaped block 65 that has a coaxial rod passage 66 therethrough and a left-hand end face abutting against the larger end face of gas nozzle 61, this left-hand end face being provided with a coaxial ring-shaped recess 67 into which the gas jet passages 64 open for supply of gas mixture to the latter regardless of relative rotational positions of the nozzle 61 and rod gripper 60; the ring-shaped recess 67 is connected to the right-hand end face by a suitable number of passages 68, illustratively three in number and spaced 120° apart (see Figure 6). Passages 68 thus form supply channels for flow of gas mixture to nozzle 61 and they are preferably uniformly distributed in the block 65 for better abstraction of heat from the block 65 of the gripper device 60 and thus to aid in protecting the gripper device against detrimental heating derived from the gas combustion nozzle 61.

The left end portion of the gripper device block 65 (see also Figure 7) is externally threaded as at 70 for receiving thereon the internally threaded part of a coupling flange 71 which is slipped on to the frusto-conical nozzle 61 to take against an end peripheral flange 72 of the latter, whereby to tightly and coaxially secure the gripper device 60 and gas nozzle 61 together in the abutting end-face relationship above described. Thereby also the two round rod passages 66 and 63 become aligned.

At about its mid-section as viewed in Figure 5, the metal block 65 of gripper device 60 is provided with an arrangement for gripping or holding a rod, with appropriate force, against axial movement of the rod, thus also "loading" the rod in the sense of requiring more power to move the rod axially. Preferably this arrangement comprises a suitable number of spring-pressed rod-engaging elements which are preferably appropriately distributed about the rod channel 66 in relation to the particular shape of cross-section of the rod in order also to substantially center the rod relative to the rod passage 66. For round rods, as in the portrayed illustration, we employ three such elements equiangularly spaced about the axis of rod passage 66.

As above noted, the refractory oxide rods are hard; they can also have, because of the nature of many of these oxides such as alumina, particularly crystalline alumina, abrasive characteristics. Desirably therefore we employ gripper elements that are hard, such as hardened steel, and preferably also arrange them so they can partake of rotational movement in response to axial movement of the rod. Conveniently they can be in the form

of hardened steel balls 74 (see Figures 6 and 5), arranged to be spring-pressed radially inwardly of rod channel 66, being spaced about the axis of the latter at 120° intervals where the oxide rods are round in cross-section or, for example, hexagonal.

A preferred and illustrative mounting and assembly of the balls 74 comprises the provision, for each, of a round cross-sectioned radially extending recess 75 (Figure 6) which can be formed, as by drilling or milling toward the axis of the metal block 65 (see also Figure 7) and halting the tool materially short of complete entry into the rod channel 66 so as to form a ring-shaped ledge 76 surrounding a hole 77 that is of lesser diameter than the drill and somewhat smaller in diameter than the diameter of the balls 74 as is better indicated in Figure 6. The ball 74 can therefore project materially into the rod channel 66 by a distance approximating the ball radius.

Slidably received in each recess 75 and bearing against ball 74 therein is a short plunger 78 (see Figure 8) which, at its outer end, has a diametrically extending slot 80 of a width slightly greater than the width of a peripherally extending groove 81 (Figures 7 and 6) turned or otherwise formed in the cylindrical block body 65 of the gripping device 60; this peripheral groove 81 intersects the radial recesses 75 along their diameters and, with the diametric slots 80 of the plungers 78 aligned with groove 81, a split spring ring 82 (Figure 6) is sprung into the groove 81 and the aligned slots 80, thus not only holding the balls and plungers assembled but also yieldingly pressing them radially inward and, in the absence of a rod in the rod channel 66, normally seating the balls 74 against their respective ring-shaped ledges 76. The balls 74 thus form in effect a variable throat in the rod passage 66, the throat being narrowest in the position of the balls just described. In Figure 6 the balls 74 are shown in an intermediate radial position, pressing radially inward upon the rod R¹ which, illustratively, is of a diameter of 1/4 of an inch, the split spring ring 82 being shown in a correspondingly intermediate stressed condition. The peripheral groove 81 and the open ends of the radial recesses 75 are closed off by a metal band 84 which is press-fitted in position and against a shoulder on the body 65 formed by an integral flange 85 which is internally threaded (Figure 5) to form a female coupling part for purposes later described.

The air nozzle 62 (Figure 5) has a main discharge passage 87 generally circular in transverse cross-section and coaxially aligned with the gas nozzle 61, substantially as shown in Figure 5, having an internal frusto-conical surface 88 which is spaced from and is coaxial with the frusto-conical portion of the gas nozzle 61 to form air passage 90 therebetween. The air nozzle 62, at its right-hand end, is externally threaded to form a male coupling part 91 and to it is connected one end of a tube 93 that extends about and over the rod gripping device 60, forming therebetween an annular air passage 94 so that, when air is admitted thereto from the air chamber 18 to supply air to the nozzle air passage 90, the substantial external and generally cylindrical areas of the gripper device 60 are swept by the air moving in the annular channel 94, thus keeping the gripper device and its parts from becoming overheated even though the gripper device is in heat-conductive relation to the gas nozzle 61.

The nozzle structure NS is connected to the receiver-distributor 16 at the front of the casing structure 11 by coaxially inter-related parts of such length as to position the nozzle structure NS at the desired distance from the casing 11 according to the reach needed to effect oxide coating at remote or otherwise inaccessible regions as is diagrammatically illustrated in Figure 1 with respect to the hollow device 15 to be interiorly coated. One of these coaxial parts is in the form of an external tube 96, shown in full in the small-scale view of Figure 1 and shown broken away in the large-scale sectional view of Figure 5, and in the latter view is also shown the

internal coaxial member 97 which has an external cylindrical surface of lesser diameter than that of the tube 96 so as to form between the two an annular passage 98 or channel of substantial capacity and serving for the transmission of air under pressure.

In assembly, of the two coaxial parts 96 and 97, it is internal part 97 that is first put into position, so it will be described first. As above noted it is round in cross-section; along its axis it is provided with a round bore that forms a rod channel 100 which forms an extension of rod channel 30 in the coupling part 28 and which, at its left-hand end, is to be aligned with the rod channel 66 in the gripper device 60. Spaced radially from rod channel 100 and extending lengthwise throughout member 97 is a suitable number of gas passages 101, illustratively three in number and equi-distantly and equi-angularly spaced about the axis of member 97.

At the right end of member 97, these gas passages open into a ring-shaped recess 102 formed in the plane end face of member 97 and adapted to overlie the gas passages 31 through the coupling part 28; the right end of member 97 is flanged as at 103 by which, through the flanged internally threaded coupling ring 104, the right end of member 97 is tightly secured against the companion end face of coupling part 28 and in coaxial relation so that rod channels 30 and 100 are neatly aligned. Thereby also gas mixture from mixing chamber 19 can flow through the gas passages 31 to the ring-shaped recess 102 from which it is distributed to the gas passages 101.

At the left end face of internal member 97, which has a length commensurate with the length of the external tube member 96, the gas passages 101 terminate in a ring-shaped recess 105 adapted to overlie the gas passages 68 which terminate in the right end face of rod gripper 60, these companion end faces being brought into tight relation by the threaded interconnection of female coupling flange 85 of the rod gripper 60 with the externally threaded coupling flange 109 provided at the left end of member 97. Thereby also the rod channels 100 and 66 are neatly aligned coaxially. And with gas nozzle 61 in threaded connection with the left end of rod gripper 60, as above described, the several sections or component lengths of round rod channels form a dependable straight-line rod guideway; they become coaxially aligned and their straight-line continuity throughout the entire length of the apparatus, that is, from the entry channel 38 in the back wall of casing 11 to the exit end of rod channel 63 in the gas nozzle 61, becomes completed for the reception of the above-described succession of rods such as rods R¹, R², R³ and R⁴ of Figure 2. At the same time the gas passages in the several axially aligned component parts become inter-connected and their continuity is completed for the flow of gas from the mixing chamber 19 to the discharge jet passages 64 of the gas nozzle 61.

Air nozzle 62 has detachably threaded to it, as above described, the short tube member 93 which is to extend over the rod gripper 60 and provide the annular air-cooling passage 94, and they may now, for completing the assembly, be treated as a sub-unit which as such is connected to the left end of the long outer tube 96; for this purpose tube 93 is internally threaded as at 106 to receive the externally threaded and shouldered coupling end 107 of the long intermediate tube 96; the right-hand end of long tube 96 is externally threaded as at 108 and is connected with the internally threaded part 56 of the coupling sleeve 55. This last threaded connection, which is preferably locked by a lock nut 110, locates the long tube member 96 coaxially with the internal part 97, and thus the long annular air passage 98, above-described, is formed therebetween and air nozzle 62 becomes coaxially positioned relative to the gas nozzle 61 and the respective frusto-conical surfaces of the latter two parts are fixed in coaxial and radially spaced relation to form the air passage 90 therebetween. Accordingly air flow may take place from the air chamber 18, through the passages 56

and into the coupling sleeve 55, and thence along the annular passages 98 and 94 to the nozzle passage 90.

To initially load the apparatus with a succession of oxide rods, the operator releases the movable casing part 48 (Figure 5) to move the upper feed drum 41 away from the lower feed drum; the operator then, without obstruction from the feed drums, inserts one oxide rod after another, through the mouthed entry opening in adapter 37 at the rear of the casing 11, each successively inserted rod pushing those ahead of it toward the left in Figures 1 and 5 to fill up the long centrally located rod passage or channel. In so doing, he is not bothered by losing inserted rods out of the distant nozzle end of the apparatus, for closely adjacent to the gas nozzle 61 is the rod gripper device 60 with the balls 74 projecting into or constricting the continuous rod passage and they block the inserted rods from sliding or falling out. In this operation, the last-inserted rod, such as rod R⁴ of Figures 1 and 2, can project rearwardly from the apparatus so long as a forward portion of it is in position to be acted upon by the feed drums 40, 41.

The operator may, by pushing the last-inserted rod, advance the entire succession of rods so that the end of the foremost one passes through the yieldingly expandible throat formed by the balls 74 in order to bring its end to the end of rod channel 63 in the gas nozzle 61 or he may leave that short distance of advancing movement to the rod-driving action of the feed drums. In either case he restores the movable feed drum 41, suitably setting the thumb screw 51 so that the rubber-cushioned drums 40, 41 press against the rod therebetween, from opposite sides thereof, and, because of the yieldability of the rubber, the two feed drums not only avoid detrimentally straining the refractory rod but also obtain substantial areas of contact with the hard surface of the rod in order, upon rotation of the drums, to apply to the rod a steady and substantially non-slipping driving force. In either case, even though the spring pressure applied to the balls 74 is relatively substantial, a rod end, because of the curvatures presented to it by the balls, in effect wedges or cams them radially apart to enlarge the throat and to bring them, as the rod progresses, into engagement with its outside cylindrical surface, as in Figure 6, the balls making contact in virtually points of tangency and thereafter acting to virtually center the rod in the rod passage 63 of the gas nozzle 61.

Upon drive of the feed drums 40, 41 at suitable surface speed, the pusher rod R⁴ (Figures 1 and 2) is fed to the left and the entire succession of rods R¹, R², R³, R⁴ advances, the leading end of the foremost oxide rod R¹ being progressed into the region of high-temperature combustion of the oxyacetylene mixture emitted from the jets of the gas nozzle 61 and coating therewith is air emitted from the coaxially arranged air nozzle passage 90, achieving high-temperature fusion of oxide particles which are released, as fused particles or agglomerates of fused particles, for substantial high-velocity projection thereof onto the metal or other surface to be coated, in the manner of the process earlier above described. Illustratively, 1/8" alumina rods may be fed at the rate of 1.18 inches per minute with the oxygen supply at 15 to 20 pounds, the acetylene at 15 to 20 pounds, and the air at 60 pounds per square inch. Illustratively, for 1/8" zirconia rods the feeding rate may be about 1.5 inches per minute, the oxygen can be at 15 to 20 pounds, the acetylene at 15 to 20 pounds, and the air at 40 pounds per square inch. In the structure depicted in Figure 5, the picking-off of molten oxide particles from the fusing rod end may be said to be effected primarily by the emitted air blast and such action may be enhanced by the action of a deflector 114 (Figure 5) in the form of a small plate attached, as by screws 115, across the upper half of the front end of air nozzle 62, the plate 114 overhanging a cutout 116 in the vertical face of which terminate several air passages 117, illustratively one on each side of the central vertical

plane of the structure, and leading, as shown, to the air passage 90, so that air emitted from passages 117 is deflected in generally downward and transverse directions, by deflector plate 114, to coact with the larger volume of moving air and gases of combustion, thus conjointly operating upon the fusing end of the oxide rod. In a generic sense however the pick-off of molten oxide particles or molten agglomerates thereof, and the projection thereof onto the surface to be coated, is effected by movement of a gas or gaseous medium. This is so where the medium is air. Also, in some cases the combustible gas, such as the acetylene, and the combustion-supporting gas, such as the oxygen, can have enough pressure to serve as such a medium; in a sense this applies to the illustrative example given above because the air blast assists in supporting combustion for it provides oxygen additional to that supplied through the hose line 22.

As above noted, sinter-bonded alumina and zirconia rods are given as examples; other oxides, preferably suitable refractory metal oxides, are usable in making up the rods and for effecting coatings as above described. By way of illustration of other materials of which to make the rods, but not by way of limitation thereto, we may mention such as barium oxide, beryllium oxide, calcium oxide, iron oxide, manganese oxide, nickel oxide, strontium oxide, thorium oxide, titanium oxide, and uranium oxide; also spinels of which a well-known type is magnesium-aluminum spinel; and others. Also mixtures of such substances may be used in making up the refractory rods for use in our apparatus. In general, for coating objects with spinel or other oxides, the air and acetylene pressures can be the same though, for a given cross-section of refractory rod, rate of feed has to be appropriately suited, and for materials fusing below 2000° C. an air pressure of about 60 pounds is preferred whereas for materials fusing above 2000° C. the air pressure should be a little lower. These factors are easily ascertainable in various ways, usually by trial tests and making appropriate adjustments of the respective air and gas pressures, and of rate of feed of the refractory rod. It will now be apparent that, in part also because of the nature of the process described above, it is desirable, for any given refractory or oxide rod composition, to maintain rate of feed against detrimental variation. In coaction with certain features already above-described, we make reliable provision for achieving desired constancy of any selected rate of rod feed.

The rod gripper device 60, with its illustrative three ball elements 74, grips the endmost rod R¹ as near its fusing end as possible, in effect applying a mechanical load which the power source driving the feed drums 40, 41 has to overcome to advance the entire succession of rods R¹, R², etc., and they do so, in centering the rod in the rod passage 66, with the advantage of avoiding abrasive action by the moving rod upon the walls of the passage 66. Moreover they are self-accommodating to possible irregularities or variations in rod contour and in that respect they might cause some variations in the load that they impose upon the feed-drive mechanism; also such an effect might be caused when the more or less butt-ended junction between two successive rods reaches and enters the throat formed by the balls. Preferably we employ an electric motor of adjustable constant speed for driving the feed drums 40, 41, through suitable reduction gearing, and preferably adapted, for any selected speed, to be inconsequentially affected as to speed by such variations in load as just noted. The electric motor is preferably a D. C. shunt motor; it is diagrammatically shown at M in Figure 4 and may take any suitable compact form, as shown in Figure 3, for ease of attachment to, and at a side of, the casing structure 11, as by providing it with an attaching flange 121 (Figure 3) to rest against a suitable external face plate 122 of the casing 11, to which it is attached as by screws 123 (Figures 3 and 5). With such mounting, the motor shaft, or a suitable extension thereof, shown at 125 in Figure 5, extends into

the casing structure 11 where it carries a worm 126 that meshes with a wormwheel 127 on a shaft 128 carried in spaced bearings 130 and 131 between which the shaft carries a worm 132 that meshes with a wormwheel 133 on the shaft of the lower feed drum 40. A flexible cable 135 (Figure 3) depends from the underside of the motor M, cable 135 having therein suitable conductors leading to the motor armature and to its shunt field, shown respectively at A and F in Figure 4, and, if desired, also control circuit conductors where it is desired to control, as from suitable manual switches or the like (not shown) mounted on the motor casing or on the casing structure 11, remotely located motor-speed setting devices.

Unidirectional current for energizing motor M is preferably derived from any usual alternating current power supply line, such as a 110-volt 60-cycle circuit diagrammatically indicated in Figure 4 at 137—138. Any suitable means, of which various types are known, may be employed to supply the shunt field F with direct current and to supply the armature A also with direct current but of selectable voltage, throughout a suitable voltage range, in order to set the motor speed at the desired value; such a power supply means is diagrammatically indicated by the broken line rectangle PS in Figure 4. For example, it may comprise a rectifier 140 which, through conductors 141 and 142, energizes the shunt field F at preferably a fixed voltage, and it may include an auto-transformer 144 provided with a shiftable control-tap 145, which may be remotely controlled, in order, through a suitable rectifier 146, to energize, via conductors 147 and 148, the armature A at any selected voltage corresponding to the motor speed desired. With such an arrangement, motor speed is substantially constant for any selected applied armature voltage. In this manner, a suitable surface speed for the feed drums 40—41 and feed speed for the succession of rods R^1 , R^2 , etc. may be selected according to the refractory employed in the rods as well as according to the cross-section of the rods, for, as the cross-section is increased, the feed rate should be diminished, other factors, including conditions of combustion for fusing the oxide, being equal. As lower feed speeds are used, armature current in motor M increases and the armature speed becomes more sensitive and more responsive, at any intended speed, to changes in load because corresponding armature current changes introduce detrimental voltage drops, as for example in the rectifier and in the transformer 144; accordingly the rectifier 146 may include any suitable means, of which various types are known, such as electronic tube circuits or arrangements of saturable reactors, for compensating for such voltage drops and in that way maintain applied armature voltage constant as well as the rate of feed of the succession of rods, particularly where the rods might impose, as by the rod gripper device 60, variations in load, for any selected or intended rate of feed. Several illustrations of possible load variation we have given above; also, it will be noted, that rate of feed of rods, that is, in terms of rate of lineal movement, may be relatively low, being on the order of 1.5" per minute for a $\frac{1}{8}$ " zirconia rod. Where there is uniformity of relative traverse between the surface being coated and the nozzle structure NS, these features contribute toward uniformity of coating deposition, and where the operator manually guides and traverses the apparatus as earlier above described, dependable constancy of rate of rod feed contributes toward avoiding bothersome interference with the operator's manipulation of the apparatus.

The rod gripper device 60, positioned as closely as possible to the exit end of the rod passage 63 of the gas nozzle 61, holds the endmost rod R^1 , whatever its length as its forward end is being used up in coating deposition, against being drawn or sucked out of the rod passage by the action of the discharging gas mixture, air blast, and gases of combustion, for the latter surround the protruding end of the rod and move in a general axial direction and thus impose an ejecting force or pull on the

rod. The rod gripper device exerts gripping force on the endmost rod not only sufficient for the just stated purpose but also to resist the additional force, in ejecting direction, which the weight of the rods behind rod R^1 impose upon the latter when the apparatus is tilted with its nozzle end downward as is oftentimes necessary in coating operations as in reaching the inside bottom surface of a deep vessel or container. The gripper device accordingly imposes, upon the motor driving the feed drums 40, 41, a more or less fixed magnitude of load over and above that which would otherwise be needed to feed a succession of rods, and this has the advantage of achieving better inherent speed regulation of the shunt driving motor M for armature-current changes due to operational variations in load are in effect measurable against the armature current corresponding to this more or less fixed load and are therefore proportionately of lesser detrimental IR drop effect.

Though in heat-conductive relation to the gas nozzle 61 or in other respects subject to heating because so closely positioned where the high-temperature combustion takes place, the gripper device and its several coacting elements are protected against detrimental heat effects by the heat-abstracting action of the gas mixture flowing through the uniformly distributed gas passages 63 (Figures 5 and 6) on its way to the nozzle passages 64 and by the heat-abstracting action of the rapidly moving air, of substantial volume, along the annular passage 94 on its way to the air nozzle passage 90. Thus, durability of spring action, as by the split wire spring 82, is maintainable and, where the rod-engaging elements such as the balls 74 and also their spring-pressed plungers 73 are made of hardened steel for good wear resistance, risk of drawing the temper of these parts and thus softening them can be lessened. Moreover, in the illustrative and preferred embodiment utilizing balls 74, the balls may partake of rotational shift as rod feed progresses, and wear thereof is minimized because their engagement with the feeding rod can be in effect a rolling engagement and in that way successively different points on the ball surfaces are brought into engagement with the moving rod and also with the spring-pressed plunger 73.

The compact nozzle structure NS, comprising gas nozzle 61 with its rod gripper device 60 axially compacted therewith and air nozzle 62 with its tube extension 93 which together envelope the gas nozzle and gripper device, are readily accommodated to the casing structure 11 and the motor-driven feed drums of the latter, with the nozzle structure NS positioned at any desired distance from the casing 11; according to the particular need met with in practice, parts 97 and 96 (Figure 5) of the desired length are selected and for that purpose sets of parts 97 and 96 of different lengths may be made up for selective substitution in the apparatus. Coaxial parts 97 and 96 together constitute the readily replaceable intermediate portion of the tubular barrel structure 13 (Figure 1) earlier mentioned above; as there stated by way of illustration, their length may be about 4 feet where a long reach of that order of magnitude, for coating application, has to be effected as is diagrammatically shown with respect to the member 15. These parts 97—96 are readily detachable by way of the various threaded coupling elements at their respective ends; accordingly, where a longer or a shorter reach has to be made, parts 97—96 are easily disassembled and replaced by a pair of internal and external parts exactly like them but of the desired greater or shorter length. The number of refractory rods R^1 , R^2 , etc., that constitute a succession of rods accommodated in the resultant continuous rod channel may therefore vary, yet dependable realization of coactions and advantages such as those above described is assured nevertheless. In like manner, nozzle structure NS may be brought closely adjacent to casing structure 11 and receiver-distributor part 16 by making or selecting intermediate members 97—96 of such short length that they are almost like short coupling elements,

resulting in an assemblage that would look like Figure 5 if the break at the center of the parts 97 and 96, in that figure, were disregarded. For many uses, apparatus of such short over-all length is desirable. The described mechanism always insures efficient utilization of oxide rods and of broken-off lengths of rods for the initially accommodated rod length, as it shortens from fusion at the nozzle end, is pushed on into the high-temperature flame by the succeeding rod. It will thus be seen that the construction we have provided is of wide adaptability to achieve many advantages under varying conditions of practical use.

The ready detachability or disassembly of the parts of the nozzle structure NS is also of advantage; for example, gas nozzles, like gas nozzle 61 of Figure 5, of different characteristics such as different sizes or angularities of gas jet passages may be substituted, being easily attachable, by coupling ring 71, to the left end of the rod gripper device 60. To effect such replacement, all that has to be done is to unscrew the air nozzle-tube unit 62-93 at the threaded coupling 106-107 to gain access to the coupling ring 71. Also where desired, air nozzles of different configuration or characteristics may be substituted for the illustrative air nozzle 62, at the threaded connection 91. Thus, gas nozzle or air nozzle may be readily changed or replaced, while always retaining the rod gripper device 60 in co-acting relation both as to its functioning as above described and as to cooling action thereon by air in the surrounding annular passage 94 and by gas mixture flowing in the gas ports or passages 68 through the main body of the gripper device itself.

It will thus be seen that there has been provided in this invention an apparatus in which the various objects hereinabove set forth together with many thoroughly practical advantages are successfully achieved. It will be seen that the apparatus is of dependable construction and of reliable and efficient action for the conversion of high melting point rod-like forms of refractory oxide and the like into dependable coatings of metal parts, graphite parts, and parts made of any other materials compatible with the reception thereon of such coatings. Moreover, the apparatus is of wide flexibility of assemblage and rearrangement of certain of its parts to the end that, without impairment of the coaction of its parts or of its many advantages, the apparatus be widely adaptable according to such requirements of the parts to be coated as size or configuration or relative location or accessibility of the surface area or areas thereof to be coated.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

We claim:

1. An apparatus for coating parts with refractory metal oxides and the like comprising a casing having therein a straight-line channel for entry therein endwise of relatively inflexible frangible oxide rods, said channel having coacting therewith opposed feed drums having operative faces of yielding material for receiving therebetween and feeding endwise an oxide rod in the channel, said apparatus having a nozzle structure positioned externally of the casing and spaced therefrom in line with said channel, said nozzle structure comprising a gas nozzle having a central rod passage at the entry end of which is a rod gripper device having a central rod passage with spring-pressed rod-engaging means projecting into the latter and forming a yieldable throat for yieldingly holding a rod therein against feeding movement, said gas nozzle having gas passages therethrough and said gripper device having gas passages therethrough and distributed in spaced relation about its rod passage, with air nozzle

means about said gas nozzle for discharge of air adjacent the exit end of the rod passage and gas passages in the gas nozzle, said air nozzle means having a tube-like air-supply part that extends in spaced relation about said rod gripper device for the flow of air in heat-abstracting relation to the latter, coaxial means connecting said nozzle structure to said casing and comprising an external tube member having therein an internal part forming an air passage therebetween, said internal part having a straight-line rod passage at its axis for receiving successively oxide rods fed thereto in end-to-end relation by said feed drums and having gas passage means extending lengthwise thereof to the gas passages in said rod gripper device, said tube member being connected to said tube-like part of said air nozzle means, a shunt motor for driving said feed drums at a selectable rod-feed rate, said shunt motor being provided with means for selectively setting the voltage applied to its armature, said rod gripping device imposing a substantially fixed load on the motor whereby the inherent speed regulation of the motor during feed of oxide rods is improved.

2. An apparatus for coating parts with refractory metal oxides and the like comprising a casing having therein a straight-line channel for entry therein endwise of relatively inflexible frangible oxide rods, said channel having coacting therewith opposed feed drums having operative faces of yielding material for receiving therebetween and feeding endwise an oxide rod in the channel, said apparatus having a nozzle structure positioned externally of the casing and spaced therefrom in line with said channel, said nozzle structure comprising gas nozzle means having a central rod passage adjacent the entry end of which is a spring-pressed rod-engaging means for yieldingly holding a rod against feeding movement, with air nozzle means about said gas nozzle means for discharge of air adjacent the exit end of the rod passage in the gas nozzle means, said air nozzle means having a tube-like air-supply part that extends in spaced relation about said rod holding means for the flow of air in heat-abstracting relation to the latter, coaxial means connecting said nozzle structure to said casing and comprising an external tube member having therein an internal part forming an air passage therebetween, said internal part having a straight-line rod passage at its axis for receiving successive oxide rods fed thereto in end-to-end relation by said feed drums and having gas passage means extending lengthwise thereof for supply of gas to said gas nozzle means, said tube member being connected to said tube-like part of said air nozzle means, a shunt motor for driving said feed drums at a selectable rod-feed rate, said shunt motor being provided with means for selectively setting the voltage applied to its armature, said rod holding means imposing a substantially fixed load on the motor armature whereby the inherent speed regulation of the motor for substantially constant rate of selected feed of oxide rods is improved.

3. An apparatus for coating parts with refractory metal oxides and the like comprising a casing having therein a straight-line channel for entry therein endwise of relatively inflexible frangible oxide rods, said channel having coacting therewith opposed feed drums having operative faces of yielding material for receiving therebetween and feeding endwise an oxide rod in the channel whereby as the trailing end of a rod emerges from in-between the feed drums it is then pushed by a succeeding rod engaged by the drums, an air discharge and gaseous combustion nozzle structure positioned externally of said casing and held in spaced relation therefrom by air-and-gas supply means having extending therethrough and in line with said channel a rod passage for passing a rod endwise to the action of said nozzle structure as the rod is fed directly by said feed drums or indirectly fed thereby through at least one succeeding rod engaging it at its trailing end face according as the trailing end thereof is approaching or has passed beyond said feed drums, and means coacting with said nozzle structure and operating

in proximity to the leading end portion of the rod for yieldingly holding it against feeding movement and thereby maintain its trailing end in engagement with a preceding rod pushing it, whereby also said yielding rod-holding means imposes per se a substantially fixed load upon said feed drums, and a shunt motor for driving said feed drums at a selectable rod-feed rate, said shunt motor being provided with means for correspondingly setting the voltage applied to its armature and thereby select the rate of drive of said feed drums whereby said substantially fixed load improves the inherent speed regulation of the motor for the selected speed of its armature.

4. An apparatus for coating parts with refractory metal oxides and the like comprising a casing having therein a straight-line channel for entry therein endwise of relatively inflexible frangible oxide rods, said channel having coating therewith opposed feed drums having operative faces of yielding material for receiving therebetween and feeding endwise an oxide rod in the channel, said apparatus having a nozzle structure positioned externally of the casing and spaced therefrom in line with said channel by air-and-gas supply means having extending therethrough a rod passage aligned with said channel for passing a rod endwise to the action of said nozzle structure as the rod is fed directly by said feed drums or indirectly fed thereby through at least one succeeding rod engaging it at its trailing end face according as the trailing end thereof is approaching or has passed beyond said feed drums, there being interposed at the exit end of said rod passage a rod gripper device having a central rod passage into which open a plurality of radial recesses with spring-pressed wear-resistant members projecting therefrom and into the rod passage of the device for substantially centering a rod therein and for yieldingly holding it against feeding movement and thereby maintain its trailing end in engagement with a preceding rod pushing it, and means for driving said feed drums at a substantially constant surface speed.

5. In an apparatus for coating parts with refractory metal oxides and the like, in combination, a casing having at one end concentrically arranged inner gas-supply and outer air-supply threaded coupling elements of which the inner has a central opening forming the terminus of a straight-line channel in the casing for successive entry therein of relatively inflexible frangible oxide rods, with driven rod-feed means engageable with a rod in said channel to feed it endwise or to push a rod ahead of it in direction toward said coupling element central opening, a nozzle structure positioned externally of said casing and spaced therefrom in line with said channel, said nozzle structure having gas-nozzle and rod-holding means comprising a rod passage through the terminus of which is presented a rod-end to flame produced at the nozzle means and coating yielding means closely adjacent said rod passage terminus for yieldingly engaging with a rod in said rod passage but with force insufficient to prevent feeding movement thereof and for yieldingly holding it against lengthwise shift after it has passed out of engagement with said feed means except as it is pushed at its trailing end by the action of said feed means upon a succeeding rod that is in engagement with said feed means, said nozzle structure having air-nozzle means for discharge of air adjacent the exit end of said rod passage, said gas-nozzle and rod-holding means and said air nozzle means having means respectively connecting them to said inner and outer coupling elements for gas supply to the gas nozzle and air supply to the air nozzle and to align said rod passage and rod-holding means with said central opening and with said channel for the successive end-to-end feed of rods thereto.

6. An apparatus as claimed in claim 5 in which said gas-nozzle and rod-holding means comprise two axially aligned coupled-together parts through which said rod passage extends and of which one part forms the gas nozzle and the other part carries said yielding rod-holding means.

7. An apparatus as claimed in claim 6 in which the means yieldingly bearing against the rod in the rod passage comprises a plurality of members projecting radially into said rod passage with spring means acting to yieldingly restrict radially the throat which they form.

8. An apparatus as claimed in claim 5 in which the means for yieldingly holding the rod against lengthwise shift along the rod passage comprises at least one rotatable element whereby it may partake of wear-reducing substantially rolling contact with the surface of the moving rod.

9. An apparatus as claimed in claim 5 in which said last-mentioned respective connecting means are relatively long for achieving a long reach for oxide coating application to a part remote from the casing and have a correspondingly long rod passage intermediate of said first mentioned rod passage and said central opening for accommodating therein a succession of oxide rods in end-to-end relation, said yielding rod-holding means holding the most remote rod against being moved by the remaining rods except as the driven feed means pushes the entire succession of rods, and said connecting means for the air-nozzle means and which supplies air to the latter comprises a tube-like outer element about said gas-nozzle and rod-holding means and providing passage means for heat-abstracting air flow relative to the latter.

10. An apparatus as claimed in claim 5 in which said last-mentioned respective connecting means are relatively short for oxide coating application to a part close at hand, said yielding rod-holding means holding the rod against movement upon its trailing end becoming disengaged from said driven feed means except as a new rod is engaged and fed by said feed means and pushes the disengaged rod onward, and said connecting means for the air-nozzle means and which supplies air to the latter comprises a tube-like outer element about said gas-nozzle and rod-holding means and providing passage means for heat-abstracting air flow relative to the latter.

11. An apparatus for coating parts with refractory metal oxides and the like comprising means forming a straight-line guideway having an entry end and an exit end for the successive entry therein of relatively inflexible frangible oxide rods, said guideway means having externally thereof and adjacent its exit end nozzle means for receiving gaseous medium to produce heat by combustion for fusing the material of a rod presented thereto by way of said exit end and to produce a blast to project fused particles from the rod end, said nozzle having a deflector to deflect said blast, said exit end of said guideway means having associated therewith yielding means for yieldingly engaging with the rod that is at the exit end of said guideway means and for holding it against lengthwise shift along said guideway means, the latter having associated with it adjacent its entry end driven feed means engageable with a rod thereat for transmitting endwise movement thereto to move it towards said exit end of the guideway means, said yielding rod-engaging means adjacent said exit end exerting a holding force on the rod that is insufficient to prevent feeding movement thereof directly by said feed means or indirectly by the latter through at least one succeeding rod in said guideway means, but sufficient to restrain rod ejecting thrust on the rod produced by the blast.

12. An apparatus as claimed in claim 11 in which said guideway means is of a length relative to the length of the rods to accommodate therein a succession of the latter in end-to-end relation, said yielding rod-holding means holding the rod at the exit end against being moved by the remaining rods except as the driven feed means pushes the entire succession of rods and thereby maintain continuity of end-to-end relation of rods in said guideway for feeding movement of the leading rod of the succession of rods.

13. In an apparatus for coating parts with refractory metal oxide and the like, in combination, a casing having therein a straight-line channel for entry therein endwise

of relatively inflexible oxide rods and having driving means for engaging and feeding endwise an oxide rod in the channel whereby as the trailing end of a rod disengages said feeding means it is then pushed by a succeeding rod engaged by said feeding means, a nozzle structure for receiving a gaseous medium to produce a flame for fusing the rod material and having a channel to convey air under pressure to produce a blast for projecting particles fused by the flame, an air deflector plate to deflect the blast away from the axis of the channel, said nozzle structure being positioned externally of said casing and held in spaced relation therefrom by means for conducting gaseous medium to the nozzle structure, said last-mentioned means having extending there-through and in line with said casing channel a rod passage for passing a succession of rods endwise to the fusing and blast action of said nozzle structure as the rod is fed directly by said feed means or indirectly fed thereby through at least one succeeding rod engaging it at its trailing end face accordingly as the rod whose leading end is in the region of the flame produced at the nozzle structure is in, or has passed out of, feeding engagement by said feed means, said nozzle structure and air channels and said deflector plate in producing said flame and directing said blast exerting a forward feeding force on the rods tending to eject them from the

nozzle, and gripper means adjacent said nozzle structure and operating in proximity to the leading end portion of the rod for yieldingly holding it against ejecting movement and thereby maintaining its trailing end in engagement with a succeeding rod pushing it.

14. Apparatus for fusing and atomizing relatively inflexible oxide rods comprising a casing, rod feeding means in the casing, a nozzle, a tube like barrel to conduct air under pressure to the nozzle to produce a blast, a deflector in the nozzle to deflect the air, said barrel having channels to conduct gases of combustion to said nozzle, said barrel having a channel for the rods, and a rod gripper to restrain the rods which have been advanced out of contact with the feeding means from ejection by the blast, the barrel connecting the casing and the rod gripper which is adjacent the nozzle.

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