METHOD AND APPARATUS FOR METAL COATING METAL PIPES BY ELECTRIC FUSION

Filed July 15, 1943 5 Sheets-Sheet 1

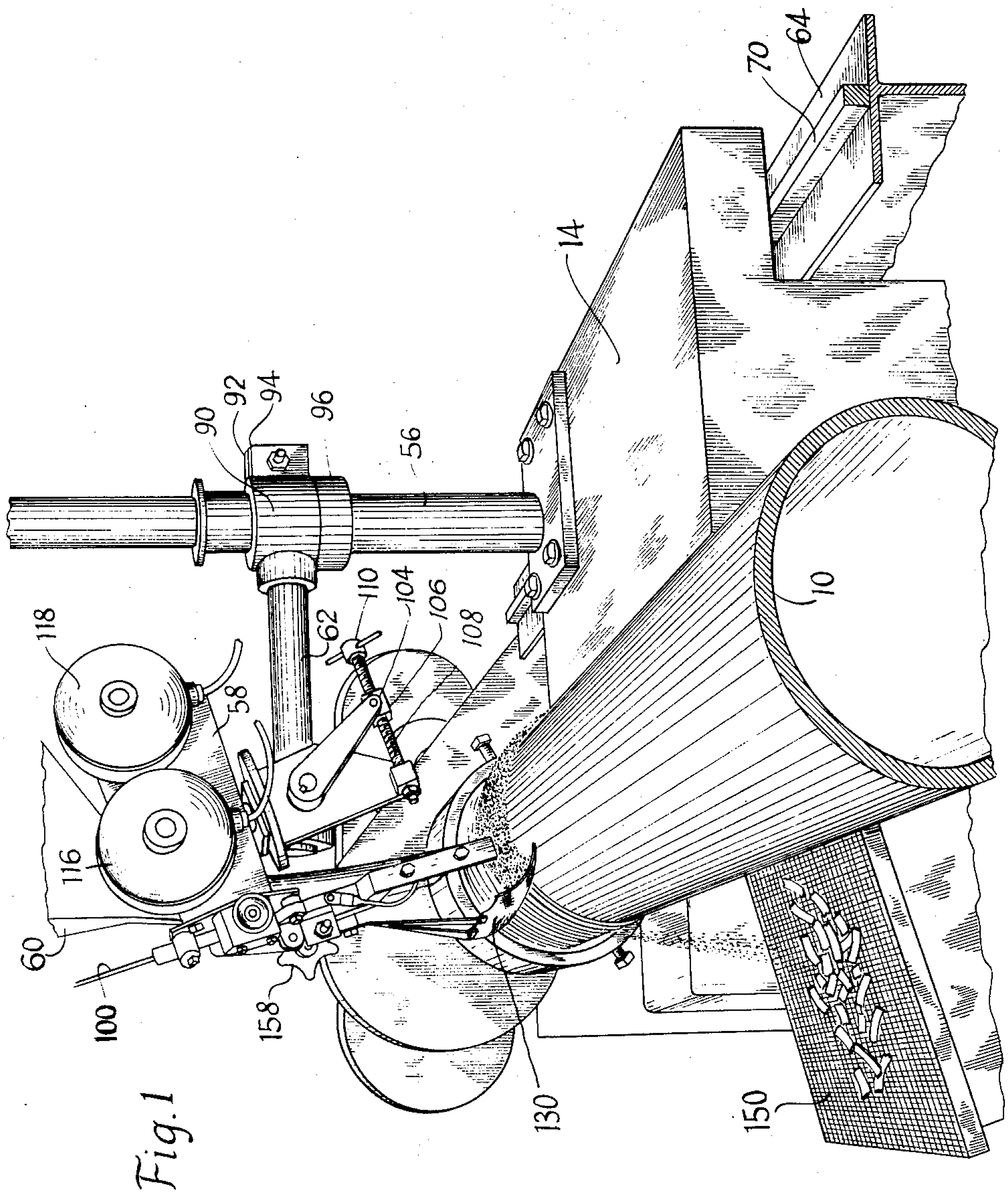

Fig. 1

INVENTORS
Otis R. Carpenter
BY and Howard J. Kerr
[signature] ATTORNEY

Sept. 16, 1947. O. R. CARPENTER ET AL 2,427,350

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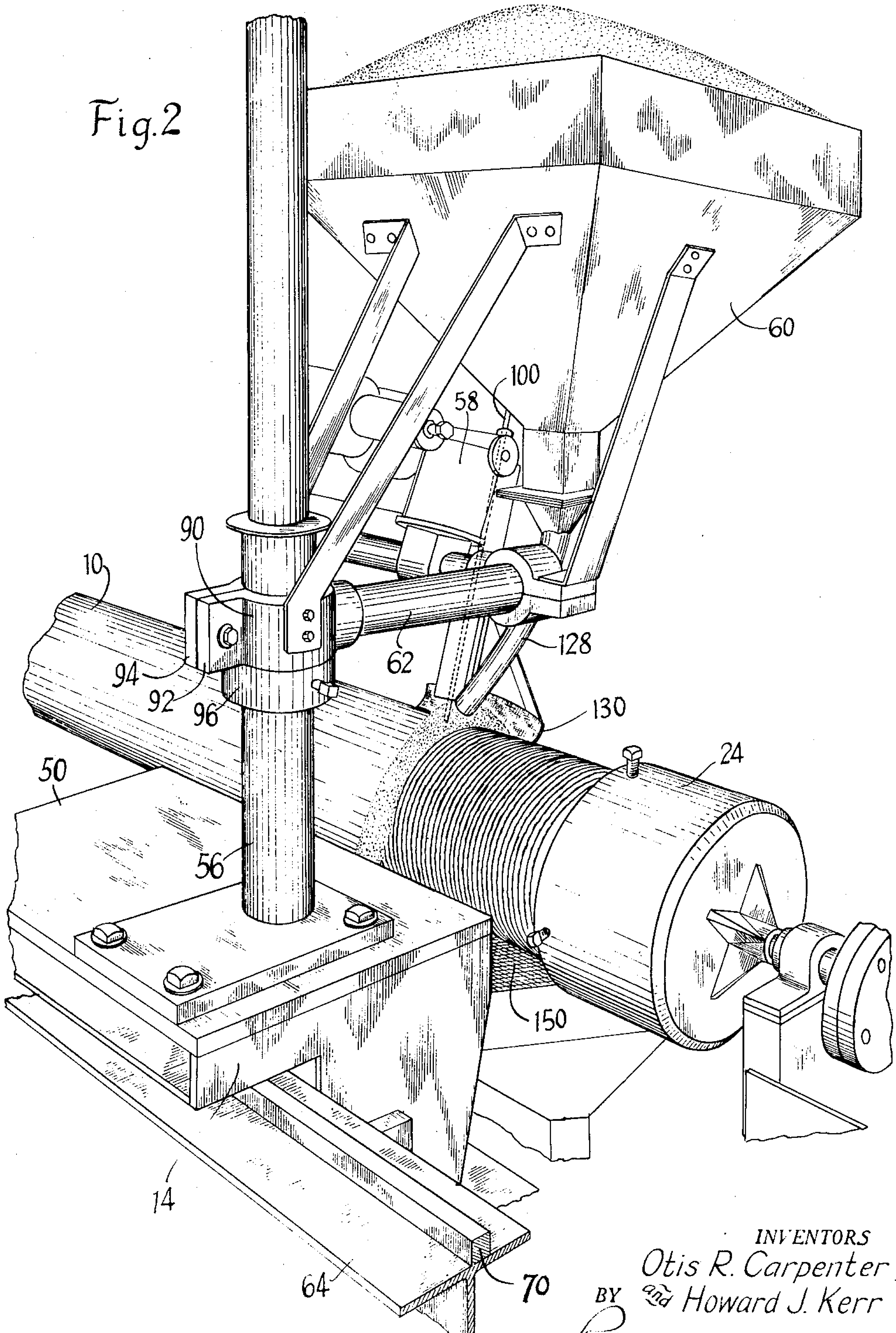
Fig. 2



INVENTORS
Otis R. Carpenter
and Howard J. Kerr
BY
W. Holbrook
ATTORNEY

METHOD AND APPARATUS FOR METAL COATING METAL PIPES BY ELECTRIC FUSION

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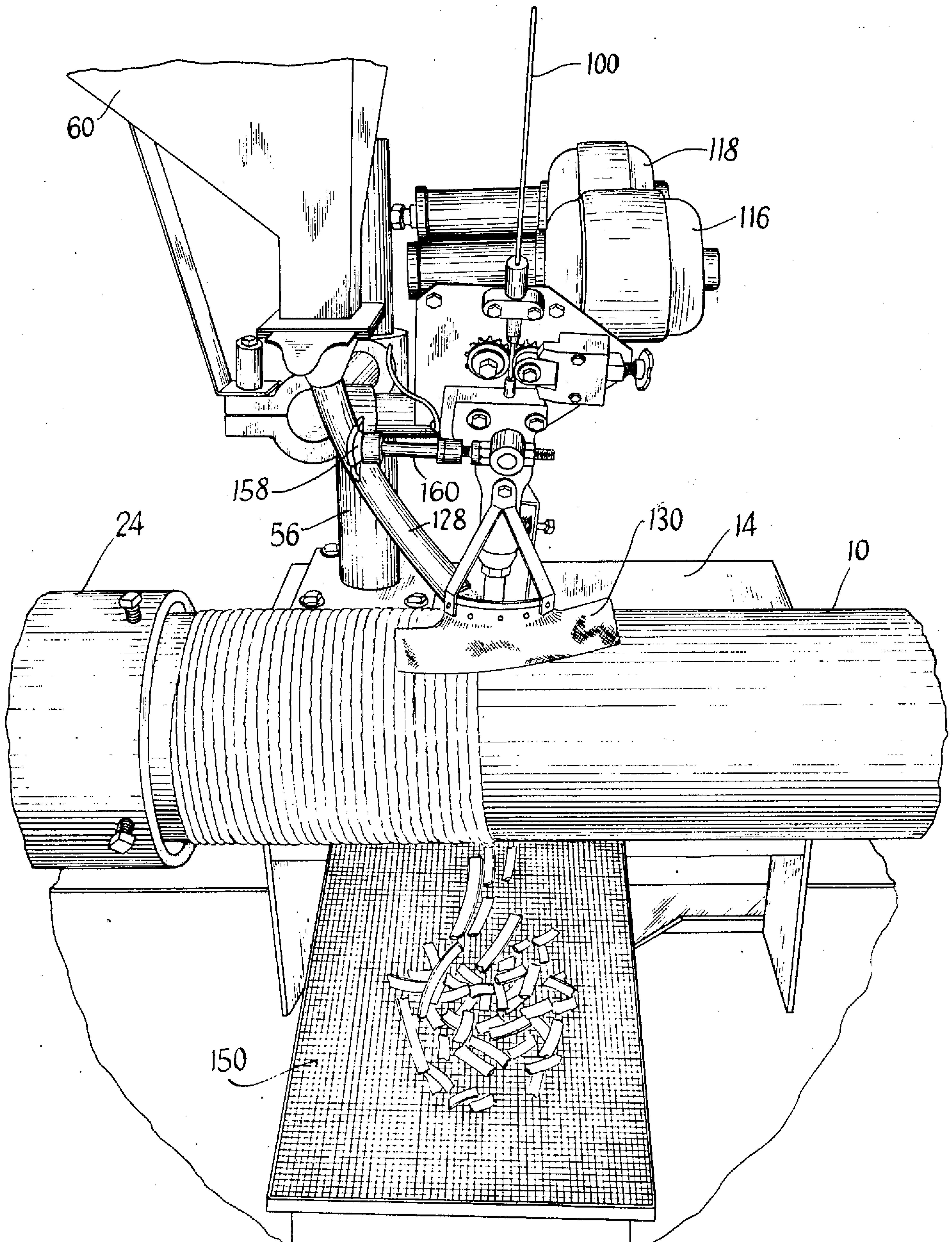
Fig. 3



INVENTORS
Otis R. Carpenter
and Howard J. Kerr
BY
[signature] ATTORNEY

Sept. 16, 1947. O. R. CARPENTER ET AL 2,427,350

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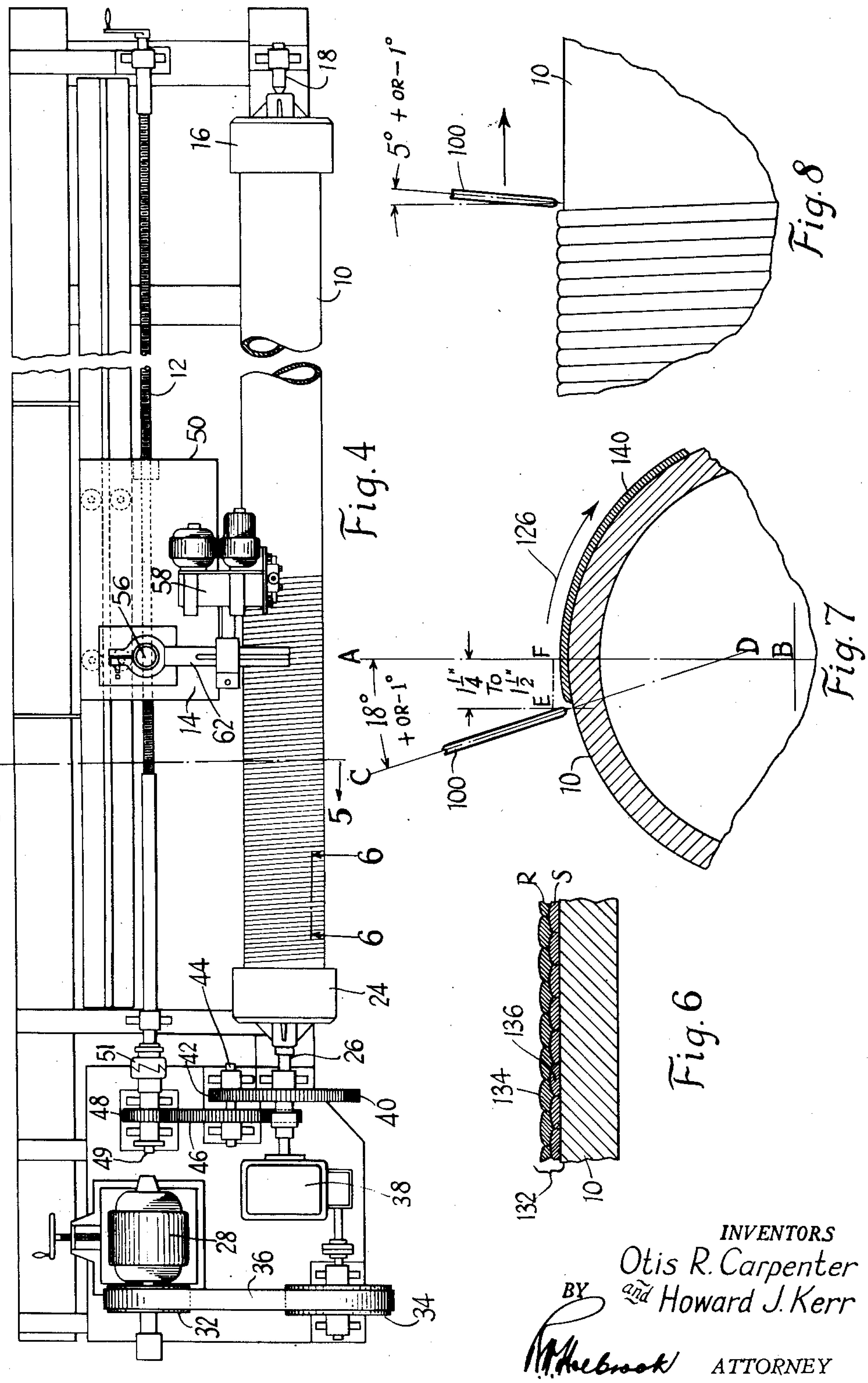

INVENTORS
Otis R. Carpenter
and Howard J. Kerr
BY
[signature]
ATTORNEY

Sept. 16, 1947. O. R. CARPENTER ET AL 2,427,350

METHOD AND APPARATUS FOR METAL COATING METAL PIPES BY ELECTRIC FUSION

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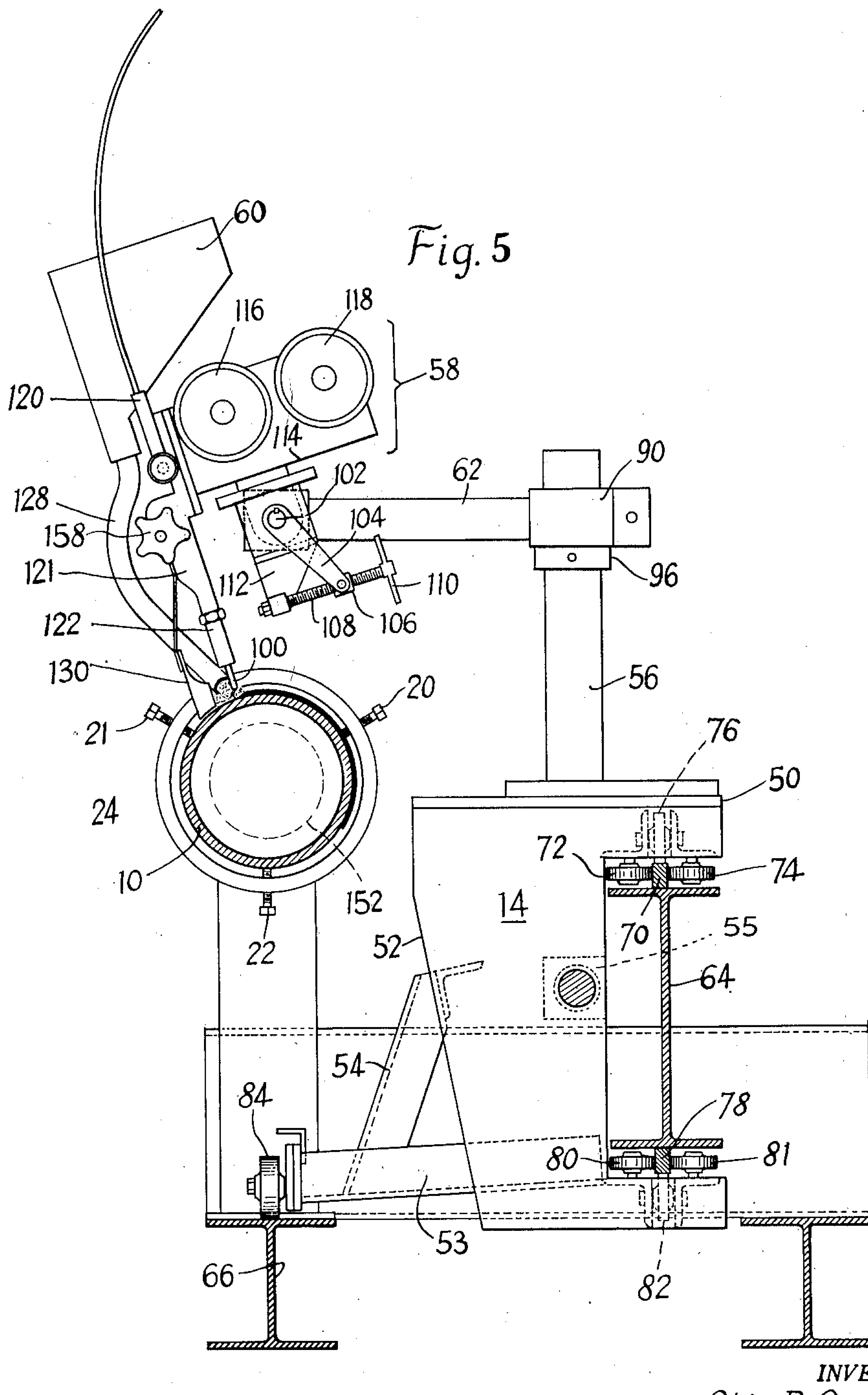
Fig. 5



INVENTORS
Otis R. Carpenter
and Howard J. Kerr
BY
ATTORNEY

UNITED STATES PATENT OFFICE

2,427,350

METHOD AND APPARATUS FOR METAL COATING METAL PIPES BY ELECTRIC FUSION

Otis R. Carpenter, Barberton, Ohio, and Howard J. Kerr, Westfield, N. J., assignors to The Babcock & Wilcox Company, Rockleigh, N. J., a corporation of New Jersey

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4 Claims. (Cl. 117—93)

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This invention relates to metal cladding improvements particularly adapted for the manufacture of retorts to be used in the ferro-silicon (Pidgeon) process of producing magnesium. This process involves the heat treatment of a natural magnesium compound in retorts which are subjected externally to furnace temperatures of the order of 2100° F. and 2300° F. The retorts are closed and are subject to a vacuum, chemical reactions taking place under these conditions. The magnesium is subsequently vaporized and thereafter collected on a fluid cooled surface within the retort. Because of the oxidizing and corrosive conditions of furnace gases at temperatures in excess of 2100° F., it has been suggested that the retorts be of cast metal, the metal being alloy of high oxidation and corrosion resistance, such as steel containing high percentages of chrome and nickel. However, this suggestion did not result in extensive commercial use because of the fact that such high chrome and high nickel alloys were highly critical materials and were not available in sufficient quantity to produce a large number of retorts required by the capacity of the magnesium industry then predicted. The present invention overcame this difficulty by improvements whereby the retort shell of carbon steel is coated with the critical alloy by a fusion welding process. In the development of the invention, known arc welding methods were tried, but it was found that the retorts produced thereby were of such poor quality and of such short life in the actual magnesium producing process that their use therein was prohibitive. Upon examination of these retorts, the cladding was found to contain a high percentage of impurities believed to be silica and chrome oxide inclusions. The deposited metal was also subject to considerable stress and intergranular cracks to such an extent as to materially shorten the life of the retort. It was also found that the chromium and nickel percentages in the cladding were considerably lower than was considered adequate to present the necessary oxidation resistance.

The present invention overcomes the above indicated difficulties by presenting a method and apparatus for applying the cladding metal in such a way that highly successful retorts of long life are produced. The present invention involves a method of cladding in which electric fusion is employed, and the fusion zone submerged with such a welding mixture that the alloy cladding may be properly bonded to the base metal and the requisite characteristics of the clad metal for

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high oxidation resistance and high corrosion resistance may be obtained. The present invention involves a mode of operation in which there is minimum penetration of the base metal due to the relation of the fusible weldrod thereto, and the simultaneous action of the welding mixture to counteract the dilution of the cladding and add oxidation resistant characteristics thereto.

The present invention has been successfully used in the quantity production of magnesium retorts, having a carbon steel base, clad with a high chromium, high nickel steel alloy coating of a thickness of the order of one half inch, the thickness of the base metal being of the order of one inch. The coating has been of substantially uniform thickness and the metal thereof has been notably free from inclusions which would produce excessive porosity. The surface of the clad coating of the retorts produced by this invention has also been substantially free from cracks, and the desired high percentage of chromium (27%–24%) and nickel (22%–19%) has been maintained. In part, this latter result has been obtained by the controlling of the penetration of the alloy coating into the base metal to minimize the migration of carbon from the carbon steel base into cladding alloy, it being appreciated that any excessive migration of this kind would result in carbide segregation in the grain boundaries of the cladding. The invention also involves the use of a welding compound which not only submerges the fusion zone, but has such characteristics that it is self-cleaning from the surface of the clad metal. This has helped materially to maintain high production rates.

The invention will be described with reference to the accompanying drawings which indicate apparatus employed in carrying out the illustrative method.

In the drawings:

Fig. 1 is a perspective view illustrating the welding apparatus in operation;

Fig. 2 is a rear perspective view of the Fig. 1 apparatus;

Fig. 3 is a front perspective view of the Fig. 1 apparatus;

Fig. 4 is a plan;

Fig. 5 is a vertical section through the Fig. 1 apparatus taken on the section line 5—5 of Fig. 4 and showing the welding head in elevation;

Fig. 6 is a fragmentary section through a part of the wall of the multiple metal retort taken longitudinally thereof at such a position as that indicated by the line 6—6 of Fig. 4;

Fig. 7 is a fragmentary view in the nature of a transverse vertical section taken transversely of the retort in the zone of the weldrod; and

Fig. 8 is a fragmentary view showing the relation of the weldrod to a previously deposited head of weld metal.

In Fig. 4 of the drawing, the tubular retort member 10 (preferably of low carbon steel) is rotatably mounted upon a machine provided with a lead screw 12 which moves the welding head 58 toward one end of the retort member as the alloy coating is deposited. The retort member is fixed in a centering member 16 rotatably supported by the tail-stock structure 18 of the machine. This member is in the nature of a cap provided with three or more centering set screws such as those indicated at 20—22 in Fig. 5.

The opposite end of the retort member 10 is centered and supported in a cap-like structure 24 similar to 16. This structure is provided with centering set screws similar to 20—22. It acts as a head-stock, and is non-rotatively connected to the driving shaft 26.

The retort member 10 is rotated at the desired R. P. M. by power transmitted from the motor 28. The power transmitting connections between the head-stock shaft 26 and the motor include the pulleys 32 and 34, the belt 36, and the speed reducer 38.

The translatory motion of the welding head is co-ordinated with the rate of rotation of the retort member 10 by power transmitting connections between the lead screw and the head-stock shaft 26. These connections include a driving gear 40 non-rotatably fixed with reference to the shaft 26 and meshing with a pinion 42 fixed on the counter-shaft 44. Fixed to this counter-shaft is a gear 46 of larger diameter, meshing with a smaller gear 48. The latter is fixed to a second counter-shaft 49 which transmits power to the lead screw 12 through a clutch or coupling 51, which permits the rotation of 12 without the rotation of the gear drive by a crank handle at the opposite end of 12.

The welding head carriage 14, as indicated in Figs. 2 and 5, includes a base plate 50, and rigidly connected structural members such as 52—54, the post 56, side plates, spacers, angles, and roller supports. This carriage supports the welding head 58 and the flux hopper 60, through the laterally extending arm 62 which is vertically and rotatively adjustable with respect to the column 56. The carriage structure is supported by the longitudinal frame members 64 and 66, the former of which acts as a guide to maintain the path of movement of the welding directly parallel to the axis of the retort member 10. To effect this guiding and supporting action, the beam or frame member 64 has an upper guide strip 70 secured thereto in the position indicated in Fig. 5. This guide strip extends longitudinally of the beam 64 and is contacted on its sides by rollers such as 72 and 74, rotatively mounted on the carriage. The top of the strip 70 is contacted by a load carrying roller 76 rotatively mounted on the carriage.

Secured to the bottom flange of the beam 64 is a longitudinal guide strip 78, the surfaces of which are contacted by rollers 80—82 rotatively mounted on the carriage in an arrangement somewhat similar to the arrangement of the previously described rollers. It will be appreciated that, with this arrangement, the welding head will be guided accurately in a path parallel to the longitudinal axis of the retort member.

To further insure accurate movements of the welding head parallel to the retort axis, and to prevent the overhang of the welding head from interfering therewith, the structural frame member 53 of the welding head carriage extends laterally in the same direction as the welding head overhang and rotatively supports a roller 84 riding along the upper surface of the beam 66 as indicated in Fig. 5. The member 53 is directly fixed to the remainder of the carriage structure and is further made rigid therewith by the brace 54.

To translate the rotary motion lead screw 12 into longitudinal movement of the welding head carriage 14, the latter is supplied with an internally screw threaded member 55. This member is non-rotatively mounted on the carriage and is threaded upon the lead screw.

The welding head support arm 62 extending from the column 56 may have a split clamping collar 90 formed with substantially parallel radial extensions 92 and 94. This collar may be tightly clamped in the desired angular position upon the column 56 by pressing these extensions toward each other. However, to insure the maintenance of the welding head at a desired elevation, the collar 90 rests upon the subjacent collar 96 which may be adjustably fixed to the post 56 by set screws.

In order that the welding head, and therefore the weldrod 100, may be accurately angulated or otherwise desirably positioned with reference to the welding or cladding zone, the welding head is pivotally supported upon a rod or trunnion 102 fixed to the outer end of the arm 62. As indicated in Fig. 5, this trunnion has keyed thereto a radial arm 104 pivotally supporting an internally screw-threaded adjustment collar 106 at its lower end. Threaded through this collar is an adjustment screw 108 having a hand wheel 110 fixed thereto. The opposite end of the shaft 108 is rotatively mounted in a downward extension 112 of the welding head base 114, the arrangement being such that the operation of the hand wheel 110 produces relative motion between the extension 112 and the fixed arm 104. Thus, when the screw 108 is turned by the hand wheel 110, the fusing end of the weldrod 100 and the entire welding head are moved in arcs, the center of which is the center of the trunnion 102. One important purpose and effect of such adjustment on the welding method will be referred to in the following description.

The welding head includes two motors 116 and 118, one of which is a constant speed motor. The other is a variable speed motor with its speed controlled by mechanism not shown, responsive to changes in one or more characteristics of the electric current between the weldrod 100 and the retort member 10 to maintain substantially constant fusion conditions. These motors are connected to appropriate mechanisms to controllably advance the weldrod 100 through the guides 120—122 to the fusion zone.

In Fig. 7 of the drawings, a partial transverse section of the retort member 10 is indicated, and the direction of rotation of the member 10 is indicated by the arrow 126. The weldrod 100 and the member 10 are connected to a power source in such a way that electric fusion of the weldrod metal takes place in the gap between the work, or the member 10, and the adjacent end of the weldrod. This fusion takes place normally under a body of granular flux completely submerging the fusion zone so that no arc can be seen. The flux flows from the hopper 60 to the fusion zone through a hopper outlet tube 128, and a submerging accumulation of flux is maintained around the fusion zone. This is facilitated by the flux retainer 130 which may be secured to the weldrod guide 121.

As also indicated in Fig. 7, the fusing end of the weldrod 100 is positioned at an angle of 18° (plus or minus 1°) from a vertical plane through the longitudinal axis of the retort member, the plane being indicated by the line A—B and the direction of the weldrod by the line C—D. The latter is preferably not radially disposed with reference to the retort. With a retort member 10, of about 12'' diameter, the line E—F indicating the spacing of the fusing end of the weldrod from the vertical A—B is preferably from 1¼'' to 1½'' long, the angulation of the weldrod and the spacing of its fusing end from the vertical A—B being controllable by the operation of the adjusting mechanism including the elements 106, 108, and 110, previously described.

For the production of a durable retort for use in the manufacture of magnesium, the retort coating 132 (Fig. 6) must have high oxidation resistance at temperatures of the order of 2100° F.–2300° F., and for this purpose the present invention provides a steel alloy coating 132 of high chromium and high nickel content. Austenitic alloy steel weldrods known as "25–20" (25% chromium, 20% nickel) are used and the final coating 132 represented in Fig. 6 consists of two layers R and S, consisting of the helical overlapping beads 134 and 136. In so far as the oxidation resistance of the coating is concerned, the chromium content is a critical factor, and considerable difficulty has been experienced in maintaining a sufficiently high percentage in the coating 132. The chief difficulty in this respect has resulted from the dilution of the weld deposited metal by the metal of the base, or retort member 10. Other things being equal, the extent of such dilution depends upon the penetration of the base metal during the welding process, and the angulation of the weldrod (indicated in Fig. 7 of the drawings) has been found to materially affect such penetration, the arrangement of the weldrod shown reducing the dilution of the coating metal to an optimum degree. The penetration of the base materially increases as the weldrod 100 is moved toward the position of the line A—B.

In the present method another factor in maintaining the dilution of the coating at a low value is the use of a granular flux containing from 10 to 15 percent of ferro-chrome, the fused metal in the fusion zone at the end of the electrode receiving additional chromium from this source during the welding process. The preferred flux also contains powdered aluminum which during the welding process promotes the absorption of chromium by the weld metal and its distribution therein, by its de-oxidizing action. One and one half to two percent of this material has been found satisfactory for the purposes of the present method. The remainder of the preferred flux consists of a mixture of the following materials in the indicated approximate percentages;

Composition "A":	Per cent
Calcium fluoride	23.1
Calcium silicate	20.2
Asbestos	29.9
Aluminum oxide	16.0
Manganese oxide	7.9
Iron oxide	1.6

All of the flux ingredients are ground mixed with sodium silicate and the mixture is then baked at 400° F., and then finely reground. The entire flux mixture is such that undesirable evolutions of gases do not occur under welding conditions.

With reference to the ferro-chrome constituent of the flux, it has been found that proportions of ferro-chrome in excess of 15% do not materially increase the chromium absorption, the optimum absorption in the present method being effected at about the 10%–15% range of ferro-chrome constituency.

During the welding process, a substantial part of the flux is fused, and this fusion, with the fusion of the weld metal causes additional chromium absorption by the deposited metal by reason of the deoxidizing action of the aluminum powder. The aluminum in the flux also has the further beneficial effect of causing the weld metal to freeze with a very smooth surface. An additional effect of the aluminum is to cause part of the fused flux to solidify in such a manner that when it becomes cooled below 1000° F., it is readily detached from the deposited weld metal which it covers and will automatically drop from the weld metal upon rotation of the tubular member.

The aluminum is distributed throughout the illustrative flux, and it is believed that this distribution, in combination with the inter-action of the aluminum and ferro-chromium with the other materials of the previously referred to composition "A," results in a better absorption and distribution of the chrome from the ferro-chrome into the weld metal.

During the operation of the illustrative method, such beneficial and highly desirable results are produced with respect to the characteristics of the clad surface and with respect to the self-cleaning action of the flux, that these results are believed to be at least in part due to the presence of residual aluminum in the flux after the oxidation of some of the aluminum has occurred. In this connection, it is to be noted that the fusion temperature of the aluminum is much less than one half of the mean fusion temperatures of the remaining constituents of the welding compound.

During the development of the invention, tests were made with welding compounds containing no aluminum, and attempts were also made to find successful substitutes for aluminum in the welding compound, but these tests merely served to prove that the illustrative aluminum containing welding compound was notably superior to the other compounds. The illustrative aluminum containing compound, when used in the method of the invention produced the following results in comparison to methods involving welding compounds free from aluminum:

1. The desired high chromium constituency (24%–27%) and high nickel constituency (20%–22%) were readily attained.

2. The overlapping and contacting helical beads of the cladding were flatter and smoother, to the end that smooth surface claddings of substantially uniform thickness were produced.

3. The fused and subsequently frozen flux over the surface of the cladding was self-cleaning. When cooled below 1000° F., it automatically removed itself from the clad metal.

4. Gaseous action in the molten pool of fused weld metal was substantially eliminated.

5. Cracks in the surface of the cladding were substantially eliminated.

6. These tests also indicated that a close spacing of the successive helical beads resulted in a

marked increase in the chromium content of the cladding. They also showed conclusively that preheating of the base metal was particularly effective in reducing the cracking in the deposited metal.

Tests proved that the cracking of the weld metal could also be materially reduced and substantially limited by decreasing the carbon content of the deposit. With this knowledge, the invention was put into commercial practice with the deposition of abutting beads and a flux consisting of—

	Per cent
High carbon ferro-chrome	12.5
Aluminum powder	1½
Composition A	86.0

This flux was dry mixed, and then bonded with sodium silicate (approximately 300 grams per hundred pounds of flux) to form a wet mixture, baked at 400° F., and then mulled to pass a 16 mesh screen.

Various tests with different current values of different welding speeds indicated clearly that low current values and low welding speeds were essential requirements of the process. Welding speeds as low as 20 inches per minute and welding currents of 350–380 amperes and 28–30 volts were found to give superior results.

Under optimum conditions, the frozen slag or flux will be automatically freed from the coating metal bead **140** (see Fig. 7), by gravity as the rotation of the retort member **10** continues. The attainment of smooth surfaced wide weld beads (to form the coating shown in Fig. 6) and the self-cleaning of the previously fused slag (frozen over the weld metal) are attributed (at least in part) to the effect of the aluminum in the flux. It may be that, by reason of the aluminum, the frozen flux has a contraction rate differing sufficiently from that of the weld metal to promote this self-cleaning action, but at any rate, the attainment of the smooth surface of the solidified flux (previously fused) certainly promotes such self-cleaning.

Immediately beyond the fusion zone at the end of the weldrod **100**, and to the right thereof, as the arrangement of work and weldrod is indicated in Figs. 5 and 7 of the drawings, it may be considered that there are three different zones from the base metal radially outwardly. In the inner zone, there is the bead of deposited metal **140** with its high chromium, high nickel content. Next outwardly of this zone, there is an intermediate zone in which the flux is fused, or has been fused. As the deposited bead recedes from the weldrod this fused flux progressively freezes or solidifies. In the outer zone there is the excess of granular flux which has not been fused. This excess drops off the work member as it rotates. The granular flux then passes through a screen **150** which is clearly shown in Figs. 1 and 3. As the work rotates further, pieces of the fused and subsequently frozen flux fall from the work and are caught upon the screen **150** as clearly indicated in the drawings. The excess granular flux falling through the screen **150** into the hopper is returned to the supply in the hopper **60**, but the frozen, or solidified, flux is not returned. It is not used again in the process.

In the present method, there are several other factors which promote a high percentage (24%–27%) of chromium in the weld deposited coating. One of these is the speed of welding, it having been found that a relatively low speed such as

twenty inches per minute will give a chromium value higher than that produced at higher speeds of welding. The second factor is that relatively low current values (350 to 380 amp.) definitely results in increased chromium values. The deposition of the beads in abutting relation with previously deposited beads also increases the chromium content of the coating.

Another important factor in the production of the illustrative magnesium retort, relates to the relative uniformity of thickness of the coating. To attain this desired result, the coating beads must be relatively wide and without a high crown. These factors also promote the manufacture of a retort of long operative life with the use of a minimum amount of the alloy steel. This result is of considerable importance owing to the fact that such material is highly critical, and relatively scarce under war conditions.

Another characteristic of the present method is that surface cracks in the deposited coating are eliminated. Several factors contribute to this. One is that the carbon content of the deposited metal is held to a very low value. Another factor is the manner of deposition of the weld metal whereby weld metal is deposited against a previously deposited bead before the latter is cooled to a value approaching room temperature. Also, the work, or retort member **10**, is preheated before the coating begins. Another factor of the illustrative method which eliminates the formation of surface cracks is the maintaining of the retort member **10** within a temperature range of 400° F.–600° F. during the coating operation. To effect this, water at room temperature may be sprayed into the retort member. To maintain some water within the member **10**, its lead end may be closed and the opposite end partially closed by a ring **152** which is fitted against the inner surface of the tubular member. The thickness of this ring is indicated by the dotted circle **152** in Fig. 5. When the temperature of the metal rises, more water is allowed to pass within the member **10**, the quantity of water within the member **10** at all times being limited by the thickness of the ring **152**.

Referring to Fig. 8 of the drawings, the overlapping of the beads of deposited metal is promoted by inclining the weldrod at about 5° (plus or minus 1°) to the normal to the longitudinal axis of the retort member **10**. As indicated, the weldrod is directed toward a previously deposited bead.

This angular adjustment of the weldrod may be effected or varied by the operation of the hand wheel **158** upon the adjusting shaft **160**. The turning of this hand wheel and its shaft moves the weldrod guides **121** and **122** as a unit, about a pivot extending forwardly of the welding head base **114**.

For convenience in claiming the invention, "clockwise" has been used to designate the normal direction of rotation of the cylinder, or retort member **10**, and "counterclockwise" the direction opposite to the normal direction of rotation.

Although the invention has been described with reference to the details of a specific method, and with reference to the details of apparatus for carrying out that method, it is to be appreciated that the invention is not to be considered as limited to all of the details thereof. It is rather to be taken as of a scope commensurate with the scope of the subjoined claims.

What is claimed is:

1. In a method of electric fusion welding upon a cylindrical steel base of relatively high carbon content, the steps comprising effecting rotational movement of the base about a horizontal axis at a peripheral speed of about 20 inches per minute beneath a source of solid coating metal of stainless steel characteristics advancing linearly, fusing the coating material at a position near the termination of a top vertical radius of the base but offset therefrom opposite to the direction of rotation to about 12½% of the diameter of the base, cooling the base during the welding process to maintain the temperature thereof except at the weld point between 400° and 600° F., effecting relative movement axially of the base between it and the metal source simultaneously with said rotation to cause the deposition of successive contacting helical beads of weld metal at a rate to form thick beads, continually supplying near and submerging the weld zone and the adjacent bead of weld material under a relatively deep blanket of granular flux containing aluminum to about 1¾%, carrying said flux along from the position of initial fusing past the vertical and to the downstream side of the base by said rotation, separating the cooled fused flux by gravity near the bottom of the base, maintaining the welding current at about 400 amperes, and advancing the coating metal along a line tilted backwardly from a radius through the fusion zone.

2. The method as defined in claim 1 in which the line of advance of the source of coating metal is also directed toward the adjacent bead at an angle of substantially 5° to the normal to the base surface at the junction therewith.

3. In apparatus for interfusing an alloy steel coating with the external face of a steel cylinder of small diameter, means effecting clockwise rotation of the cylinder while the latter is held fixed against endwise movement, a consumable alloy weldrod disposed at a position offset counter-clockwise from the vertical including a radius of the cylinder and acting as a source of weld metal for said coating, means constantly submerging the fusing end of the weldrod and the adjacent bead of freshly deposited weld metal in a granular flux containing an appreciable amount of aluminum and an alloy augmenting material, and means effecting movement of the weldrod in a direction axially of the cylinder, said last named means being operative simultaneously with the means for effecting said relative rotation.

4. In apparatus for interfusing an alloy steel coating with the external face of a steel cylinder of small diameter, means effecting clockwise rotation of the cylinder while the latter is held fixed against endwise movement, a consumable alloy weldrod disposed at a position offset counter-clockwise from the vertical including a radius of the cylinder and acting as a source of weld metal for said coating, means constantly submerging the fusing end of the weldrod and the adjacent bead of freshly deposited weld metal in a granular flux containing an appreciable amount of aluminum and an alloy augmenting material, means cooling the cylinder to a temperature within the 400° F.–600° F. range to permit a high rate of metal deposition, and means effecting movement of the weldrod in a direction axially of the cylinder, said last named means being operative simultaneously with the means for effecting said relative rotation.

OTIS R. CARPENTER.
HOWARD J. KERR.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,151,914	Hopkins	Mar. 28, 1939
2,191,469	Hopkins	Feb. 27, 1940
1,709,729	Landgraf et al.	Apr. 16, 1929
2,065,157	Stine	Dec. 22, 1936
1,905,081	Woods	Apr. 25, 1933
1,956,327	Jerabek	Apr. 24, 1934
1,953,382	Wortmann	Apr. 3, 1934
2,043,960	Jones et al.	June 9, 1936
2,200,737	Clapp	May 14, 1940
2,282,175	Emerson	May 5, 1942
1,924,876	Morgan	Aug. 29, 1933
2,295,702	Wissler	Sept. 15, 1942
1,485,120	Lincoln	Feb. 26, 1924
1,886,503	Shockey	Nov. 8, 1932
1,898,060	Noble	Feb. 21, 1933
2,153,785	Williams	Apr. 11, 1939
2,299,747	Harter	Oct. 27, 1942